

Environmental Licensing Programme  
Office of Environmental Sustainability

4<sup>th</sup> January 2023

Regulation 10(2)(b)(ii) of the EPA (Industrial Emissions) (Licensing) Regulations 2013, in respect of a licence review from Knockharley Landfill Limited for an installation located at Knockharley Landfill, Knockharley, Navan, (Includes Townlands of Tuite Rath & Flemingstown), Meath, C15 FX09 (Reg. No: W0146-04)

Dear Sir/Madam,

I refer to the Agency's request dated 20<sup>th</sup> December for information in accordance with the above referenced regulations. The Agency's individual requests are set out in italics followed by Knockharley Landfill Ltd responses.

1. *The Agency acknowledges the drawings for the "Existing Site Drains" and "Proposed Land Drains After Construction" submitted on 30 August 2022. However, the drawings are unclear, and both exclude the southern boundary and existing surface water lagoon. Accordingly, please resubmit the drawings ensuring the following are clearly provided [Regulation 9(2)(i)]:*

a. *The overall site showing the red line boundary and the relevant streams outside the site to which the land drains enter.*

b. *The existing and proposed drains within the site and where they either enter the surface water lagoon or cross the red line boundary and enter the relevant streams outside the site.*

c. *Information relating to power lines, gas mains etc. should be removed from the drawings to ensure they are clear.*

The drawings submitted on 30<sup>th</sup> August 2022 relate to drainage works in the north of the site only and therefore did not show the southern section of the site. As described in Section 12.4.2 of Chapter 12 of the Environmental Impact Assessment Report (EIAR) submitted with the review application on the 22<sup>nd</sup> October 2019, the surface water management infrastructure in the southern part of the site has the capacity to accommodate the run-off from the proposed development and does not require any alteration. Additional surface water management measures will be provided in the north of the site and this will require diversion of the existing drains, as shown on the Drawings submitted on 30<sup>th</sup> August 2022.

For clarity it is not the intention of the application to seek to amend the existing redline boundary. Chapter 12 of the EIAR provides comprehensive details of the hydrology at and in the vicinity of the site. Figures 12.2 and 12.6 in the Chapter show the existing red line boundary, the streams outside the site boundary and the proposed drainage layout. The Figures are in Attachment A, they do not show power line, gas mains etc and are clearly legible.

2. *The Agency notes your correspondence dated 26 October 2022 in relation to the request for a copy of planning permission NA70015 and any associated files. However, as planning permission NA70015 directly relates to the principal industrial emissions activity, you are reminded to provide the information required as soon as possible [Regulation 9(2)(e)].*

A copy of planning permission NA70015 granted in 2007 for the gas utilisation compound is in Attachment B. For clarity the gas utilisation plant is permitted under the permission granted by An Bord Pleanála (Reference ABP-303211-18).

3. *Taking account of the information provided in correspondence on 26 October and the air dispersion model, clarify or provide information relating to the emission points for the gas utilisation engines and gas flares as follows [Regulation 9(2)(i)]:*

a. *Clarify that the table below now reflects the details of the air emission points correctly. In the event of any errors, reproduce the table with amended details and add additional rows where required. Note: any omitted emission point would not be permitted to operate.*

b. *Provide the co-ordinates for A2-1 and A2-2 as the co-ordinates for the other referenced points have been amended in the correspondence.*

c. *Provide typical day's usage/yr for A2-1 and A2-2.*

The existing gas utilisation engines and flares have the capacity to effectively manage landfill gas emissions and licence review does not seek approval for additional engines/flares. The number of the existing engines and flares on-site is described in Section 7.4.2.2 of the EIAR and include:

- 4 No. Landfill Engines
- Flare 1 with a capacity of 1,500m<sup>3</sup>/hr
- Flare 2 with a capacity of 1500m<sup>3</sup>/hr
- Flare 3 with a capacity of 2,500m<sup>3</sup>/hr
- Flare 4, with a capacity of 500m<sup>3</sup>/hr

Flare 1, as described in the EIAR is not listed in the Table and the Table has been amended to include Flare 1, referred to as A2-7 in accordance with the Agency’s nomenclature. Flare A2-7 is a back—up to the Flare A2-6 used for burning gas unsuitable for the engines. For clarity Flare 3, as referenced in the EIAR, is the one used during engine shutdown/maintenance (A2-5) and it has an operational capacity of 1,500m<sup>3</sup>/hr.

The Table has also been amended to include the correct coordinates and the typical day’s usage/year. The amended Table now correctly reflects the details of the existing air emission points.

| <b>Emission Point Code</b> | <b>Site Ref.</b>    | <b>Easting</b> | <b>Northing</b> | <b>Typical Days Usage/ Yr</b> | <b>Source of waste gases</b>                         | <b>Capacity (m<sup>3</sup>/hr)</b> | <b>Thermal Input Capacity (MW)</b> |
|----------------------------|---------------------|----------------|-----------------|-------------------------------|--|------------------------------------|------------------------------------|
| A2-1 (main)                | KH01                | 297569         | 266888          | 5                             | Back-up gas engine                                   | 800                                | 1.4                                |
| A2-2 (main)                | KH02                | 297576         | 266889          | 5                             | Back-up gas engine                                   | 800                                | 1.4                                |
| A2-3 (S3) (main)           | KH03                | 297582         | 266891          | 365                           | Lead gas engine                                      | 675                                | 1.06                               |
| A2-4 (S4) (main)           | KH04                | 297595         | 266892          | 365                           | Lead gas engine                                      | 675                                | 1.06                               |
| A2-5 (S1) (main)           | F1 (enclosed flare) | 297564         | 266894          | 14                            | Flare – during engine shutdown/ maintenance          | 1,500                              |                                    |
| A2-6 (S2) (main)           | F2 (enclosed flare) | 2975558        | 266915          | 365                           | Flare – for burning gas unsuitable for engines       | 1,500                              |                                    |
| A2-7                       | F3 (open flare)     | 297559         | 266907          | 3 to 5                        | Flare back-up for burning gas unsuitable for engines | 1,500                              |                                    |
| A3-2 (minor)               | F4 (open flare)     | N/A            | N/A             | <7                            | Flare – mobile unit in event of repair               | 500                                |                                    |

4. In relation to the Olfasense air dispersion model, clarify or provide the following information [Regulation 9(2)(k): ]

a. Provide a copy of the Air Scientific Air Emissions Monitoring Reports referenced on pg. 7 of the report.

The Air Scientific Reports are in Attachment C.

- b. *Confirm the flow rates are correct for Flare 2 in Table 4 and for Flare 1 and 2 in Table 6 of the report.*

Olfasense confirms that the flow rates for Flare 2 in Table 4 and for Flare 1 and 2 in Table 6 of the report are correct (each exhaust flow rate is based on the capacity of each flare 1500 m<sup>3</sup> of gas burnt per hour).

- c. *In accordance with EPA Air Guidance Document AG4, assess the impact for the maximum volume flow rate (i.e. 3000m<sup>3</sup>/hr as proposed ELV), as the current assessment relates to normal operational conditions only.*

The air quality assessment completed by Olfasense is in accordance with the EPA Air Guidance Document AG4. As detailed in Section 2.2.2 of the Olfasense report the assessment included two scenarios:

- Scenario 1: The normal operating scenario (Engines 3 and 4 and Flare 2 in operation), and
- Scenario 2: Two flares operating in the highly unlikely event of the failure of all 4 (lead and back-up) engines i.e. abnormal conditions that are only likely to occur for a small number of hours per year.

The modelling inputs for Scenario 2 assumed that each flare has a capacity of 1500 m<sup>3</sup> of gas burnt per hour, giving a combined maximum capacity of 3000 m<sup>3</sup>/hr.

In relation to ELVs Knockharley Landfill Ltd is satisfied to accept flow rate ELVs based on the listed capacities of the engines and flares in the table above.

5. *Provide a copy of the information submitted to An Bord Pleanála as required under Condition 4(f) of the planning permission order ABP-303211-18 [Regulation 9(2)(i)].*

Condition 4(f) of the planning permission ABP-303211-18 requires the submission of information to the planning authority, which in this instance is Meath County Council. A copy of the submission made to the Council is in Attachment D.

6. *The EIA assesses the impacts related to recovery and disposal options for IBA, however taking account of the fact that IBA will now only be stored for recovery, with a planning permission for storage not to exceed 5 years (unless otherwise agreed with the planning authority), provide additional information related to the likely significant effects of the removal of all of the IBA material from the installation on the environment [Regulation 9(2)(k)].*

The EIAR submitted with the licence review application on 22<sup>nd</sup> October 2019 does consider the likely significant effects of the removal of all of the IBA material from the installation on

the environment. This is the same EIAR that was submitted to and approved by An Bord Pleanála when that body carried out its environmental impact assessment prior to granting planning permission.

Part 3 of the Development Description in the Board's Order ABP-303211-18 specifically refers to permission being sought for the storage of the IBA until recovery outlets are identified and for trials to prepare the IBA for recovery and removal off-site.

In its Order the Board states *'The Board completed an environmental impact assessment in relation to the proposed development and concluded that, subject to the implementation of the mitigation measures proposed, as set out in the Environmental Impact Assessment Report and, subject to the conditions set out below [ which include limiting the storage of the IBA to five years unless otherwise agreed with the planning authority], the effects of the proposed development on the environment, by itself and in combination with other plans and projects in the vicinity, would be acceptable'*.

Chapter 2 of the EIAR defines the project characteristics and forms the basis for the assessment of impacts in the following Chapters. It is a development objective that the IBA delivered to the site be treated to a point where it can be sent off site for off-site uses.

Section 2.5.6 states that a significant factor in the proposal to develop the IBA cells was to enable the future recovery of the materials for use in off-site applications, for example road construction and concrete manufacture. Section 2.5.6.2 describes how the IBA would be sent off-site for recovery trials and that this may require crushing to loosen the materials.

Section 8.3.1 of the Roads Traffic & Transport Chapter considers the impacts of the transfer of the IBA from the site and this scenario was assessed in the Air Quality and Climate Chapter. Chapter 9 Noise and Vibration assesses the impacts of all traffic movements to and from the site, including vehicles removing the IBA.

Section 12.1 of Chapter 12 Hydrology & Surface Water Quality, which defines the scope of the assessment, states that the development involves the storage of IBA pending trials to confirm suitability for recovery and removal off-site. Section 15.5.3 of Chapter 15 Material Assets describes the impacts of the off-site use of the IBA.

The mitigation measures in Chapter 16 of the EIAR are designed to mitigate the impacts associated with the overall proposed development including the acceptance, storage, processing and removal of the IBA from the site. The operational stage mitigation measures relevant to the removal of the IBA include:

Mitigation No 12. The existing access road from the N2 to the administration area is surface sealed, as are other internal roads where required. The IBA facility haul roads will be surfaced to mitigate dusts.

Mitigation No 15. All HGVs (heavy goods vehicles) leaving the site will be required to pass through the wheel wash

Mitigation No 17. All IBA handled at the facility will be handled at an appropriate moisture content to prevent dust emissions

Mitigation No 18. Waste including IBA will be hauled in covered trucks to avoid windblown dusts

Mitigation No 52. Select equipment conforming to international standards on noise and vibration.

Mitigation No 53. Select equipment with quiet and low vibration emissions and ensure equipment is regularly maintained ensuring it operates in an efficient manner.

Mitigation Measure 55. Locate equipment as far away from noise sensitive receptors as possible within the constraints of the site.

Mitigation No 96. Additional wheel washing facilities will be provided at the exit of the IBA facility. This will supplement the existing wheel wash which will be retained at the entrance to the site. The silt traps will be cleaned on a regular basis.

Mitigation No 118. Surface water run-off from the IBA facility perimeter road will be directed to the IBA weathering and leachate collection system to avoid dust contamination of drainage outfalls.

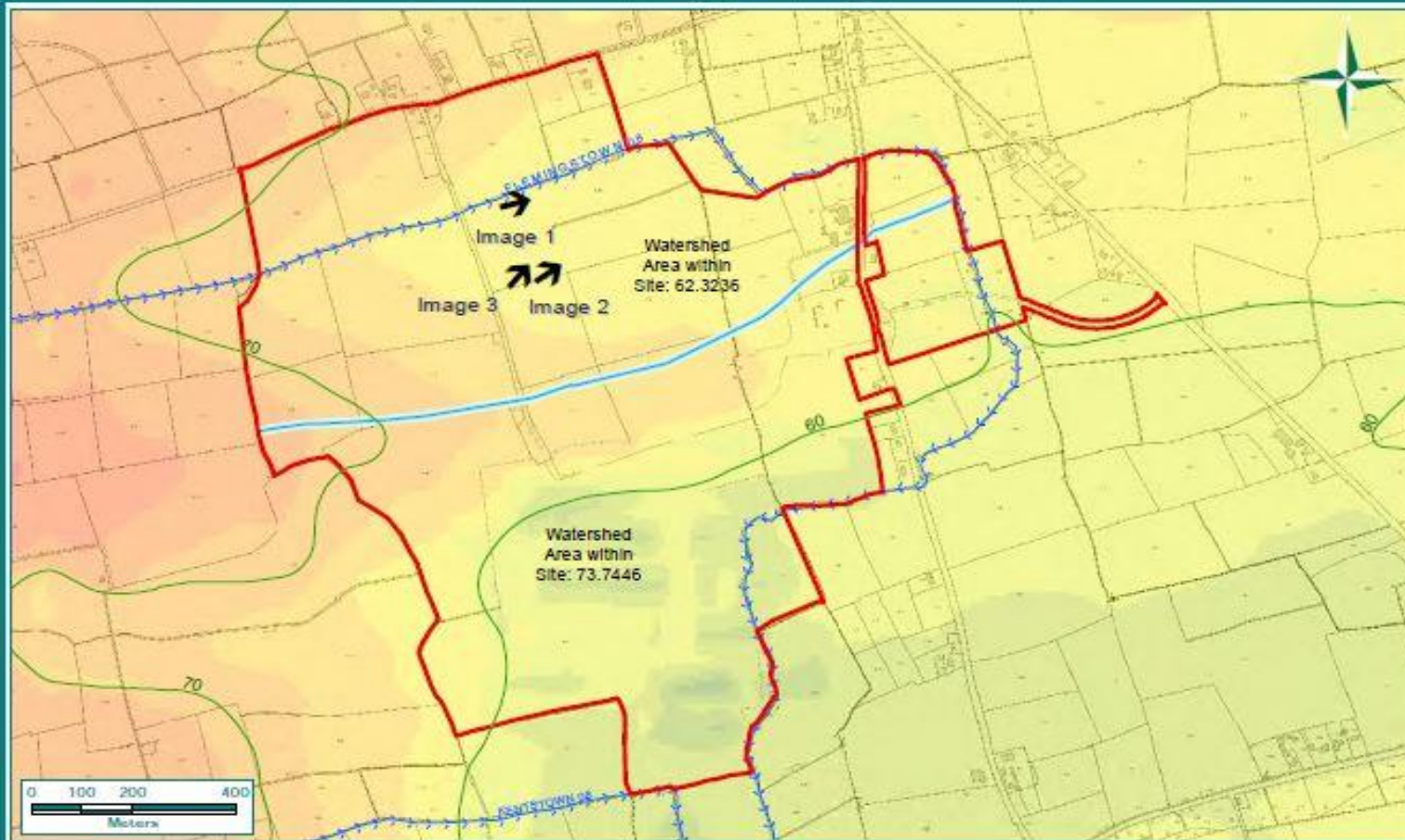
*In addition to the above, please also provide an updated non-technical summary (Application Form, and EIS where applicable) to reflect the information provided in your reply, insofar as that information impinges on the non-technical summary.*

An updated non-technical summary has been submitted.

Yours Sincerely,

  
Jim O'Callaghan

**ATTACHMENT A**



### Legend

- Site Boundary
- Rivers
- 10m Contours
- Indicative Watershed Boundary within Site
- ➔ Field Survey Photograph Locations

Date: 18/05/2018

Client Name: Knockharley Landfill Ltd.

Project Title: Proposed Development at Knockharley Landfill

Figure Title: Hydrological Features Map

Figure No.: 12.2 Rev. A

Scale: 1:12,500 © A4

CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES

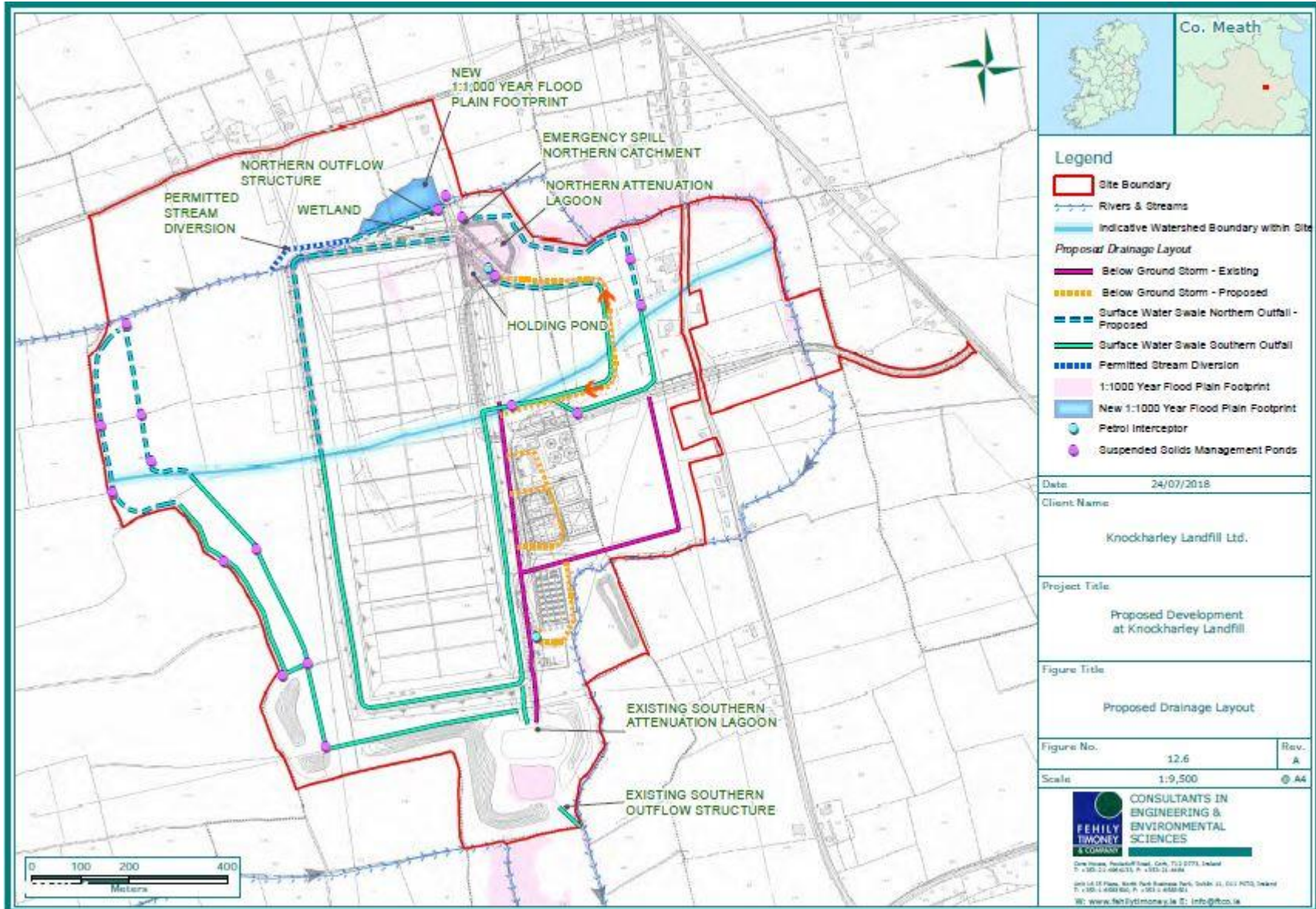
One Plaza, Parkside@East, Cork, T12 8T75, Ireland  
T: +353 21 494 6335 P: +353 21 494 6344

2nd 24 1/2 Floor, North Park Road@East Park, Dublin 11, D04 1N73, Ireland  
T: +353 1 4500 800 P: +353 1 4500 801

Web: www.fehilytimoney.ie E: info@ftco.ie







**Legend**

- Site Boundary
- Rivers & Streams
- Indicative Watershed Boundary within Site

*Proposed Drainage Layout*

- Below Ground Storm - Existing
- Below Ground Storm - Proposed
- Surface Water Swale Northern Outfall - Proposed
- Surface Water Swale Southern Outfall
- Permitted Stream Diversion
- 1:1000 Year Flood Plain Footprint
- New 1:1000 Year Flood Plain Footprint
- Petrol Interceptor
- Suspended Solids Management Ponds

Date: 24/07/2018

Client Name:  
Knockharley Landfill Ltd.

Project Title:  
Proposed Development at Knockharley Landfill

Figure Title:  
Proposed Drainage Layout

|                 |        |
|-----------------|--------|
| Figure No. 12.6 | Rev. A |
|-----------------|--------|

Scale: 1:9,500 © A4

**CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES**

**FEMILY TOWNY & COMPANY**

Cork Office: Parkside Park, Cork, T12 2T71, Ireland  
 P: +353 (0) 21 464 6333, F: +353 (0) 21 464 6344  
 200 St. John's Road, North Park Business Park, Dublin 11, D11 X072, Ireland  
 P: +353 (0) 1 458 8800, F: +353 (0) 1 458 8801  
 W: www.familytowny.ie E: info@ftco.ie

**ATTACHMENT B**

**MEATH COUNTY COUNCIL**

Planning Section  
County Hall  
Navan  
046 - 9097040


**Planning & Development Act 2000**  
**NOTIFICATION OF GRANT**

TO: Greenstar Ltd  
C/o Golder Associates Ireland  
Town Centre House  
Dublin Road  
Naas  
Co Kildare

PLANNING REGISTER NUMBER: NA/70015  
APPLICATION RECEIPT DATE: 12/02/2007

In pursuance of the powers conferred upon them by the above mentioned Act, Meath County Council have by order dated 03/04/2007 granted PERMISSION to the above named, for the development of land, in accordance with the documents submitted namely:- a landfill gas utilisation plant on a 0.3 hectare site located in the townland of Knockharley at the Knockharley Residual Waste Landfill in the townlands of Knockharley, Flemingstown and Tuiterrath, Co Meath. The proposed development of the landfill gas utilisation plant will be phased and will generate up to 4.2MW of electricity for input into the national grid. The proposed development includes the following key components: (i) 3 separate purpose built and environmentally controlled containers (each circa 2.5m x 12.2m x 2.6m high) enclosing a landfill gas engine with a 6.0m high stack generating approx 1.4MW of power each. (ii) 3 separate purpose built and environmentally controlled containers (each 3.0m x 3.0m x 3.0m high) enclosing a transformer. (iii) an enclosed flare comprising a purpose built container (ca 2.5m x 12.2m x 2.7m high) and stack (2.0m diameter x 10m high) (iv) ESB substation and Switch room (ca 6.0m x 9.7m x 4.5m high) (v) a steel equipment storage container (ca 2.5m x 12.2m x 2.5m high) (vi) 2 no bunded oil tanks (each 5m cubic capacity) and (vii) ancillary concrete foundation slabs, earthworks and site grading, landscaping, paladin fencing (2.4m high x ca 180m long) double gates, ducting and services, above ground piping and all associated works. The proposed development relates to an activity covered by Waste Licence No W0146-01 issued by the Environmental Protection Agency. The proposed development will not require a review of the Waste Licence at Knockharley Waste Landfill Flemingstown & Tuiterrath Navan, Co Meath subject to the 7 conditions set out in the Schedule attached.

Signed on behalf of MEATH COUNTY COUNCIL.

  
\_\_\_\_\_  
Area Administrator/Town Clerk

DATE: 17/5/2007

**NOTE: (Outline Permission Applications Only)**

OUTLINE PERMISSION is subject to the subsequent Application for Permission consequent on the grant of Outline Permission of the Planning Authority. Until such has been obtained to detailed plans of the development proposed, the development is **NOT AUTHORISED**

**NOTE:**

The permission herein granted shall, on the expiration of the period of 5 years beginning on the date of the granting of permission, cease to have effect as regards:-

- (1) In case the development to which the permission relates is not commenced during the period, the entire development and
- (2) In case such development is so commenced, so much thereof as is not completed within that period.

### Schedule of Conditions

- 1 The development shall be in accordance with plans and particulars submitted on 12<sup>th</sup> February, 2007 except where conditions hereunder specify otherwise.

**Reason:** In the interest of proper planning and development.

- 2 The applicant shall send written notification to the National Monuments Service, Department of the Environment, Heritage & Local Government of his/her intention to carry out site preparation works at the proposed development site at least four weeks in advance of the commencement of works.

The applicant shall employ an archaeologist to carry out Archaeological Monitoring of all sub-surface works carried out within the proposed development site. This will include the archaeological monitoring of the removal of topsoil, the excavation of trenches for foundations, services and drainage associated with the proposed development.

Should archaeological material be discovered during the course of Archaeological Monitoring, the applicant shall facilitate the archaeologist in fully recording this material. The applicant shall also be prepared to be advised by the National Monuments Service Department of the Environment, Heritage & Local Government with regard to the appropriate course of action, should archaeological material be discovered.

The archaeologist shall prepare and submit a report, describing the results of the Archaeological Monitoring to the Local Authority and the National Monuments Service within six weeks following the completion of Archaeological monitoring on site.

**Reason:** To ensure proper planning and development of the area.

- 3 Should archaeological material be found during the course of sub-surface drainage and foundation construction the applicant shall fully inform the Department of the Environment Heritage & Local Government to facilitate the recording of this material. The applicant shall also be prepared to be advised by the Department of the Environment Heritage & Local Government with regard to the appropriate course of action should archaeological material be found.

**Reason** To facilitate the recovery and recording of archaeological material.

- 4 The conditions of PL17.125891 relating to the development shall be fully complied with except where conditions hereunder specify otherwise.

**Reason:** In the interest of proper planning control.

- 5 The developer shall pay the sum of €756 (seven hundred and fifty six euros) to the Planning Authority as a contribution towards expenditure that was and/or that is proposed to be incurred by the Planning Authority in the revision, refurbishment, upgrading, enlargement or replacement of water treatment and mains water network infrastructure by the Council benefiting development in the area of the Authority, as provided for in the Contribution Scheme for Meath County Council. The Contribution Scheme was adopted in accordance with the provisions of Section 48 of the Planning & Development Act 2000 – 2002. Payment of this sum shall be made prior to commencement of development unless the phasing of payments and the giving of security to ensure payment in full is agreed in writing with the Planning Authority prior to the commencement of development. The above sum shall apply until 31<sup>st</sup> December, 2007 and shall be subject to review on that date and to annual review thereafter unless previously paid. The contribution rates shall be updated effective from January 1<sup>st</sup> each year during the lifetime of the Development Contribution Scheme in accordance with the Wholesale Price Indices – Building and Construction (Capital Goods) published by the Central Statistics Office.

**Reason:** The provision of such sanitary services in the area by the Council will facilitate the proposed development. It is considered reasonable that the developer should contribute towards the cost of providing the services.

- 6 The developer shall pay the sum of €1,965 (one thousand nine hundred and sixty five euros) to the Planning Authority as a contribution towards expenditure that was and/or that is proposed to be incurred by the Planning Authority in the provision, refurbishment, upgrading, enlargement or replacement of public roads and public transport infrastructure by the Council benefiting development in the area of the Authority, as provided for in the Contribution Scheme for Meath County Council. The Contribution Scheme was adopted in accordance with the provisions of Section 48 of the Planning & Development Act 2000 – 2002. Payment of this sum shall be made prior to commencement of development unless the phasing of payments and the giving of security to ensure payment in full is agreed in writing with the Planning Authority prior to the commencement of development.

The above sum shall apply until 31st December, 2007 and shall be subject to review on that date and to annual review thereafter unless previously paid. The contribution rates shall be updated effective from January 1<sup>st</sup> each year during the lifetime of the Development Contribution Scheme in accordance with the Wholesale Price Indices – Building and Construction (Capital Goods) published by the Central Statistics Office.

**Reason:** The provision of such roads and public transport infrastructure in the area by the Council will facilitate the proposed development. It is considered reasonable that the developer should contribute towards the cost of providing these services.

- 7 The developer shall pay the sum of €282 (two hundred and eighty two euros) to the Planning Authority as a contribution towards expenditure that was and/or that is proposed to be incurred by the Planning Authority in the provision and extension of social infrastructure (open spaces, recreational and community facilities, amenities and landscaping works) by the Council benefiting development in the area of the Authority, as provided for in the Contribution Scheme for Meath County Council. The Contribution Scheme was adopted in accordance with the provisions of Section 48 of the Planning & Development Act 2000 – 2002. Payment of this sum shall be made prior to commencement of development unless the phasing of payments and the giving of security to ensure payment in full is agreed in writing with the Planning Authority prior to the commencement of development.

The above sum shall apply until 31st December, 2007 and shall be subject to review on that date and to annual review thereafter unless previously paid. The contribution rates shall be updated effective from January 1<sup>st</sup> each year during the lifetime of the Development Contribution Scheme in accordance with the Wholesale Price Indices – Building and Construction (Capital Goods) published by the Central Statistics Office.

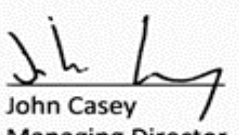
**Reason:** The provision of such social infrastructure in the area by the Council will facilitate the proposed development. It is considered reasonable that the developer should contribute towards the cost of providing these services.

**ATTACHMENT C**

Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH03  
Facility Location: Knickharley Facility  
Rev.No: 1



|   |   |
|---|---|
| <b>Report Title</b>                                   | Air Emissions Compliance Monitoring Emissions Report  |
| <b>Company address</b>                                | Air Scientific Ltd., 32 DeGranville Court, Dublin road,<br>Trim, Co. Meath  |
| <b>Stack Emissions Testing Report Commissioned by</b> | Knockharley Landfill  |
| <b>Facility Name</b>                                  | Knickharley Facility  |
| <b>Contact Person</b>                                 | Mr Sean O Callaghan   |
| <b>EPA Licence Number</b>                             | WL0146-02   |
| <b>Licence Holder</b>                                 | Knockharley Landfill, KH03  |
| <b>Stack Reference Number</b>                         | KH03  |
| <b>Dates of the Monitoring Campaign</b>               | 17/07/2019  |
| <b>Job Reference Number</b>                           | KNLATL1170719 / 2019432   |
| <b>Report Written By</b>                              | Amanda Sheridan   |
| <b>Report Approved by</b>                             | Dr. John Casey  |
| <b>Stack Testing Team</b>                             | Dr. John Casey, Amanda Sheridan   |
| <b>Report Date</b>                                    | 15/08/2019  |
| <b>Report Type</b>                                    | Test Report Compliance Monitoring   |
| <b>Version</b>  | 1   |
| <b>Signature of Approver</b>                          | <br>John Casey<br>Managing Director |



## Contents

|  |    |
|--|----|
| 1. Executive Summary .....   | 4  |
| I. Monitoring Objectives .....   | 4  |
| Overall Aim of the monitoring Campaign .....                               | 4  |
| Special Requirements .....   | 4  |
| Target Parameters .....  | 4  |
| Emission Limit Values .....  | 5  |
| Reference Conditions .....   | 5  |
| Overall Results .....  | 6  |
| Accreditation details .....  | 7  |
| Monitoring Dates & Times .....   | 8  |
| Monitoring, Equipment & Analytical Methods .....                           | 9  |
| Sampling Deviations .....  | 11 |
| Reference Documents .....  | 11 |
| Suitability of sampling location .....                                     | 12 |
| Process details .....  | 13 |
| Stack diagram .....  | 14 |
| 2. APPENDICES .....  | 15 |
| II. Appendix I - Monitoring Personnel & Equipment .....                    | 15 |
| Stack Emissions Monitoring Personnel .....                                 | 15 |
| III. Appendix II - Stack Details & flow characteristics .....              | 16 |
| Preliminary stack survey calculations .....                                | 16 |
| IV. Appendix III - Individual parameter sampling details and results ..... | 22 |
| Total Particulate Matter: Sampling details and results .....               | 22 |
| Total Particulates Quality Assurance .....                                 | 23 |
| Carbon Monoxide Quality Assurance .....                                    | 24 |
| Carbon Monoxide Results & Sampling details .....                           | 27 |
| Carbon Monoxide Trend .....  | 33 |
| Carbon Monoxide Measurement Uncertainty .....                              | 34 |
| Oxides of Nitrogen Quality Assurance .....                                 | 35 |
| Oxides of Nitrogen Results & Sampling details .....                        | 37 |
| Oxides of Nitrogen Trend .....   | 41 |
| Oxides of Nitrogen Measurement Uncertainty .....                           | 43 |
| Hydrogen Chloride Sampling Details & Results .....                         | 45 |
| Hydrogen Chloride Quality Assurance .....                                  | 46 |
| Hydrogen Chloride Results & Measurement Uncertainty .....                  | 48 |
| Hydrogen Fluoride Sampling Details & Results .....                         | 50 |
| Hydrogen Fluoride Quality Assurance .....                                  | 51 |
| Hydrogen Fluoride Results & Measurement Uncertainty .....                  | 53 |
| Sulphur Dioxide Quality Assurance .....                                    | 54 |
| Sulphur Dioxide Sampling Details & Results .....                           | 55 |
| Sulphur Dioxide Trend .....  | 64 |
| Sulphur Dioxide Results & Measurement Uncertainty .....                    | 70 |

Document No.: KNLATL1170719 / 2019432

EPA Licence No.: WL0146-02

Visit No: 1

Licence Holder: Knockharley Landfill, KH03

Year: 2019

Facility Location: Knickharley Facility

Office: Trim

Rev.No: 1

T A Luft Organics ..... 82

Oxygen Quality Assurance ..... 84

Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH03  
Facility Location: Knickharley Facility  
Rev.No: 1

|  |    |
|--|----|
| Oxygen Trend .....                               | 91 |
| Carbon Dioxide Quality Assurance .....           | 92 |
| Carbon Dioxide Sampling Details & Results .....  | 92 |
| Carbon Dioxide Trend .....                       | 94 |
| Moisture Results & Measurement Uncertainty ..... | 96 |
| <br>   |    |
| Uncertainty Sheets .....                         | 99 |

*Opinions and interpretations expressed herein are outside the scope of Air Scientific Limited INAB accreditation.  
This test report shall not be reproduced, without the written approval of Air Scientific Limited. All sampling  
and reporting is completed in accordance with Environmental Protection Agency Air Guidance Note 2 requirements.*

## 1. Executive Summary

### I. Monitoring Objectives

#### Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

#### Special Requirements

There were no special requirements.

#### Target Parameters

|   |
|---|
| Total Particulate Matter (TPM)              |
| Carbon Monoxide (CO)                        |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> |
| Hydrogen Chloride (HCL)                     |
| Hydrogen Fluoride (HF)                      |
| T A Luft Organics                           |
| Sulphur Dioxide (SO <sub>2</sub> )          |
| Stack Gas Temperature                       |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )   |
| Oxygen (O <sub>2</sub> )                    |
| Carbon Dioxide (CO <sub>2</sub> )           |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

### Emission Limit Values

| Emission Limit Values / Mass Emissions Limit Values | mg.m <sup>-3</sup> | kg.h <sup>-1</sup> |
|---|--------------------|--------------------|
| TPM   | 130                | -                  |
| CO  | 1400               | -                  |
| NOx as NO <sub>2</sub>                              | 500                | -                  |
| HCL   | 50                 | -                  |
| HF  | 5                  | -                  |
| T A Luft Organics                                   | 20                 | -                  |
| SO <sub>2</sub>                                     | -                  | -                  |
| Stack Gas Temperature                               | -                  | -                  |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )           | 3,000              | -                  |

### Reference Conditions

| Reference Condition | Value  |
|---------------------|--------|
| Oxygen Reference %  | 5      |
| Temperature K       | 273.15 |
| Total Pressure kPa  | 101.3  |
| Moisture Correction | Yes    |

Executive Summary

Overall Results

| Parameter                         | Concentration                   | Result  | MU +/- | Blanks | Limit | Compliant | Mass Emission      | Result | Run 1 | Dates      | Time on  | Time off | O2 Ref. (%) | Accreditation | LOD  |
|-----------------------------------|---------------------------------|---------|--------|--------|-------|-----------|--------------------|--------|-------|------------|----------|----------|-------------|---------------|------|
|                                   | Units                           |         |        |        |       |           | Units              |        | Limit |            |          |          |             |               |      |
| TPM EN13284-1:2017                | mg.m <sup>-3</sup>              | <1.43   | 0.81   | <1.34  | 130   | Yes       | kg.h <sup>-1</sup> | <0.003 | -     | 17/07/2019 | 13:40:00 | 14:10:00 | 5           | Yes           | 0.95 |
| CO EN15058:2017                   | mg.m <sup>-3</sup>              | 952.13  | 53.83  | -      | 1400  | Yes       | kg.h <sup>-1</sup> | 2.279  | -     | 17/07/2019 | 09:37:00 | 10:08:00 | 5           | Yes           | <1.7 |
| NOx EN14792:2017                  | mg.m <sup>-3</sup>              | 293.8   | 22.33  | -      | 500   | Yes       | kg.h <sup>-1</sup> | 0.703  | -     | 17/07/2019 | 09:37:00 | 10:08:00 | 5           | Yes           | <1.8 |
| HCL EN1911:2010                   | mg.m <sup>-3</sup>              | 10.58   | 0.73   | 0.53   | 50    | Yes       | kg.h <sup>-1</sup> | 0.025  | -     | 17/07/2019 | 09:26:00 | 10:16:00 | 5           | Yes           | 0.14 |
| HF EN15713:2006                   | mg.m <sup>-3</sup>              | <0.33   | 0.02   | <0.09  | 5     | Yes       | kg.h <sup>-1</sup> | <0.001 | -     | 17/07/2019 | 10:08:00 | 10:38:00 | 5           | Yes           | 0.31 |
| Total TA Luft VOC EN13649:2014    | mg.m <sup>-3</sup>              | <14.45  | 2.67   | <0.08  | 150   | Yes       | kg.h <sup>-1</sup> | <0.035 | -     | 17/07/2019 | 10:20:00 | 10:51:00 | 5           | Yes           | 0.09 |
| Class I EN13649:2014              | mg.m <sup>-3</sup>              | <3.75   | 0.69   | -      | 20    | Yes       | kg.h <sup>-1</sup> | <0.009 | -     | 17/07/2019 | 10:20:00 | 10:51:00 | 5           | Yes           | 0.09 |
| Class II EN13649:2014             | mg.m <sup>-3</sup>              | <4.3    | 0.79   | -      | 100   | Yes       | kg.h <sup>-1</sup> | <0.01  | -     | 17/07/2019 | 10:20:00 | 10:51:00 | 5           | Yes           | 0.09 |
| Class III EN13649:2014            | mg.m <sup>-3</sup>              | <6.4    | 1.18   | -      | 150   | Yes       | kg.h <sup>-1</sup> | <0.015 | -     | 17/07/2019 | 10:20:00 | 10:51:00 | 5           | Yes           | 0.09 |
| SO <sub>2</sub> CEN/TS 17021:2017 | mg.m <sup>-3</sup>              | 2040.78 | 124.78 | -      | -     | N/A       | kg.h <sup>-1</sup> | 4.885  | -     | 17/07/2019 | 09:37:00 | 10:08:00 | 5           | Yes           | <6.1 |
| Oxygen (%) EN14789:2017           | % v/v                           | 6.03    | 0.13   | -      | -     | N/A       | -                  | -      | -     | 17/07/2019 | 09:37:00 | 10:08:00 | 5           | Yes           | -    |
| CO <sub>2</sub> ISO12039:2001     | % v/v                           | 11.25   | 0.35   | -      | -     | N/A       | -                  | -      | -     | 17/07/2019 | 09:37:00 | 10:08:00 | 5           | Yes           | -    |
| H <sub>2</sub> O EN14790:2017     | % v/v                           | 8.5     | 0.41   | -      | -     | N/A       | -                  | -      | -     | 17/07/2019 | 09:10:00 | 09:40:00 | 5           | Yes           | -    |
| Stack Gas Temperature             | K                               | 698.15  | -      | -      | -     | N/A       | -                  | -      | -     | 17/07/2019 | 13:30:00 | 13:40:00 | 5           | Yes           | -    |
| Stack Gas Velocity EN16911:2013   | m.s <sup>-1</sup>               | 15.82   | 0.59   | -      | -     | N/A       | -                  | -      | -     | 17/07/2019 | 13:30:00 | 13:40:00 | 5           | Yes           | -    |
| Volumetric Flow Rate              | m <sup>3</sup> .h <sup>-1</sup> | 2,558   | 312    | -      | 3,000 | Yes       | -                  | -      | -     | -          | -        | -        | 5           | Yes           | -    |
| Volumetric Flow Rate (Ref)        | m <sup>3</sup> .h <sup>-1</sup> | 2,394   | -      | -      | 3,000 | Yes       | -                  | -      | -     | -          | -        | -        | 5           | Yes           | -    |

Accreditation details

|                                |          |
|--------------------------------|----------|
| Air Scientific Limited         | INAB319T |
| External Analytical Laboratory | UKAS1549 |
| Other                          | UKAS0605 |



## Executive Summary

## Monitoring Dates &amp; Times

| Parameter                                   | Run   | Location ID | Sampling Dates | Sampling Time On | Sampling Time Off | Duration (mins.) |
|---|-------|-------------|----------------|------------------|-------------------|------------------|
| Total Particulate Matter (TPM)              | Run 1 | KH03        | 17/07/2019     | 13:40:00         | 14:10:00          | 00:30:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Carbon Monoxide (CO)                        | Run 1 | KH03        | 17/07/2019     | 09:37:00         | 10:08:00          | 00:31:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> | Run 1 | KH03        | 17/07/2019     | 09:37:00         | 10:08:00          | 00:31:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Chloride (HCL)                     | Run 1 | A2-1        | 17/07/2019     | 09:26:00         | 10:16:00          | 00:50:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Fluoride (HF)                      | Run 1 | KH03        | 17/07/2019     | 10:08:00         | 10:38:00          | 00:30:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| T A Luft Organics                           | Run 1 | KH03        | 17/07/2019     | 10:20:00         | 10:51:00          | 00:31:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Sulphur Dioxide (SO <sub>2</sub> )          | Run 1 | KH03        | 17/07/2019     | 09:37:00         | 10:08:00          | 00:31:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxygen (%)                                  | Run 1 | KH03        | 17/07/2019     | 09:37:00         | 10:08:00          | 00:31:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Water Vapour (%)                            |       | KH03        | 17/07/2019     | 09:10:00         | 09:40:00          | 00:30:00         |
| Stack Gas Temperature                       |       | KH03        | 17/07/2019     | 13:30:00         | 13:40:00          | 00:10:00         |
| Stack Gas Velocity                          |       | KH03        | 17/07/2019     | 13:30:00         | 13:40:00          | 00:10:00         |
| Carbon Dioxide (%)                          | Run 1 | KH03        | 17/07/2019     | 09:37:00         | 10:08:00          | 00:31:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

Executive Summary

Monitoring, Equipment & Analytical Methods

| Parameter                          | Monitoring        |                     |                    |             | Analysis              |               |
|------------------------------------|-------------------|---------------------|--------------------|-------------|-----------------------|---------------|
|                                    | Standard          | Technical Procedure | Accredited Testing | Testing Lab | Analytical Technique  | INAB Analysis |
| Total Particulate Matter (TPM)     | EN13284-1:2017    | SOP 2000            | Yes                | RPS         | Gravimetric           | -             |
| Carbon Monoxide (CO)               | EN15058:2017      | SOP 2004            | Yes                | AirSci      | NCIR By Horiba PG-250 | -             |
| Oxides of Nitrogen (NOx)           | EN14792:2017      | SOP 2002            | Yes                | AirSci      | Chemiluminescence     | -             |
| Hydrogen Chloride (HCL)            | EN1911:2010       | SOP 2014            | Yes                | SAL         | Ion Chromatography    | -             |
| Hydrogen Fluoride (HF)             | EN15713:2006      | SOP 2024            | Yes                | SAL         | Ion Chromatography    | -             |
| T A Luft Organics                  | EN13649:2014      | SOP 2019            | Yes                | SAL         | GC/MS                 | -             |
| Sulphur Dioxide (SO <sub>2</sub> ) | CEN/TS 17021:2017 | SOP 2046            | Yes                | AirSci      | NDIR Absorption       | -             |
| Oxygen (%)                         | EN14789:2017      | SOP 2008            | Yes                | AirSci      | Paramagnetic          | -             |
| Carbon Dioxide                     | ISO12039:2001     | SOP 2045            | Yes                | AirSci      | NDIR                  | -             |
| Water Vapour (%)                   | EN14790:2017      | SOP 2007            | Yes                | AirSci      | Gravimetric           | -             |
| Stack Gas Temperature              | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Thermocouple          | -             |
| Stack Gas Velocity                 | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Pitot tubes           | -             |



Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

### List of Equipment

| ID           | Item of Equipment                        | Manufacturer        | Serial No.          |
|--------------|--|---------------------|---------------------|
| ASLTM12EQ504 | SKC Aircheck Sampler SKC 3               | SKC                 | 826914              |
| ASLTM12EQ512 | Horiba PG2500 Portable Gas Analyzer      | Horiba              | 41343020031         |
| ASLTM12EQ517 | Testo 400 Gas Pressure Vacuum and Flow   | Testo               | 00828828/305        |
| ASLTM12EQ520 | Buhler Sample Gas Cooler                 | Buhler Technologies | 100063602044367-001 |
| ASLTM12EQ522 | Ohaus Scales                             | Ohaus               | 8732189114          |
| ASLTM12EQ526 | Knob weights (200,500,1000mg)            | KERN & Sohn GmbH    | G1117388            |
| ASLTM13EQ509 | 10 metre industrial heated sample line   | Neptech             | 13B088              |
| ASLTM14EQ506 | Stanley 5m Measuring Tape                | Stanley             | 30-696              |
| ASLTM14EQ512 | GemRed Electronic Level 0 to 180 Degrees | GemRed              | 8088                |
| ASLTM14EQ513 | ISO Stack Sampling Machine               | TCR Tecora          | 070205976 & 049039P |
| ASLTM14EQ514 | Mass flow meter                          | Siargo              | A3J04316            |
| ASLTM14EQ516 | 6" Digital Calliper                      | Stanley             | 052013w             |
| ASLTM14EQ518 | Mini Probe                               | TRC Tecora          | N/A                 |
| ASLTM14EQ519 | S TYPE PITOT TUBE                        | Tecora              | 33011               |
| ASLTM14EQ522 | S TYPE PITOT TUBE                        | TRC Tecora          | 323                 |
| ASLTM15EQ502 | Mass flow meter                          | Siargo              | A3J04318            |
| ASLTM15EQ505 | Mass flow meter                          | Siargo              | A1K05286            |
| ASLTM16EQ503 | K type thermocouple                      | TCR Tecora          | Tra20162208/01      |
| ASLTM18EQ509 | Bios Defender                            | Bios                | N/A                 |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Sampling Deviations**

| Parameter   | Deviation  |
|-------------|--|
| Standard ID | EN16911:2013 – flow rates in accordance with MID6911-1   |
| Standard ID | EN13284-1 - Sampling on one plane and one point only due to access restrictions  |
| Standard ID | HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4). |
| Standard ID | -  |

**Reference Documents**

|                              |         |
|------------------------------|---------|
| Risk Assessment (RA)         | SOP1011 |
| Site Review (SR)             | SOP1015 |
| Site Specific Protocol (SSP) | SOP1015 |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Executive Summary**

**Suitability of sampling location**

| General Information | Value     |
|---------------------|-----------|
| Permanent/Temporary | Temporary |
| Inside/ Outside     | Outside   |

| Platform Details   |       |         |
|--|-------|---------|
| Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements      | Value | Comment |
| Sufficient Working area to manipulate probe and measuring instruments          | Yes   | -       |
| Platform has 2 handrails (approx. 0.5m & 1.0 m high)                           | Yes   | -       |
| Platform has vertical base boards (approx. 0.25 m high)                        | Yes   | -       |
| Platform has chains / self closing gates at top of ladders                     | Yes   | -       |
| There are no obstructions present which hamper insertion of sampling equipment | No    | -       |
| Safe Access Available  | Yes   | -       |
| Easy Access Available  | Yes   | -       |

| Sampling Location / Platform Improvement Recommendations |
|--|
| None   |

| BSEN 15259 Homogeneity Test Requirements   |
|--|
| 1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack |

**Process details**

| Parameter                           |            |
|-------------------------------------|------------|
| Process status                      | Normal     |
| Capacity (per/hour) (if applicable) | As Normal  |
| Continuous or Batch Process         | Continuous |
| Feedstock                           | LFG        |
| Abatement System                    | No         |
| Abatement Systems Running Status    | N/A        |
| Fuel                                | Gas        |
| Plume Appearance                    | No         |
| Other information                   | None       |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

The process information below has been supplied by the client and as such ASL assume no responsibility or liability for any errors or omissions in the content of this Process Detail Form. The information provided in this form is provided on an 'as is' basis with no guarantees of completeness, accuracy or reliability.

| Licensee     |                     |                      |                     |
|--------------|---------------------|----------------------|---------------------|
| Reg. number  | WL0146-02           | Contractor           | Air Scientific Ltd. |
| Site Contact | Mr Sean O Callaghan | Contractor's contact | Amanda Sheridan     |
| Role         |                     | Role                 | -                   |
| Signature    |                     | Signature            | -                   |

| Emissions point       |     | -               |                            |     |                                   |   |
|-----------------------|-----|-----------------|----------------------------|-----|-----------------------------------|---|
| Type of process       |     | Load of process | Abatement system           |     | List of Solvents used per process |   |
| Rotogravure Printing  | -   | as normal       | Bag filter                 | -   | -                                 | - |
| Cement Plant          | -   |                 | Electrostatic precipitator | -   | -                                 | - |
| Electrical generation | -   |                 | Cyclone                    | -   | -                                 | - |
| Steam boiler          | -   |                 | Thermal oxidiser           | -   | -                                 | - |
| Other                 | Yes |                 | Active carbon bed          | -   | -                                 | - |
|                       |     |                 | NSCR                       | -   | -                                 | - |
|                       |     |                 | SCR                        | -   | -                                 | - |
|                       |     |                 | Dry scrubber               | -   | -                                 | - |
|                       |     |                 | Wet scrubber               | -   | -                                 | - |
|                       |     |                 | Lime injection             | -   | -                                 | - |
|                       |     |                 | Biofilter                  | -   | -                                 | - |
|                       |     |                 | None                       | Yes | -                                 | - |
|                       |     |                 | Other:                     | -   | -                                 | - |

Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH03  
Facility Location: Knickharley Facility  
Rev.No: 1

**Executive Summary**

**Stack diagram**



Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**2. APPENDICES**

**II. Appendix I - Monitoring Personnel & Equipment**

**Stack Emissions Monitoring Personnel**

|                    |                        |                                       |
|--------------------|------------------------|---------------------------------------|
| <b>Team Leader</b> | <b>Name</b>            | Dr. John Casey                        |
|                    | <b>Qualifications</b>  | PhD. (Eng.), MSc. (Agr.), B. Agr. Sc. |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Technician</b>  | <b>Name</b>            | Amanda Sheridan                       |
|                    | <b>Qualifications</b>  | B.A.                                  |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Team Leader</b> | <b>Name</b>            | -                                     |
|                    | <b>Qualifications</b>  | -                                     |
|                    | <b>System approval</b> | -                                     |
|                    |                        | -                                     |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**III. Appendix II - Stack Details & flow characteristics**

**Preliminary stack survey calculations**

| <b>General Stack Details</b>                |              |              |
|---|--------------|--------------|
| <b>Stack details</b>                        | <b>Units</b> | <b>Value</b> |
| Date of survey                              |              | 17/07/2019   |
| Time of survey                              |              | 13:30        |
| Type  |              | Circular     |
| Stack Diameter / Depth, D                   | m            | 0.4          |
| Stack Width, W                              | m            | -            |
| Average Stack Gas Temp., Ta                 | C            | 425          |
| Average Static Pressure, P static           | kPa          | 0.1          |
| Average Barometric Pressure, Pb             | kPa          | 101          |
| Type of Pitot                               |              | S            |
| Are Water Droplets Present?                 |              | No           |
| Average Pitot Tube Calibration Coeff, Cp    |              | 0.848        |
| Negative flow                               |              | No           |
| Highly homogeneous flow stream/gas velocity |              | Yes          |

|                           |    |          |
|---------------------------|----|----------|
| Sample Port Size          | mm | 60       |
| Initial Pitot Leak Check  | Pa | 550      |
| Final Pitot Leak Check    | Pa | 554      |
| Orientation of Duct       |    | Vertical |
| Pitot Tube Cp             |    | 0.998    |
| Number of Lines Available |    | 2        |
| Number of Lines Used      |    | 2        |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

| Sampling Line A |                      |     |         |                |            |                |
|-----------------|----------------------|-----|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa  | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | 0.02                 | -   | -       | -              | -          | -              |
| 2               | 0.06                 | 70  | 425     | 14.1           | -          | <15            |
| 3               | 0.12                 | 81  | 425     | 15.1           | -          | <15            |
| 4               | 0.28                 | 94  | 425     | 16.3           | -          | <15            |
| 5               | 0.34                 | 103 | 425     | 17             | -          | <15            |
| 6               | 0.38                 | -   | -       | -              | -          | -              |
| 7               | -                    | -   | -       | -              | -          | -              |
| 8               | -                    | -   | -       | -              | -          | -              |
| 9               | -                    | -   | -       | -              | -          | -              |
| 10              | -                    | -   | -       | -              | -          | -              |
| Average         | -                    | 87  | 425     | 15.63          | -          | <15            |
| Min             | -                    | 70  | 425     | 14.05          | -          | <15            |
| Max             | -                    | 103 | 425     | 17.05          | -          | <15            |



| Sampling Line B |                      |       |         |                |            |                |
|-----------------|----------------------|-------|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa    | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | 0.02                 | -     | -       | -              | -          | -              |
| 2               | 0.06                 | 77    | 425     | 14.7           | -          | <15            |
| 3               | 0.12                 | 86    | 425     | 15.6           | -          | <15            |
| 4               | 0.28                 | 97    | 425     | 16.5           | -          | <15            |
| 5               | 0.34                 | 105   | 425     | 17.2           | -          | <15            |
| 6               | 0.38                 | -     | -       | -              | -          | -              |
| 7               | -                    | -     | -       | -              | -          | -              |
| 8               | -                    | -     | -       | -              | -          | -              |
| 9               | -                    | -     | -       | -              | -          | -              |
| 10              | -                    | -     | -       | -              | -          | -              |
| Average         | -                    | 91.25 | 425     | 16.02          | -          | <15            |
| Min             | -                    | 77    | 425     | 14.74          | -          | <15            |
| Max             | -                    | 105   | 425     | 17.21          | -          | <15            |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

| Component                      | Conc. ppm | Conc. Dry % v/v | Conc. Wet % v/v | Molar Mass |
|--------------------------------|-----------|-----------------|-----------------|------------|
| Carbon Dioxide CO <sub>2</sub> | -         | 11.2            | -               | 44.01      |
| Oxygen O <sub>2</sub>          | -         | 6.02            | -               | 32         |
| Nitrogen N <sub>2</sub>        | -         | 82.78           | -               | 28.1       |
| Moisture (H <sub>2</sub> O)    | -         | -               | 8.5             | 18.02      |
| <b>Reference Conditions</b>    |           |                 |                 |            |
| Temperature                    | °C        | 273.15          |                 |            |
| Total Pressure                 | kPa       | 101.3           |                 |            |
| Moisture                       | %         | -               |                 |            |
| Oxygen (Dry)                   | %         | 5               |                 |            |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

| Stack Gas Composition & Molecular Weights |              |                             |                 |                       |                                |                 |                       |                                |
|---|--------------|-----------------------------|-----------------|-----------------------|--------------------------------|-----------------|-----------------------|--------------------------------|
| Component                                 | Molar Mass M | Density Kg/m <sup>3</sup> p | Conc. Dry % v/v | Dry Volume Fraction r | Dry Conc. kg/m <sup>3</sup> pi | Conc. wet % v/v | Wet Volume Fraction r | Wet Conc. kg/m <sup>3</sup> pi |
| Carbon Dioxide CO <sub>2</sub>            | 44.01        | 1.96                        | 11.2            | 0.112                 | 0.22                           | 10.25           | 0.1                   | 0.2                            |
| Oxygen O <sub>2</sub>                     | 32           | 1.43                        | 6.02            | 0.0602                | 0.09                           | 5.51            | 0.06                  | 0.08                           |
| Nitrogen N <sub>2</sub>                   | 28.1         | 1.25                        | 82.78           | 0.8278                | 1.04                           | 75.74           | 0.76                  | 0.95                           |
| Moisture (H <sub>2</sub> O)               | 18.02        | 0.8                         | -               | -                     | -                              | 8.5             | 0.09                  | 0.07                           |
| where $p = M/22.41$                       |              |                             |                 |                       |                                |                 |                       |                                |
| $p_i = r \times p$                        |              |                             |                 |                       |                                |                 |                       |                                |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

| Calculation of Stack Gas Densities  |                    |        |
|---|--------------------|--------|
| Determinant   | Units              | Result |
| Dry Density (STP), P STD  | kg.m <sup>-3</sup> | 1.344  |
| Wet Density (STP), P STW  | kg.m <sup>-3</sup> | 1.302  |
| Dry Density (Actual), P Actual  | kg.m <sup>-3</sup> | 0.524  |
| Average wet Density (Actual), P Actual W  | kg.m <sup>-3</sup> | 0.508  |
| <b>Where</b>  |                    |        |
| P STD = sum of component concentrations, kg/m <sup>3</sup> (excluding water vapour)               |                    |        |
| $P_{STW} = (P_{STD} + p_{i \text{ of } H_2O}) / (1 + (p_{i \text{ of } H_2O} / 0.8036))$          |                    |        |
| $P_{actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times (P_a / T_a)$                            |                    |        |
| $P_{actual \ W} \text{ (at each sampling point)} = P_{STW} \times (T_s / P_s) \times (P_a / T_a)$ |                    |        |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

| Sampling Plane Validation Criteria     | Value | Units   | Requirement | Compliance | Method       |
|--|-------|---------|-------------|------------|--------------|
| Lowest Differential Pressure           | 70    | Pa      | >5 Pa       | Yes        | EN16911:2013 |
| Lowest Gas Velocity                    | 14.05 | m/s     | -           | N/A        | -            |
| Highest Gas Velocity                   | 17.21 | m/s     | -           | N/A        | -            |
| Ratio of Above                         | 1.22  | :1      | <3:1        | Yes        | EN16911:2013 |
| Mean Velocity                          | 15.82 | m/s     | -           | N/A        | -            |
| Angle of flow with regard to duct axis | <15   | degrees | < 15        | Yes        | EN16911:2013 |
| No local negative flow                 | No    | -       | -           | Yes        | -            |
| Homogeneous flow stream/gas velocity   | Yes   | -       | -           | Yes        | -            |

| Calculation of stack Gas Velocity, V  |             |
|---|-------------|
| Velocity at Traverse Point, $V = K_{cp} * \text{Sqrt}((2 * DP) / \text{Density})$ | 351.0802321 |
| <b>Where</b>  |             |
| $K_{pt}$ = Pitot tube calibration coefficient                                     | 0.848       |
| Compressibility correction factor, assumed at a constant 0.998                    | 0.998       |

| Gas Volumetric Flowrate               | Units        | Result |
|---------------------------------------|--------------|--------|
| Gas Volumetric Flow Rate (Actual)     | $m^3.h^{-1}$ | 7158   |
| Gas Volumetric Flow Rate (STP, Wet)   | $m^3.h^{-1}$ | 2795   |
| Gas Volumetric Flowrate (STP, Dry)    | $m^3.h^{-1}$ | 2558   |
| Gas Volumetric Flowrate REF to Oxygen | $m^3.h^{-1}$ | 2394   |

|  |      |  |      |  |     |
|--|------|--|------|--|-----|
| Standard uncertainty of velocity (m/s) | 0.29 | Expanded uncertainty of velocity (m/s) | 0.59 | Volume flow rate expanded uncertainty ( $m^3/hr$ ) | 312 |
|--|------|--|------|--|-----|

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

IV. Appendix 3 - Individual parameter sampling details and results

**Total Particulate Matter Sampling details and results**

|                             |         |                                 |                     |          |                |
|-----------------------------|---------|---------------------------------|---------------------|----------|----------------|
| Run 1                       |         |                                 | Time On             | 13:40:00 |                |
| Stack ID                    | KH03    |                                 | Time Off            | 14:10:00 |                |
| Filter ID                   | KH03    |                                 | Uncertainty Data    |          |                |
| Start Dry Gas Meter         | -       | m <sup>3</sup>                  | Temperature at Pump | 16.1     | Deg C          |
| Finish Dry Gas Meter        | -       | m <sup>3</sup>                  | Pressure at Pump    | 101      | kPa            |
| Average Stack Temperature   | 425     | °C                              | Air Volume at Pump  | 0.39     | m <sup>3</sup> |
| Moisture Content            | 8.5     | %                               | Humidity at Pumps   | 0.1      | %              |
| Stack Flow Rate STP, Dry    | 2558    | m <sup>3</sup> .h <sup>-1</sup> | Filter Weight       | <0.04    | mg             |
| Volume of Air Sampled       | 0.37    | m <sup>3</sup> (VgN)            | Front End Weight    | <0.5     | mg             |
|                             |         |                                 |                     |          |                |
| Balance Calibration         | Weight  |                                 |                     |          |                |
| 300.0                       | -       | g                               |                     |          |                |
| 500.0                       | -       | g                               |                     |          |                |
| 1000.0                      | -       | g                               |                     |          |                |
| Inpinger Weights            | Initial | Final                           | Difference          |          |                |
| 1                           | -       | -                               | -                   |          |                |
| 2                           | -       | -                               | -                   |          |                |
| 3                           | -       | -                               | -                   |          |                |
| 4                           | -       | -                               | -                   |          |                |
| Volume of Air Sampled       | 0.37    | Nm <sup>3</sup>                 |                     |          |                |
| Moisture Content (EN 14790) | 0       | %                               |                     |          |                |
|                             |         |                                 |                     |          |                |
| Leak Check Results          | Result  |                                 | % Leak              |          |                |
| Before Blank                | 0.1     | l/min                           | 0.3                 |          |                |
| After Blank                 | 0.1     | l/min                           | 0.3                 |          |                |
| Before Sample 1             | 0.1     | l/min                           | 0.3                 |          |                |
| After Sample 1              | 0.3     | l/min                           | 1                   |          |                |
| Average Flow Rate           | 29.5    | l/min                           | 1                   |          |                |
| Standard Maximum            | 0.59    | l/min                           | 2%                  |          |                |
| Back Pressure               | -       | bar                             | -                   |          |                |
| Leak check acceptable       | Yes     |                                 | Yes/No              |          |                |
| Water droplets present      | No      |                                 | Yes/No              |          |                |
|                             |         |                                 |                     |          |                |
| Standard Criteria to be Met | Result  | Standard Requirement            |                     |          |                |
| Angle of Flow               | <15     | <15 Degrees                     |                     |          |                |
| Negative Flow in the Stack  | None    | None                            |                     |          |                |
| Pitot Pressure Difference   | >5Pa    | >5Pa                            |                     |          |                |
| Ratio of Flow Measurement   | 1.47    | <3:1                            |                     |          |                |

|   |               |                         |                             |                    |  |
|---|---------------|-------------------------|-----------------------------|--------------------|--|
| <b>Pitot Tube Leak Check</b>                  | <b>Result</b> |                         |                             |                    |  |
| Positive Pressure                             | Pass          |                         |                             |                    |  |
| Negative Pressure                             | Pass          |                         |                             |                    |  |
| <b>Number of Ports</b>                        |               |                         |                             |                    |  |
|   | 2             |                         |                             |                    |  |
| <b>Straight length before sample point</b>    | > 5           | > 5 Hydraulic Diameters |                             |                    |  |
| <b>Straight length after sample point</b>     | > 5           | > 5 Hydraulic Diameters |                             |                    |  |
| <b>Sample Calculations</b>                    |               |                         |                             |                    |  |
| <b>Blank (Filter and Front Wash Combined)</b> |               |                         |                             |                    |  |
|   | <0.54         | mg                      |                             |                    |  |
| <b>Sample 1 (Filter and Front Combined)</b>   |               |                         |                             |                    |  |
|   | <0.54         | mg                      |                             |                    |  |
| <b>Volume of Air Sampled</b>                  | 0.4           | Nm <sup>3</sup>         |                             |                    |  |
| <b>Blank Result</b>                           | <1.34         | mg.m <sup>-3</sup>      |                             |                    |  |
| <b>Sample Result</b>                          | <1.34         | mg.m <sup>-3</sup>      |                             |                    |  |
| <b>Emission Limit Value</b>                   | 130           | mg.m <sup>-3</sup>      |                             |                    |  |
| <b>Blank as Percentage of ELV</b>             |               |                         |                             |                    |  |
|   | 1             | %                       | <b>Standard Requirement</b> | <b>&lt;10% ELV</b> |  |
| <b>Isokinetic Criterion Compliance</b>        |               |                         |                             |                    |  |
| Isokinetic Variation                          | %             | 0.8                     |                             |                    |  |
| Allowable Isokinetic Range                    | %             | 95-115                  |                             |                    |  |
| Iso Kineticity Acceptable                     | -             | Yes                     |                             |                    |  |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Total Particulates Quality Assurance**

| Stack ID                       | KH03           |                         |       |       |       |       |       |
|--------------------------------|----------------|-------------------------|-------|-------|-------|-------|-------|
| Parameter                      | Units          | Run 1                   | Run 2 | Run 3 | Blank | Blank | Blank |
| Sampling Times                 | -              | 13:40:00                | -     | -     | -     | -     | -     |
| Sampling Dates                 | -              | 17/07/2019              | -     | -     | -     | -     | -     |
| Sampling Device                | -              | Basic                   | -     | -     | -     | -     | -     |
| Volume Sampled (REF.)          | m <sup>3</sup> | 0.37                    | -     | -     | -     | -     | -     |
| Filter ID Number               | -              | KH03                    | -     | -     | -     | -     | -     |
| Probe rinse ID                 | -              | KH03 W                  | -     | -     | -     | -     | -     |
| Total Filter Mass              | mg             | <0.04                   | -     | -     | -     | -     | -     |
| Probe Rinse Solids Mass        | mg             | <0.5                    | -     | -     | -     | -     | -     |
| Total Mass Collected           | mg             | <0.54                   | -     | -     | -     | -     | -     |
| <b>General information</b>     |                |                         |       |       |       |       |       |
| Standard                       | ISEN13284-1    |                         |       |       |       |       |       |
| Technical Procedure            | -              | SOP 2000                | -     | -     | -     | -     | -     |
| Probe Material                 | -              | SS                      | -     | -     | -     | -     | -     |
| Filter Housing                 | -              | SS                      | -     | -     | -     | -     | -     |
| Positioning of Filter          | -              | In-stack                | -     | -     | -     | -     | -     |
| Filter Size and Material       | -              | 25mm filter, 6mm nozzle | -     | -     | -     | -     | -     |
| Number of Sampling lines used  | -              | 1                       | -     | -     | -     | -     | -     |
| Number of Sampling Points used | -              | 4                       | -     | -     | -     | -     | -     |



**Carbon Monoxide Quality Assurance**

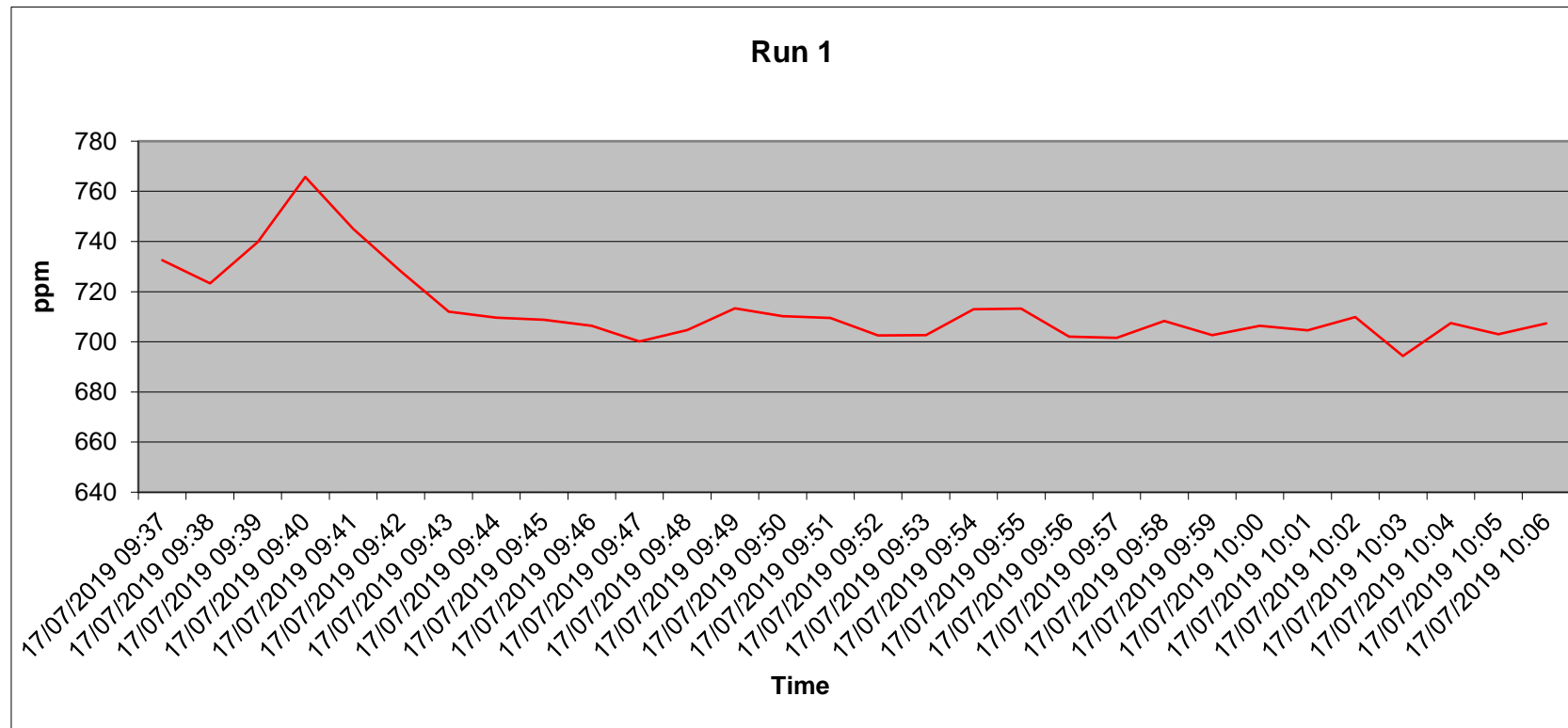
| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | KH03              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 09:35        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 1000         | -            | -            |
| Span Gas Value                 | ppm               | 616          | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 2            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 6            | -            | -            |
| Zero Drift                     | ppm               | -4           | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 30.7         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.65        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 614          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 618          | -            | -            |
| Span Drift                     | ppm               | -4           | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 30.7         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.65        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 616          | -            | -            |
| Recorded Conc. down Line       | ppm               | 618          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |

**Carbon Monoxide Results & Sampling Details**

| Parameter     | Units              | Run 1  | Run 2 | Run 3 | Mean |
|---------------|--------------------|--------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 890.75 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 53.83  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | 2.28   | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | EN15058       |
| Technical Procedure              | SOP2004       |
| Probe material                   | SS            |
| Filtration Type/Size             | PTFE          |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM18ING515 |
| Span Gas Expiry Date             | 22-Dec        |
| Span Gas Start Pressure (bar)    | 50            |
| Gas Cylinder Concentration (ppm) | 616           |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | KH03          |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 5             |

### Carbon Monoxide Trend



**Carbon Monoxide Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.36-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 1000      | -     | -     |
| Measured Reading   | ppm                | 712.6     | -     | -     |
|  |                    |           |       |       |
| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.9       | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.14      | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.12     | -     | -     |
| Cross-sensitivity  | %                  | 0.08      | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
|  |                    |           |       |       |
| Parameter  | Units              | Run 1     | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 10.98     | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 21.96     | -     | -     |
|  |                    |           |       |       |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 53.83     | -     | -     |
|  |                    |           |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 3.85      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 53.83     | -     | -     |
|  |                    |           |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 6.04      | -     | -     |
|  |                    |           |       |       |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |

**Oxides of Nitrogen Quality Assurance**

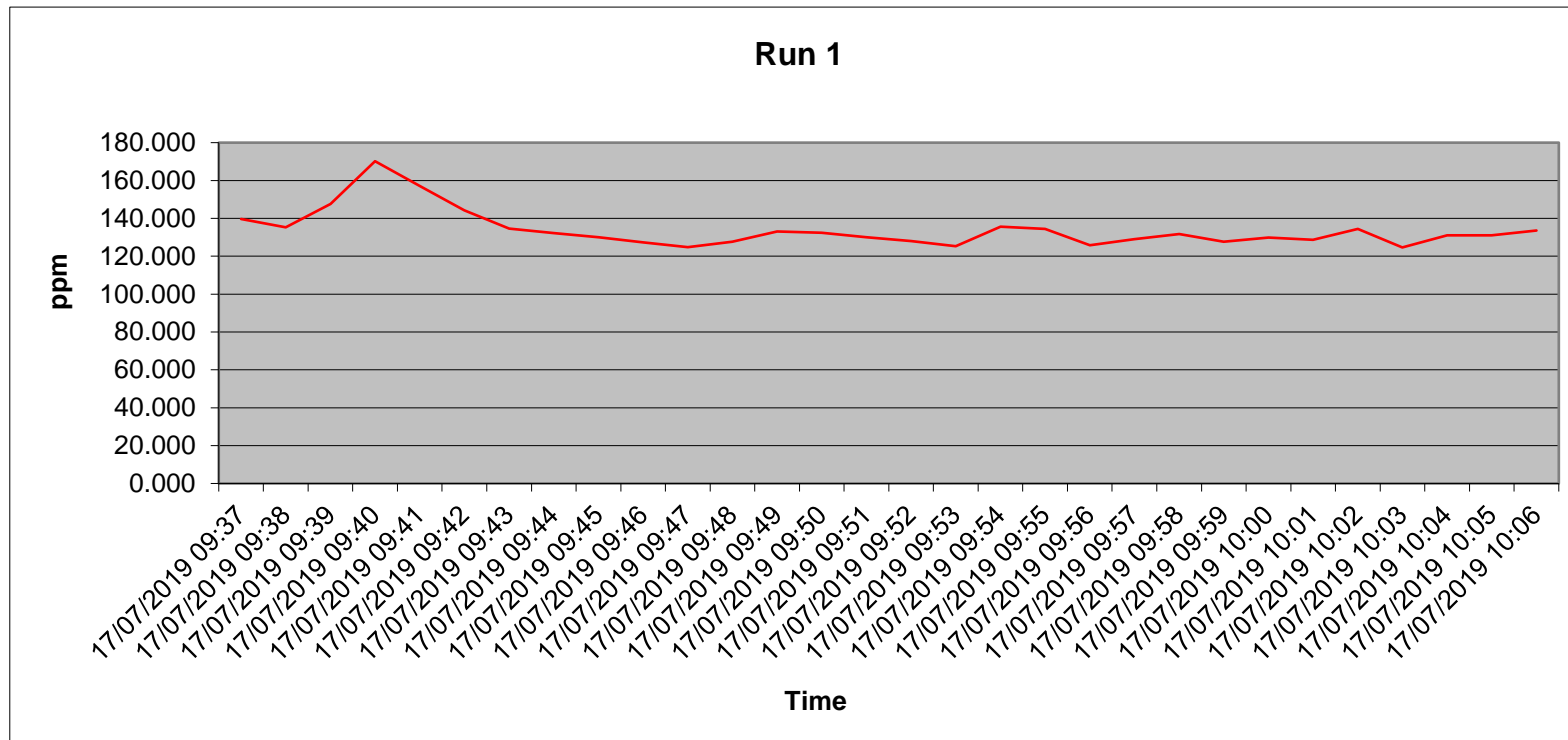
| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | KH03              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 09:35        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 250          | -            | -            |
| Span Gas Value                 | ppm               | 160.7        | -            | -            |
| Acceptable Gas Range           | -                 | Yes          | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.2          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.5          | -            | -            |
| Zero Drift                     | ppm               | -0.3         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 8.02         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.19        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 160.3        | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 160.7        | -            | -            |
| Span Drift                     | ppm               | -0.4         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 8.02         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.25        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 160.7        | -            | -            |
| Recorded Conc. down Line       | ppm               | 160.7        | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |

**Oxides of Nitrogen Results & Sampling Details**

| Parameter     | Units              | Run 1  | Run 2 | Run 3 | Mean |
|---------------|--------------------|--------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 274.86 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 22.33  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | 0.7    | -     | -     | -    |

| General Sampling Information          |               |
|---------------------------------------|---------------|
| Parameter                             | Value         |
| Standard                              | EN14792       |
| Technical Procedure                   | SOP2002       |
| Probe material                        | SS            |
| Filtration Type/Size                  | PTFE          |
| Heated Head Filter Used               | Yes           |
| Heated Line Temperature               | 180           |
| Date & Result of last converter check | 95.3          |
| Span Gas Reference Number             | ASLTM18ING503 |
| Span Gas Expiry Date                  | 19-Nov        |
| Span Gas Start Pressure (bar)         | 30            |
| Gas Cylinder Concentration (ppm)      | 160.7         |
| Span Gas Uncertainty (%)              | <2            |
| Zero Gas Type                         | N             |
| Number of Sampling Lines Used         | 1             |
| Number of Sampling Points Used        | 1             |
| Sample Point I.D's                    | KH03          |
| Reference Conditions                  |               |
| Temperature (K)                       | 273.15        |
| Pressure (kPa)                        | 101.3         |
| Gas (Wet or Dry)                      | Dry           |
| Oxygen                                | 5             |

### Oxides of Nitrogen Trend



**Oxides of Nitrogen Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.87-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 250       | -     | -     |
| Measured Reading   | ppm                | 133.88    | -     | -     |
| <b>Measured Quantities</b>   |                    |           |       |       |
| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
| Nonlinearity   | %                  | 1.4       | -     | -     |
| Temperature Dependent Zero drift   | %                  | -0.04     | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.25     | -     | -     |
| Cross-sensitivity  | %                  | 0.5       | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
| Mass Flow Controllers (Dilution) Uncertainty   | %                  | <1        | -     | -     |
| NOx Converter Efficiency   | %                  | 95.3      | -     | -     |
| <b>Parameter</b>   |                    |           |       |       |
| Parameter  | Units              | Run 1     | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 8.13      | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 16.25     | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 22.33     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 4.47      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 22.33     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 8.12      | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |



Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Hydrogen Chloride Sampling Details & Results**

|                               |              |                 |
|-------------------------------|--------------|-----------------|
| <b>Stack ID</b>               | A2-1         | <b>Run 1</b>    |
| <b>Sample ID</b>              | KH03 HCL 1+2 | <b>mls</b>      |
| <b>Impinger 1 ID</b>          | KH03 HCL 1+2 | 255             |
| <b>Impinger 2 ID</b>          | -            | 0               |
| <b>Impinger 3 ID</b>          | KH03 HCL 3   | 141             |
| <b>Time on</b>                | 09:26        |                 |
| <b>Time off</b>               | 10:16        |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 2.9          | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ502 |                 |
| Calibration Rate Before Test: | 2.9          | l/min           |
| Calibration Rate After Test:  | 2.9          | l/min           |
| Average sample Volume:        | 2.9          | l/min           |
| Sample Test Time:             | 50           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.145        | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.145        | Nm <sup>3</sup> |

## Hydrogen Chloride Quality Assurance

| Stack ID                     | A2-1               | Run 1      | Run 2 | Run 3 |
|------------------------------|--------------------|------------|-------|-------|
| Date                         | 17/07/2019         | -          | -     | -     |
| Start time                   |                    | 09:26:00   | -     | -     |
| Finish Time                  |                    | 10:16:00   | -     | -     |
| <b>Leak test results</b>     |                    |            |       |       |
|                              | Units              | Run 1      | Run 2 | Run 3 |
| Mean Sampling Rate           | l/min              | 2.9        | -     | -     |
| Pre-sampling leak rate       | l/min              | 0.01       | -     | -     |
| Post-sampling leak rate      | l/min              | 0.01       | -     | -     |
| Leak rate                    | l/min              | 0          | -     | -     |
| Acceptable leak rate (<2%)   | Y/N                | Yes        | -     | -     |
| <b>Filtration</b>            |                    |            |       |       |
| Filter Material              |                    | N/A        | -     | -     |
| Filter Size                  | mm                 | N/A        | -     | -     |
| Max. Filter Temp             | degrees            | N/A        | -     | -     |
| Absorbers Type               | Glass/PTFE/ Other  | PTFE       | -     | -     |
| Absorption Solution          |                    | Di H2O     | -     | -     |
| <b>Absorption Efficiency</b> |                    |            |       |       |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 1435.05    | -     | -     |
| Impinger 3                   | µg                 | 7.05       | -     | -     |
| Absorption efficiency        | %                  | 100        | -     | -     |
| Acceptable Absorption Eff.   | >95% (Y/N)         | Y          | -     | -     |
| <b>Blank sample</b>          |                    |            |       |       |
| Blank sample ID              |                    | KH01 HCL B | -     | -     |
| Blank result                 | mg.m <sup>-3</sup> | 0.53       | -     | -     |
| Acceptable Blank             | <10% ELV (Y/N)     | Y          | -     | -     |
| <b>Testing laboratory</b>    |                    |            |       |       |
| Laboratory Name              |                    | UKAS1549   | -     | -     |
| Test certificate Number      |                    | 835558     | -     | -     |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Hydrogen Chloride Results & Measurement Uncertainty**

|                         |         |                    |
|-------------------------|---------|--------------------|
| <b>Stack ID</b>         | A2-1    | <b>Run 1</b>       |
| <b>Date</b>             | -       |                    |
| <b>Start time</b>       | 09:26   |                    |
| <b>Finish Time</b>      | 10:16   |                    |
| <b>Results</b>          |         |                    |
| Laboratory Result       | 1435.05 | µg                 |
| Impinger final Volume   | 396     | ml                 |
| Factor                  | -       |                    |
| Concentration           | 1.44    | mg                 |
| Sample Volume           | 0.145   | Nm <sup>3</sup>    |
| Emissions Concentration | 9.9     | mg.m <sup>-3</sup> |
| Mass Emissions          | -       | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0.37  | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 7.42  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.73  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 1.47  | -     | -     | -    |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Hydrogen Fluoride Sampling Details & Results**

| <b>Sampling Details</b>       |              | <b>Run 1</b>    |
|-------------------------------|--------------|-----------------|
| <b>Stack ID</b>               | KH03         |                 |
| <b>Time on</b>                | 10:08        |                 |
| <b>Time off</b>               | 10:38        |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 1.99         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ505 |                 |
| Calibration Rate Before Test: | 1.99         | l/min           |
| Calibration Rate After Test:  | 1.99         | l/min           |
| Average sample Volume:        | 1.99         | l/min           |
| Sample Test Time:             | 30           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.0597       | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.0597       | Nm <sup>3</sup> |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

### Hydrogen Fluoride Quality Assurance

| Stack ID                     | KH03               | Run 1     | Run 2 | Run 3 |
|------------------------------|--------------------|-----------|-------|-------|
| Date                         | 17/07/2019         | -         | -     | -     |
| Start time                   |                    | 10:08:00  | -     | -     |
| Finish Time                  |                    | 10:38:00  | -     | -     |
| <b>Leak test results</b>     |                    |           |       |       |
| Leak test results            | Units              | Run 1     | Run 2 | Run 3 |
| Mean Sampling Rate           | l/min              | 1.99      | -     | -     |
| Pre-sampling leak rate       | l/min              | 0.01      | -     | -     |
| Post-sampling leak rate      | l/min              | 0.01      | -     | -     |
| Leak rate                    | l/min              | 0         | -     | -     |
| Acceptable leak rate (<2%)   | Y/N                | Yes       | -     | -     |
| <b>Filtration</b>            |                    |           |       |       |
| Filter Material              |                    | N/A       | -     | -     |
| Filter Size                  | mm                 | N/A       | -     | -     |
| Max. Filter Temp             | degrees            | N/A       | -     | -     |
| Absorbers Type               | Glass/PTFE/ Other  | Glass     | -     | -     |
| Absorption Solution          |                    | 0.1m NaOH | -     | -     |
| <b>Absorption Efficiency</b> |                    |           |       |       |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 18.5      | -     | -     |
| Impinger 3                   | µg                 | 6.5       | -     | -     |
| Absorption efficiency        | %                  | 65        | -     | -     |
| Acceptable Absorption Eff.   | >95% (Y/N)         | N         | -     | -     |
| <b>Blank sample</b>          |                    |           |       |       |
| Blank sample ID              |                    | KH01 HF B | -     | -     |
| Blank result                 | mg.m <sup>-3</sup> | <0.09     | -     | -     |
| Acceptable Blank             | <10% ELV (Y/N)     | Y         | -     | -     |
| <b>Testing laboratory</b>    |                    |           |       |       |
| Laboratory Name              |                    | UKAS1549  | -     | -     |
| Test certificate Number      |                    | 835558    | -     | -     |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

### Hydrogen Fluoride Results & Measurement Uncertainty

|                         |          |                    |
|-------------------------|----------|--------------------|
| <b>Stack ID</b>         | KH03     | <b>Run 1</b>       |
| <b>Date</b>             | -        |                    |
| <b>Start time</b>       | 10:08:00 |                    |
| <b>Finish Time</b>      | 10:38:00 |                    |
| <b>Results</b>          |          |                    |
| Laboratory Result       | 18.5     | µg                 |
| Impinger final Volume   | 370      | ml                 |
| Factor                  | -        |                    |
| Concentration           | 0.02     | mg                 |
| Sample Volume           | 0.06     | Nm <sup>3</sup>    |
| Emissions Concentration | 0.31     | mg.m <sup>-3</sup> |
| Mass Emissions          | -        | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0.01  | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 8.02  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.02  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.5   | -     | -     | -    |

## Sulphur Dioxide Quality Assurance

| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | KH03              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 09:35        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 1000         | -            | -            |
| Span Gas Value                 | ppm               | 733          | -            | -            |
| Acceptable Gas Range           | -                 | -            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 3            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 8            | -            | -            |
| Zero Drift                     | ppm               | -5           | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 36.55        | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.68        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 731          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 742          | -            | -            |
| Span Drift                     | ppm               | -11          | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 36.55        | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -1.5         | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 733          | -            | -            |
| Recorded Conc. down Line       | ppm               | 742          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |

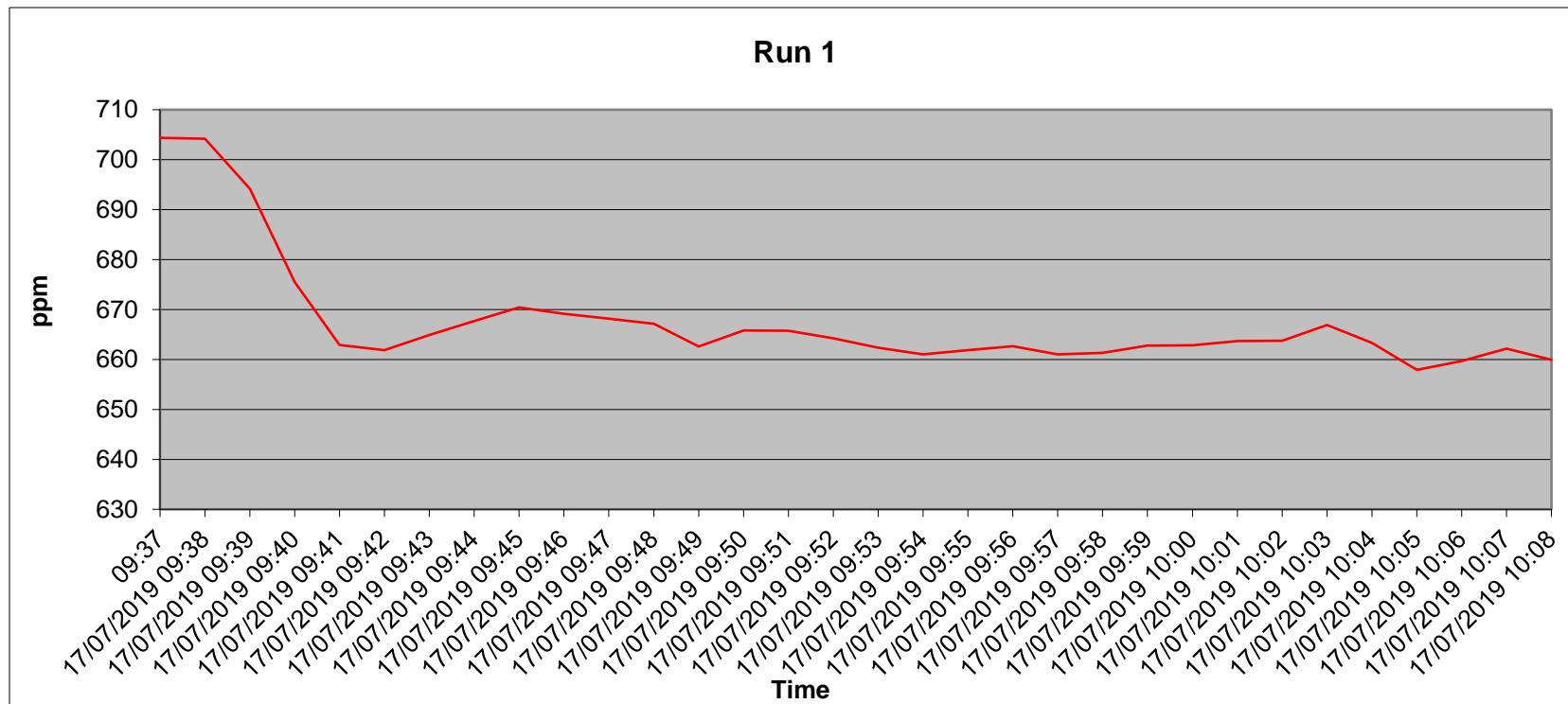
**Sulphur Dioxide Results & Sampling Details**

| Parameter     | Units              | Run 1   | Run 2 | Run 3 | Mean |
|---------------|--------------------|---------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 1909.22 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 124.78  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | 4.88    | -     | -     | -    |

| General Sampling Information          |               |
|---------------------------------------|---------------|
| Parameter                             | Value         |
| Standard                              | CEN/TS 17021  |
| Technical Procedure                   | SOP 2046      |
| Probe material                        | SS            |
| Filtration Type/Size                  | PTFE          |
| Heated Head Filter Used               | Yes           |
| Heated Line Temperature               | 180           |
| Date & Result of last converter check | -             |
| Span Gas Reference Number             | ASLTM18ING512 |
| Span Gas Expiry Date                  | Aug-19        |
| Span Gas Start Pressure (bar)         | 60            |
| Gas Cylinder Concentration (ppm)      | 733           |
| Span Gas Uncertainty (%)              | <2            |
| Zero Gas Type                         | N             |
| Number of Sampling Lines Used         | 1             |
| Number of Sampling Points Used        | 1             |
| Sample Point I.D's                    | KH03          |
| Reference Conditions                  |               |
| Temperature (K)                       | 273.15        |
| Pressure (kPa)                        | 101.3         |
| Gas (Wet or Dry)                      | Dry           |
| Oxygen                                | 5             |



### Sulphur Dioxide Trend



Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

**Sulphur Dioxide Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
|--|--------------------|--------------|-------|-------|
| Certified Range of Analyser  | ppm                | 2.14 to 1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 1000         | -     | -     |
| Measured Reading   | ppm                | 667.56       | -     | -     |
|  |                    |              |       |       |
| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.8          | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.8          | -     | -     |
| Temperature Dependent Span drift   | %                  | 2            | -     | -     |
| Cross-sensitivity  | %                  | 1.5          | -     | -     |
| Leak   | %                  | 0            | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2 %         | -     | -     |
|  |                    |              |       |       |
| Parameter  | Units              | Run 1        | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 32.25        | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 64.5         | -     | -     |
|  |                    |              |       |       |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 124.78       | -     | -     |
|  |                    |              |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | -            | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 124.78       | -     | -     |
|  |                    |              |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 6.54         | -     | -     |
|  |                    |              |       |       |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |              |       |       |

**T A Luft Organics**

| <b>Title:</b>                 | <b>Determination of Speciated Organic Compounds</b> |                   |       | <b>Run 1</b>    |
|-------------------------------|---|-------------------|-------|-----------------|
| Method:                       | EN 13649  | -                 | -     | -               |
| Client:                       | Knockharley Landfill                                | -                 | 10:20 | <b>Time on</b>  |
| Log Sheet Complete by:        | Amanda Sheridan                                     | -                 | 10:51 | <b>Time off</b> |
| Test Date:                    | 17/07/2019  | -                 | -     | -               |
| Laboratory Used:              | UKAS1549  | -                 | -     | -               |
| Certificate Numbers:          | 835558  | -                 | -     | -               |
| Stack Reference:              | KH03  | -                 | -     | -               |
| <b>Leak Check Results</b>     |   |                   |       |                 |
| Prior to test:                | 0.0001  | l/min             | -     | -               |
| Post Test:                    | 0.0001  | l/min             | -     | -               |
| Sample Volume Flow Rate:      | 0.3999  | l/min             | -     | -               |
| Standard Requirement:         | <2  | %                 | -     | -               |
| Test Result:                  | 0   | %                 | -     | -               |
| Test Status                   | Pass  | -                 | -     | -               |
| <b>Calibration Details</b>    |   |                   |       |                 |
| Pump Number:                  | ASLTM12EQ504  | -                 | -     | -               |
| Calibration Unit:             | ASLTM18E509   | -                 | -     | -               |
| Calibration Rate Before Test: | 0.399   | litres per minute | -     | -               |
| Calibration Rate After Test:  | 0.399   | litres per minute | -     | -               |
| Average sample Volume:        | 0.399   | litres per minute | -     | -               |
| Sample Test Time:             | 31  | minutes           | -     | -               |
| Pump Gas Temperature:         | 15  | °C                | -     | -               |
| Pump Sample Pressure:         | 101   | kPa               | -     | -               |
| Actual Sample Volume:         | 0.01237   | m <sup>3</sup>    | -     | -               |
| Normalised Gas Volume:        | 0.01169   | Nm <sup>3</sup>   | -     | -               |
| <b>Tube Details</b>           |   |                   |       |                 |
| Tube Type:                    | 226-09  | -                 | -     | -               |
| Tube Identification Number:   | 7899119276  | -                 | -     | -               |
| Blank Identification Number:  | 7899119272  | -                 | -     | -               |
| Blank Result                  | 0.08  | mg/m <sup>3</sup> | -     | -               |

| <b>Test Details</b>              |                |                          |              |              |
|----------------------------------|----------------|--------------------------|--------------|--------------|
| Adsorption Tube Temperature:     | 15             | °C                       | -            | -            |
| Max Temperature Allowable:       | 40             | °C                       | -            | -            |
| <b>Stack Flow Rates</b>          |                |                          |              |              |
| Diameter:                        | 0.4            | m                        | -            | -            |
| Average Velocity:                | 15.82          | m/s                      | -            | -            |
| Average Temperature:             | 425            | °C                       | -            | -            |
| Average Pressure:                | 101            | kPa                      | -            | -            |
| Actual Flow Rate:                | 7158           | m <sup>3</sup> /Hr       | -            | -            |
| Normalised Flow Rate:            | 2558           | Nm <sup>3</sup> /Hr      | -            | -            |
| <b>Speciated Organic Results</b> |                |                          |              |              |
| <b>Class I</b>                   | <b>ug/tube</b> | <b>mg/Nm<sup>3</sup></b> | <b>kg/hr</b> |              |
| Chloroform                       | <5             | < 0.43                   | < 0.0011     | -            |
| Benzene                          | <1             | < 0.09                   | < 0.0002     | -            |
| Dichloromethane (DCM)            | <10            | < 0.86                   | < 0.0022     | -            |
| Tetrachloroethylene              | <10            | < 0.86                   | < 0.0022     | -            |
| Trichloroethylene                | <10            | < 0.86                   | < 0.0022     | -            |
| Carbon Tetrachloride             | <5             | < 0.43                   | < 0.0011     | -            |
| Limit of detection               | -              | -                        | -            | -            |
| <b>Class II</b>                  | <b>ug/tube</b> | <b>mg/Nm<sup>3</sup></b> | <b>kg/hr</b> |              |
| Toluene                          | <5             | < 0.43                   | < 0.0011     | -            |
| M+P Xylene                       | <1             | < 0.09                   | < 0.0002     | -            |
| Cyclohexane                      | <20            | < 1.71                   | < 0.0044     | -            |
| Cyclohexanone                    | <10            | < 0.86                   | < 0.0022     | -            |
| O-Xylene                         | <1             | < 0.09                   | < 0.0002     | -            |
| Tetrahydrofuran                  | <10            | < 0.86                   | < 0.0022     | -            |
| Limit of detection               | -              | -                        | -            | -            |
| <b>Class III</b>                 | <b>ug/tube</b> | <b>mg/Nm<sup>3</sup></b> | <b>kg/hr</b> |              |
| Ethanol                          | <10            | < 0.86                   | < 0.002      | -            |
| Ethyl Acetate                    | <10            | < 0.86                   | < 0.002      | -            |
| Heptane                          | <10            | < 0.86                   | < 0.002      | -            |
| Hexane                           | <10            | < 0.86                   | < 0.002      | -            |
| Methyl-iso-butyl Ketone          | <5             | < 0.43                   | < 0.001      | -            |
| Methyl Ethyl Ketone              | <5             | < 0.43                   | < 0.001      | -            |
| Propan-2-ol                      | <10            | < 0.86                   | < 0.002      | -            |
| Acetone                          | <10            | < 0.86                   | < 0.002      | -            |
| Limit of detection               | -              | -                        | -            | -            |
| <b>Total Class I</b>             | 3.51           | <b>mg/Nm<sup>3</sup></b> | 0.009        | <b>kg/hr</b> |
| <b>Total Class II</b>            | 4.02           | <b>mg/Nm<sup>3</sup></b> | 0.01         | <b>kg/hr</b> |

Document No.: KNLATL1170719 / 2019432

EPA Licence No.: WL0146-02

Visit No: 1

Licence Holder: Knockharley Landfill, KH03

Year: 2019

Facility Location: Knickharley Facility

Office: Trim

Rev.No: 1

|                                    |       |                    |       |       |
|------------------------------------|-------|--------------------|-------|-------|
| Total Class III                    | 5.99  | mg/Nm <sup>3</sup> | 0.015 | kg/hr |
| Total Organics                     | 13.52 | mg/Nm <sup>3</sup> | 0.035 | kg/hr |
| <i>Subtracted less than values</i> |       |                    |       |       |
| Total Class I                      | 3.51  | mg/Nm <sup>3</sup> |       |       |
| Total Class II                     | 4.02  | mg/Nm <sup>3</sup> |       |       |
| Total Class III                    | 5.99  | mg/Nm <sup>3</sup> |       |       |
| Total Organics                     | 13.52 | mg/Nm <sup>3</sup> |       |       |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH03

Facility Location: Knickharley Facility

Rev.No: 1

| <i>Non-detected less than values</i> |   |                          |  |  |
|--------------------------------------|---|--------------------------|--|--|
| <b>Total Class I</b>                 | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |
| <b>Total Class II</b>                | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |
| <b>Total Class III</b>               | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |
| <b>Total Organics</b>                | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |

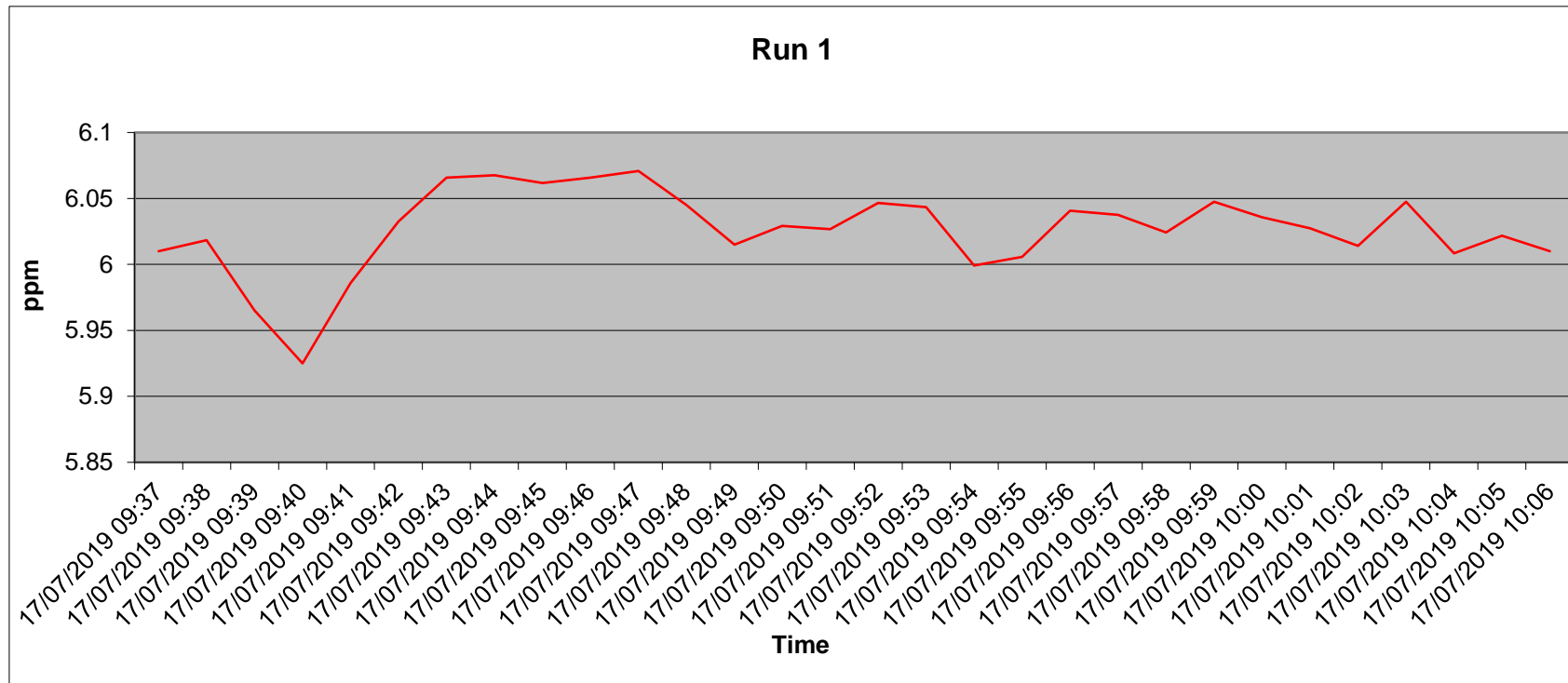
| <b>Parameter</b>                                  | <b>Units</b>        | <b>Run 1</b> |
|---|---------------------|--------------|
| Combined Uncertainty                              | mg.m <sup>-3</sup>  | 1.25         |
| Expanded uncertainty                              | % of measured value | 18.49        |
| Expanded uncertainty in units                     | mg.m <sup>-3</sup>  | 2.5          |
| Expanded uncertainty as percentage of limit value | % Of ELV            | -            |

**Oxygen Quality Assurance**

| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                |                   | KH03         |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 09:35        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 25           | -            | -            |
| Span Gas Value                 | ppm               | 20.9         | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0            | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0.1          | -            | -            |
| Zero Drift                     | %                 | -0.1         | -            | -            |
| Allowable Zero Drift (5%)      | %                 | 1.05         | -            | -            |
| Zero Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 20.9         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 20.9         | -            | -            |
| Span Drift                     | %                 | 0            | -            | -            |
| Allowable Span Drift (5%)      | %                 | 1.05         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | %                 | 20.9         | -            | -            |
| Recorded Conc. down Line       | %                 | 20.9         | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |
| Combined uncertainty           | % vol             | 0.13         | -            | -            |
| % of value                     | %                 | 2.22         | -            | -            |
| Expanded uncertainty           | % of value        | 4.44         | -            | -            |
| Expanded uncertainty           | % vol             | 0.27         | -            | -            |



### Oxygen trend



**Carbon Dioxide Quality Assurance**

| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | KH03              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 09:35        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 20           | -            | -            |
| Span Gas Value                 | ppm               | 14.96        | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0.2          | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0.3          | -            | -            |
| Zero Drift                     | %                 | -0.1         | -            | -            |
| Allowable Zero Drift (4%)      | %                 | 0.59         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 14.8         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 14.85        | -            | -            |
| Span Drift                     | %                 | -0.05        | -            | -            |
| Allowable Span Drift (4%)      | %                 | 0.59         | -            | -            |
| Span Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 14.96        | -            | -            |
| Recorded Conc. down Line       | ppm               | 14.85        | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |
| Combined uncertainty           | % vol             | 0.18         | -            | -            |
| % of value                     | %                 | 1.56         | -            | -            |
| Expanded uncertainty           | % of value        | 3.11         | -            | -            |
| Expanded uncertainty           | % vol             | 0.35         | -            | -            |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

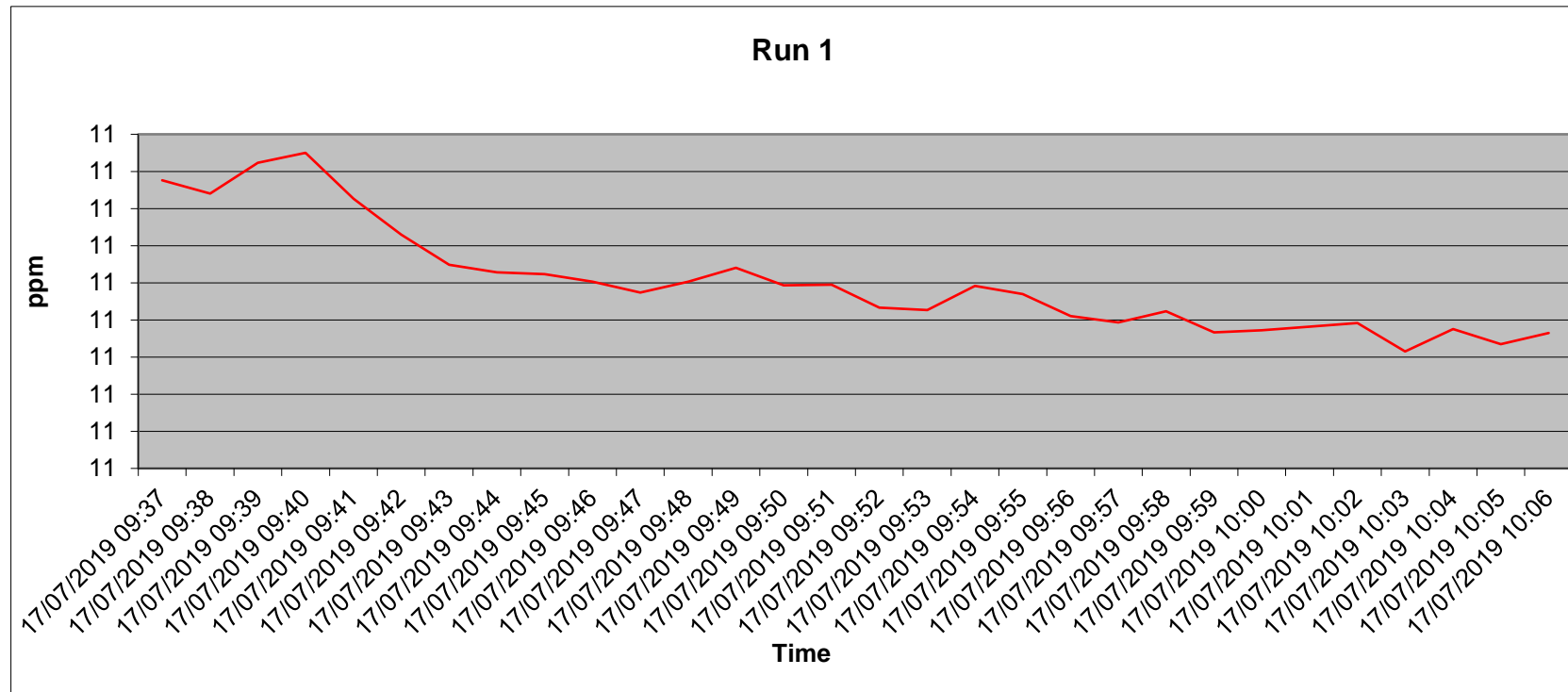
EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH03  
 Facility Location: Knickharley Facility  
 Rev.No: 1

### Carbon Dioxide Results & Sampling Details

| Parameter     | Units | Run 1 | Run 2 | Run 3 | Mean |
|---------------|-------|-------|-------|-------|------|
| Concentration | %     | 11.25 | -     | -     | -    |
| Uncertainty   | %     | 0.35  | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | ISO12039      |
| Technical Procedure              | SOP 2045      |
| Probe material                   | SS            |
| Filtration Type/Size             | Ceramic       |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM18ING525 |
| Span Gas Expiry Date             | 22-Dec        |
| Span Gas Start Pressure (bar)    | 50            |
| Gas Cylinder Concentration (ppm) | 14.96         |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | KH03          |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 5             |

### Carbon Dioxide Trend



Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH03  
Facility Location: Knickharley Facility  
Rev.No: 1

**Moisture Results & Sampling Details**

|   |                                  |                 |                            |       |       |
|---|----------------------------------|-----------------|----------------------------|-------|-------|
| <b>Title:</b>   | <b>Determination of Moisture</b> |                 |                            |       |       |
| <b>Method:</b>  | EN 14790                         |                 |                            |       |       |
| <b>Stack Name</b>   | KH03                             | <b>Time off</b> | <b>Temperature at Pump</b> | 0     | Deg C |
| <b>Test Time</b>  | 09:10                            | 09:40           | <b>Pressure at Pump</b>    | 101.3 | kPa   |
| <b>Dry Gas Meter Reading Before</b>                         | -                                | m <sup>3</sup>  | <b>Humidity at Pumps</b>   | 0.1   | %     |
| <b>Dry Gas Meter Reading After</b>                          | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Volume of Air Sampled</b>                                | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Normalised Air Volume Sampled</b>                        | 0.06                             | Nm <sup>3</sup> |                            |       |       |
| <b>Leak Rate</b>  | 0.001                            |                 |                            |       |       |
| <b>Balance Calibration</b>                                  |                                  |                 |                            |       |       |
|   | <b>Weight</b>                    |                 |                            |       |       |
| 200.0   | 200                              | g               |                            |       |       |
| 1000.0  | 1000                             | g               |                            |       |       |
| <b>Inpinger Weights</b>                                     |                                  |                 |                            |       |       |
|   | <b>Initial</b>                   | <b>Final</b>    | <b>Difference</b>          |       |       |
| 1   | 484.9                            | 487.4           | 2.5                        |       |       |
| 2   | 439.1                            | 440.6           | 1.5                        |       |       |
| 3   | 454.1                            | 454.5           | 0.4                        |       |       |
| 4   | 644.1                            | 644.2           | 0.1                        |       |       |
| <b>Volume of Air Sampled</b>                                | 0.06                             | Nm <sup>3</sup> | <b>4.5</b>                 |       |       |
| <b>Moisture Content (EN 14790)</b>                          | 8.5                              | %               |                            |       |       |
| <b>Combined uncertainty</b>                                 |                                  |                 |                            |       |       |
|   |                                  | 0.2             | %                          |       |       |
| <b>Expanded uncertainty as percentage of measured value</b> |                                  |                 |                            |       |       |
|   |                                  | 4.79            | % measured value           |       |       |
| <b>Expanded uncertainty in units of measurement</b>         |                                  |                 |                            |       |       |
|   |                                  | 0.41            | %                          |       |       |
| <b>Expanded uncertainty as percentage of limit value</b>    |                                  |                 |                            |       |       |
|   |                                  | -               | % ELV                      |       |       |

Uncert Sheets

TPM Uncert

Run 1

Uncertainty calculation for EN 13284 Determination of low range mass concentration of dust, Manual Gravimetric Method

Stack Name: KH03

Measurement Equation

$$c = \frac{m}{V} f_c$$

|                        |      |                    |                           |   |             |
|------------------------|------|--------------------|---------------------------|---|-------------|
| Limit value (ELV)      | 130  | mg.m <sup>-3</sup> | Reference oxygen          | 5 | % by volume |
| Measured concentration | 1.34 | mg.m <sup>-3</sup> | (at reference conditions) |   |             |

| Measured Quantities   | Symbol           | Value | Standard uncertainty | Units                | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|------------------|-------|----------------------|----------------------|---------------------------|-------------------|--------------------|
| Sampled Volume  | V <sub>m</sub>   | 0.39  | uV <sub>m</sub>      | 0.001 m <sup>3</sup> | 0.26                      |                   | <=2%               |
| Sampled gas Temperature   | T <sub>m</sub>   | 289.1 | uT <sub>m</sub>      | 2 k                  | 0.69                      |                   | <=1%               |
| Sampled gas Pressure  | p <sub>m</sub>   | 101   | uρ <sub>m</sub>      | 1 kPa                | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | H <sub>m</sub>   | 0.1   | uH <sub>m</sub>      | 1 % by volume        | 1000.00                   |                   | <=1%               |
| Oxygen content  | O <sub>2,m</sub> | 0     | uO <sub>2,m</sub>    | 0.1 % by volume      | 0.00                      |                   | <=5%               |
| Mass particulate  | m                | 0.54  | um                   | 0.16 mg              | 29.10                     | 0.30              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |       |                      |                      |                           |                   |                    |
| Leak  | L                | 1.02  |                      | %                    | 1.02                      |                   | <=2%               |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM              | 0.5   |                      | mg                   | 92.59259259               |                   | <=10%              |

| Intermediate calculations |                  |                   |                    |   |
|---------------------------|------------------|-------------------|--------------------|---|
| Factor for std conds      | fs               | 0.94              |                    |   |
| uncertainty components    | symbol           | sensitivity coeff | u (in units of fs) |   |
|                           | ρ <sub>m</sub>   | 0.009             | 0.009              |   |
|                           | H <sub>m</sub>   | 0.009             | 0.009              |   |
|                           | T <sub>m</sub>   | 0.003             | 0.007              |   |
|                           | ufs              |                   | 0.015              | 1.57  |
| Corrected volume          | V                | 0.37              | uV                 | 0.006 m <sup>3</sup>                        |
|                           |                  |                   |                    | $V = V_m f_s$                               |
| Factor for O2 correction  | fc               | 0.76              |                    |   |
| uncertainty components    | symbol           | sensitivity coeff | u                  |   |
|                           | O <sub>2,m</sub> | 0.04              | 0.004              |   |
| Factor for O2 Correction  | ufc              | 0.76              |                    | 0.48  |
|                           |                  |                   |                    | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |

| Parameter                               | Value | Units                   | Sensitivity cc | Uncertainty contribution      | Uncertainty as % |
|---|-------|-------------------------|----------------|-------------------------------|------------------|
| Corrected Volume (standard conditions)  | V     | 0.37 m <sup>3</sup>     | 3.64           | 0.02 mg.m <sup>-3</sup>       | 1.59 %           |
| Mass                                    | m     | 0.54 mg                 | 2.47           | 0.39 mg.m <sup>-3</sup>       | 29.10 %          |
| Factor for O2 Correction                | fc    | 0.76                    | 1.75           | 0.01 mg.m <sup>-3</sup>       | 0.48 %           |
| Leak                                    | L     | 0.01 mg.m <sup>-3</sup> | 1.00           | 0.01 mg.m <sup>-3</sup>       | 0.59 %           |
| Uncollected mass                        | UCM   | 0.29 mg                 | 2.47           | 0.71 mg.m <sup>-3</sup>       | 53.46 %          |
| <b>Combined measurement uncertainty</b> |       |                         |                | <b>0.81 mg.m<sup>-3</sup></b> |                  |

### Uncert Sheets

|  |        |                     |  |
|--|--------|---------------------|--|
| Expanded uncertainty as percentage of measured value | 121.78 | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | 1.63   | mg.m <sup>-3</sup>  |  |
| Expanded uncertainty as percentage of limit value    | 1.25   | % ELV               |  |

Note: Enter values into green boxes  
 Developed for the STA by R Robinson, NPL

$$f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

### CO Uncert

#### Uncertainty calculation for Gaseous Measurement CO

|                        |        |                            |            |        |
|------------------------|--------|----------------------------|------------|--------|
| Limit value            | 1400   | mg/m3 (corre Cal gas conc) | 770        | mg.m-3 |
| Measured concentration | 890.75 | mg/m3                      | Full Scale | 1000   |
| Measured concentration | 890.75 | mg/m3 (Corrected)          |            |        |

| Correction for reference conditions |          |             |           |               |                |
|-------------------------------------|----------|-------------|-----------|---------------|----------------|
|                                     |          | O2, %       | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 5.00        | 0.00      | 101.30        | 273.00         |
|                                     | measured | 6.03        | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35        | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.07        | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.02        | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | <b>1.08</b> | uf        | <b>0.03</b>   |                |

| Performance characteristics           | Value |                       | specification    |
|---------------------------------------|-------|-----------------------|------------------|
| Response time                         | 180   | seconds               | 180.000          |
| Logger sampling interval              | 60    | seconds               |                  |
| Measurement period                    | 32    | minutes               |                  |
| Number of readings in measurement     | 32    |                       |                  |
| Repeatability at zero                 | 0.25  | % full scale          | <1 % range       |
| Repeatability at span level           | 0.15  | % full scale          | <2 % range       |
| Deviation from linearity(lack of fit) | 0.7   | % of value            | <2 % range       |
| Zero drift                            | -5    | mg/m3                 | <2% range / 24hr |
| Span drift                            | -5    | mg/m3                 | <2% range/24hr   |
| volume or pressure flow dependence    | 0.02  | % of full scale/3 kPa | <2 % / 3 kPa     |
| atmospheric pressure dependence       | 0.8   | % of full scale/2 kPa | <3% / 2 kPa      |
| ambient temperature dependence        | 0.01  | % full scale/10K      | <3% range / 10 K |
| N2O (mg/m3)                           | 20    | 0.2                   | mg/m3            |
| CO2 (% vol)                           | 15    | 0.2                   | mg/m3            |
| CH4 (mg/m3)                           | 40    | 0.7                   | mg/m3            |
| H2O (% vol)                           | 20    | 0.2                   | mg/m3            |
| dependence on voltage                 | 0.1   | % full scale/10V      | <2% range        |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | min    | max    | value at calib |       |
|-----------|--------|--------|----------------|-------|
| flow      | 95.00  | 105    | 100            | kPa   |
| pressure  | 100.76 | 100.92 | 100.88         | kPa   |
| temp      | 287    | 288.5  | 287.5          | K     |
| N2O range | 0      | 40     | 0              | mg/m3 |
| CO2 range | 0      | 15     | 0              | %vol  |
| CH4 range | 0      | 57     | 0              | mg/m3 |
| H2O range | 0      | 1      | 0              | %vol  |
| Voltage   | 93     | 121    | 110            | V     |



**Uncert Sheets**

|   |      |            |                    |
|---|------|------------|--------------------|
| losses in the line (leak)                         | 0.00 | % of value | < 0.1%vol /10 volt |
| Uncertainty of calibration gas                    | 2    | % of value | < 2% of value      |
| <b>Performance characteristic</b>                 |      |            |                    |
| Standard deviation of repeatability at zero       |      | ur0        | for mean           |
| Standard deviation of repeatability at span level |      | urs        | for mean           |
| Lack of fit                                       |      | ufit       |                    |
| Drift   |      | u0dr       |                    |
| volume or pressure flow dependence                |      | uspres     |                    |
| atmospheric pressure dependence                   |      | uapres     |                    |
| ambient temperature dependence                    |      | utemp      |                    |
| N2O (mg/m3)                                       |      | uinterf    |                    |
| CO2 (% vol)                                       |      | uinterf    |                    |
| CH4 (mg/m3)                                       |      | uinterf    |                    |
| H2O (% vol)                                       |      | uinterf    |                    |
| Dependence on voltage                             |      | uvolt      |                    |
| losses in the line (leak)                         |      | uleak      |                    |
| Uncertainty of calibration gas                    |      | ucalib     |                    |
| Uncertainty in factor                             |      | uf         |                    |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.93 all +ves  | Criteria<br>sum <4% range<br>17.81500947 |
| 0 all -ves   |  |
| 0.93 largest   |  |
| <b>Value to use for intereference uncertainty</b>                    |  |
| uint   | 0.93                                     |

|   |                           |              |              |
|---|---------------------------|--------------|--------------|
| <b>Measurement uncertainty</b>            |                           |              |              |
| Combined uncertainty                      |                           | 10.98        | mg/m3        |
| Expanded uncertainty                      | k = 2                     | 21.96        | mg/m3        |
| <b>Uncertainty corrected to std conds</b> |                           | <b>53.83</b> | <b>mg/m3</b> |
| Expanded uncertainty                      | expressed with a level of | 3.85         | % ELV        |
| Expanded uncertainty                      | expressed with a level of | 53.83        | mg.m-3       |
| Expanded uncertainty                      | expressed with a level of | 6.04         | % value      |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

**NOx Uncert**

**Uncertainty calculation for Gaseous Measurement NOx EN14792**

Uncert Sheets

**RUN 1**

|                        |        |                           |          |              |
|------------------------|--------|---------------------------|----------|--------------|
| Limit value            | 500    | mg/m3 (corre Cal gas conc | 329.9171 | mg.m-3 (NO2) |
| Measured concentration | 134    | ppm                       |          |              |
| Measured concentration | 274.86 | mg/m3 (101.3 Full Scale   | 513.25   | mg/m3 (NO2)  |
| Measured concentration | 274.86 | mg/m3 (Corrected)         |          |              |

|              |        |
|--------------|--------|
| NO/NO2 ratio | 100.00 |
|--------------|--------|

|              |           |
|--------------|-----------|
| Gas          | NO        |
| Full Scale   | 250 ppm   |
| Cal gas conc | 160.7 ppm |
| Conversion   | 2.053     |

| Correction for reference conditions |          |       |           |               |                |
|-------------------------------------|----------|-------|-----------|---------------|----------------|
|                                     |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 5.00  | 0.00      | 101.30        | 273.00         |
|                                     | measured | 6.03  | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35  | 0.00      | 0.00          | 1.00           |
| Factors                             |          | 1.07  | 1.00      | 1.00          | 1.01           |
| Uncertainty in factor               |          | 0.02  | 0.00      | 0.00          | 0.00           |
| Correction Factor                   |          | 1.08  | uf        | 0.03          |                |

| Performance characteristics           | Value |                    | specification      |
|---------------------------------------|-------|--------------------|--------------------|
| Response time                         | 180   | seconds            | 180.000            |
| Logger sampling interval              | 60    | seconds            |                    |
| Measurement period                    | 32    | minutes            |                    |
| Number of readings in measurement     | 32    |                    |                    |
| Repeatability at zero                 | 0.03  | % full scale       | <1 % range         |
| Repeatability at span level           | 0.06  | % full scale       | <2 % range         |
| Deviation from linearity(lack of fit) | 0.2   | % of value         | <2 % range         |
| Zero drift                            | 0.8   | mg/m3              | <2% range / 24hr   |
| Span drift                            | 1.48  | mg/m3              | <2% range/24hr     |
| volume or pressure flow dependence    | 0     | %of full scale/kPa | <2 % / kPa         |
| atmospheric pressure dependence       | 0     | %of value /kPa     | <3% / kPa          |
| ambient temperature dependence        | 0.3   | % full scale/10K   | <3% range / 10 K   |
| NH3 (mg/m3)                           | 20    | 0.0                | mg/m3              |
| CO2 (% vol)                           | 15    | 0.2                | mg/m3              |
| H2O (% vol)                           | 30    | 0.0                | mg/m3              |
| dependence on voltage                 | 0.1   | % full scale/10V   | <2% range          |
| losses in the line (leak)             | 0     | % of value         | < 0.1%vol /10 volt |
| Converter efficiency                  | 95.3  | %                  | >95%               |
| Uncertainty of calibration gas        | 2     | % of value         | < 2% of value      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | ranges |       |                |
|-----------|--------|-------|----------------|
|           | min    | max   | value at calib |
| flow      | 95.00  | 105   | 100 kPa        |
| pressure  | 101.30 | 101.3 | 101.3 kPa      |
| temp      | 289    | 289   | 289 K          |
| NH3 range | 0      | 0     | 0 mg/m3        |
| CO2 range | 0      | 15    | 0 %vol         |
| H2O range | 0      | 0     | 0 %vol         |
| Voltage   | 93     | 121   | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.05            |
| Lack of fit                                       | ufit        |                               | 0.32            |
| Drift   | u0dr        |                               | 0.00            |
| volume or pressure flow dependence                | uspres      |                               | 0.00            |
| atmospheric pressure dependence                   | uapres      |                               | 0.00            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| NH3   | uinterf     |                               | 0.00            |
| CO2 (% vol)                                       | uinterf     |                               | 0.12            |

|   |
|---|
| Use largest of sum of all positive or all negative influences |
| 0.12 all +ves   |
| 0 all -ves  |
| Criteria sum <4% range  |

**Uncert Sheets**

|                                |  |  |         |  |  |  |      |  |             |
|--------------------------------|--|--|---------|--|--|--|------|--|-------------|
| H2O (% vol)                    |  |  | uinterf |  |  |  | 0.00 | 0.12 largest                               | 5.497208838 |
| Dependence on voltage          |  |  | uvolt   |  |  |  | 0.44 | Value to use for intereference uncertainty |             |
| losses in the line (leak)      |  |  | uleak   |  |  |  | 0.00 | uint                                       | 0.12        |
| Uncertainty of calibration gas |  |  | ucalib  |  |  |  | 3.17 |  |             |
| converter efficiency           |  |  | uceff   |  |  |  | 7.46 |  |             |
| Uncertainty in factor          |  |  | uf      |  |  |  | 6.94 |  |             |

|   |                           |   |       |         |
|---|---------------------------|---|-------|---------|
| <b>Measurement uncertainty</b>                        |                           |   |       |         |
| Combined uncertainty                                  |                           |   | 8.13  | mg/m3   |
| Expanded uncertainty                                  | k =                       | 2 | 16.25 | mg/m3   |
| <b>Uncertainty corrected to std conds</b>             |                           |   |       |         |
|   |                           |   | 22.33 | mg/m3   |
| Expanded uncertainty                                  | expressed with a level of |   | 4.47  | % ELV   |
| Expanded uncertainty                                  | expressed with a level of |   | 22.33 | mg.m-3  |
| <b>Expanded uncertainty expressed with a level of</b> |                           |   |       |         |
|   |                           |   | 8.12  | % value |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

corrected drift to be based on mg/m3 reading and the correction alert to be based on % full scale

**HCL Uncert**

QGU-009-2013 Uncertainty calculation for HCL

v2

|                        |      |                                  |                  |   |             |
|------------------------|------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 50   | mg.m-3                           | Reference oxygen | 5 | % by volume |
| Measured concentration | 9.90 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities     | Symbol | Value | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|-------------------------|--------|-------|----------------------|-----------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas      | Vm     | 0.145 | uVm                  | 0.001 m3        | 1.56                      |                   | <=2%               |
| Sampled gas Temperature | Tm     | 273   | uTm                  | 2 k             | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure    | pm     | 101.3 | upm                  | 1 kPa           | 0.99                      |                   | <=1%               |
| Sampled gas Humidity    | Hm     | 0     | uHm                  | 1 % by volume   | 1.00                      |                   | <=1%               |
| Oxygen content          | O2,m   | 6.02  | uO2,m                | 0.1 % by volume | 1.66                      |                   | <=5%               |

**Uncert Sheets**

|   |    |        |     |        |      |      |      |                    |
|---|----|--------|-----|--------|------|------|------|--------------------|
| Concentration in impinger   | C  | 5.65   | uC  | 0.1695 | mg/l | 3.00 |      | <5%                |
| Impinger solution volume  | VS | 396    | uVS | 0.001  | l    | 0.00 |      | <1%                |
| Mass SO2  | m  | 2237.4 | um  | 67.12  | mg   | 3.00 | 1.35 | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |    |        |     |        |      |      |      |                    |
| Leak  | L  | 2      |     |        | %    | 2.00 |      | <=2%               |

|   |        |                   |    |                    |      |
|---|--------|-------------------|----|--------------------|------|
| Intermediate calculations                   |        |                   |    |                    |      |
| Factor for std conds                        | fs     | 1.00              |    |                    |      |
| uncertainty components                      | symbol | sensitivity coeff |    | u (in units of fs) |      |
|   | ρm     | 0.010             |    | 0.010              |      |
|   | Hm     | 0.010             |    | 0.010              |      |
|   | Tm     | 0.004             |    | 0.007              |      |
|   | ufs    |                   |    | 0.016              | 1.58 |
| Corrected volume                            | V      | 0.15              | uV | 0.003 m3           | 1.73 |
| $V = V_m f_s$                               |        |                   |    |                    |      |
| Factor for O2 correction                    | fc     | 1.07              |    |                    |      |
| uncertainty components                      | symbol | sensitivity coeff |    | u                  |      |
|   | O2,m   | 0.07              |    | 0.007              |      |
| Factor for O2 Correction                    | ufc    | 1.07              |    | 0.007              | 0.67 |
| $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |        |                   |    |                    |      |

| Parameter                              | Value | Units       | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|-------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.15 m3     | 68.25          | 0.17 mg.m-3              | 1.73 %           |
| Mass                                   | m     | 2237.40 mg  | 0.00           | 0.30 mg.m-3              | 3.00 %           |
| Factor for O2 Correction               | fc    | 1.07        | 9.27           | 0.07 mg.m-3              | 0.67 %           |
| Leak                                   | L     | 0.11 mg.m-3 | 1.00           | 0.11 mg.m-3              | 1.15 %           |
| <b>Combined uncertainty</b>            |       |             |                | <b>0.37 mg.m-3</b>       |                  |

|  |             |                     |  |
|--|-------------|---------------------|--|
| Expanded uncertainty as percentage of measured value | <b>7.42</b> | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | <b>0.73</b> | mg.m-3              |  |
| Expanded uncertainty as percentage of limit value    | <b>1.47</b> | % ELV               |  |

Note: Enter values into green boxes

Developed for the STA by R Robinson, NPL

$$f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

Uncert Sheets

$$HFU \left[ f_s = \frac{100 - H_m}{100} \frac{273}{T_m} \frac{\rho_m}{101.3} \right]$$

QGU-009-2013 Uncertainty calculation for HF

v2

|                        |      |                                  |                  |   |             |
|------------------------|------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 5    | mg.m-3                           | Reference oxygen | 5 | % by volume |
| Measured concentration | 0.31 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities   | Symbol | Value  | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|--------|--------|----------------------|-----------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas  | Vm     | 0.0597 | uVm                  | 0.001 m3        | 1.68                      |                   | <=2%               |
| Sampled gas Temperature   | Tm     | 273    | uTm                  | 2 k             | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure  | pm     | 101.3  | upm                  | 1 kPa           | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | Hm     | 0      | uHm                  | 1 % by volume   | 1.00                      |                   | <=1%               |
| Oxygen content  | O2,m   | 6.02   | uO2,m                | 0.1 % by volume | 1.66                      |                   | <=5%               |
| Concentration in impinger   | C      | 0.1    | uC                   | 0.003 mg/l      | 3.00                      |                   | <5%                |
| Impinger solution volume  | VS     | 370    | uVS                  | 0.001 l         | 0.00                      |                   | <1%                |
| Mass SO2  | m      | 37     | um                   | 1.11 mg         | 3.00                      | 0.19              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |        |        |                      |                 |                           |                   |                    |
| Leak  | L      | 2      |                      | %               | 2.00                      |                   | <=2%               |

| Intermediate calculations |        |                   |                    |
|---------------------------|--------|-------------------|--------------------|
| Factor for std conds      | fs     | 1.00              |                    |
| uncertainty components    | symbol | sensitivity coeff | u (in units of fs) |
|                           | pm     | 0.010             | 0.010              |
|                           | Hm     | 0.010             | 0.010              |
|                           | Tm     | 0.004             | 0.007              |
|                           | ufs    |                   | 0.016              |
|                           |        |                   | 1.58               |
| Corrected volume          | V      | 0.06              | uV                 |
|                           |        |                   | 0.001 m3           |
|                           |        |                   | 2.31               |
| Factor for O2 correction  | fc     | 1.07              |                    |
| uncertainty components    | symbol | sensitivity coeff | u                  |
|                           | O2,m   | 0.07              | 0.007              |
| Factor for O2 Correction  | ufc    | 1.07              | 0.007              |
|                           |        |                   | 0.67               |

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$$

$$V = V_m f_s$$

$$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$$

| Parameter                              | Value | Units       | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|-------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.06 m3     | 5.19           | 0.01 mg.m-3              | 2.31 %           |
| Mass                                   | m     | 37.00 mg    | 0.01           | 0.01 mg.m-3              | 3.00 %           |
| Factor for O2 Correction               | fc    | 1.07        | 0.29           | 0.00 mg.m-3              | 0.67 %           |
| Leak                                   | L     | 0.00 mg.m-3 | 1.00           | 0.00 mg.m-3              | 1.15 %           |
| <b>Combined uncertainty</b>            |       |             |                | <b>0.01 mg.m-3</b>       |                  |

**Uncert Sheets**

|  |      |                     |  |
|--|------|---------------------|--|
| Expanded uncertainty as percentage of measured value | 8.02 | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | 0.02 | mg.m-3              |  |
| Expanded uncertainty as percentqge of limit value    | 0.50 | % ELV               |  |

Note: Enter values into green boxes

Developed for the STA by R Robinson, NPL

$$SO_2 U_{f_s} = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

**Run 1**

**Uncertainty calculation for Gaseous Measurement SO2 EA M21**

|                        |         |                           |            |        |
|------------------------|---------|---------------------------|------------|--------|
| Limit value            | -       | mg/m3 (corre Cal gas conc | 2096.38    | mg.m-3 |
| Measured concentration | 1909.22 | mg/m3                     | Full Scale | 2860   |
| Measured concentration | 1909.22 | mg/m3 (Corrected)         |            |        |

| Correction for reference conditions |          |             |           |               |                |
|-------------------------------------|----------|-------------|-----------|---------------|----------------|
|                                     |          | O2, %       | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 5.00        | 0.00      | 101.30        | 273.00         |
|                                     | measured | 6.03        | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35        | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.07        | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.02        | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | <b>1.08</b> | uf        | <b>0.03</b>   |                |

| Performance characteristics           | Value |                       | specification    |
|---------------------------------------|-------|-----------------------|------------------|
| Response time                         | 180   | seconds               | 180.000          |
| Logger sampling interval              | 60    | seconds               |                  |
| Measurement period                    | 32    | minutes               |                  |
| Number of readings in measurement     | 32    |                       |                  |
| Repeatability at zero                 | 0.25  | % full scale          | <1 % range       |
| Repeatability at span level           | 0.15  | % full scale          | <2 % range       |
| Deviation from linearity(lack of fit) | 0.7   | % of value            | <2 % range       |
| Zero drift                            | 0     | mg/m3                 | <2% range / 24hr |
| Span drift                            | 0.5   | mg/m3                 | <2% range/24hr   |
| volume or pressure flow dependence    | 0.02  | % of full scale/3 kPa | <2 % / 3 kPa     |
| atmospheric pressure dependence       | 0.8   | % of full scale/2 kPa | <3% / 2 kPa      |
| ambient temperature dependence        | 0.01  | % full scale/10K      | <3% range / 10 K |
| N2O (mg/m3)                           | 20    | 0.2                   | mg/m3            |
| CO2 (% vol)                           | 15    | 0.2                   | mg/m3            |
| CH4 (mg/m3)                           | 40    | 0.7                   | mg/m3            |

| Effect of drift |                   |
|-----------------|-------------------|
|                 | 0.46 mg/m3        |
|                 | 0.02 % full scale |

|           | min    | max    | value at calib |       |
|-----------|--------|--------|----------------|-------|
| flow      | 95.00  | 105    | 100            | kPa   |
| pressure  | 100.76 | 100.92 | 100.88         | kPa   |
| temp      | 287    | 288.5  | 287.5          | K     |
| N2O range | 0      | 40     | 0              | mg/m3 |
| CO2 range | 0      | 15     | 0              | %vol  |
| CH4 range | 0      | 57     | 0              | mg/m3 |

**Uncert Sheets**

|                                |    |     |                  |                    |           |    |     |     |      |
|--------------------------------|----|-----|------------------|--------------------|-----------|----|-----|-----|------|
| H2O (% vol)                    | 20 | 0.2 | mg/m3            |                    | H2O range | 0  | 1   | 0   | %vol |
| dependence on voltage          |    | 0.1 | % full scale/10V | <2% range          | Voltage   | 93 | 121 | 110 | V    |
| losses in the line (leak)      |    | 2   | % of value       | < 0.1%vol /10 volt |           |    |     |     |      |
| Uncertainty of calibration gas |    | 2   | % of value       | < 2% of value      |           |    |     |     |      |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.76            |
| Lack of fit                                       | ufit        |                               | 7.72            |
| Drift   | u0dr        |                               | 0.26            |
| volume or pressure flow dependence                | uspres      |                               | 0.55            |
| atmospheric pressure dependence                   | uapres      |                               | 0.70            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| N2O (mg/m3)                                       | uinterf     |                               | 0.23            |
| CO2 (% vol)                                       | uinterf     |                               | 0.12            |
| CH4 (mg/m3)                                       | uinterf     |                               | 0.58            |
| H2O (% vol)                                       | uinterf     |                               | 0.01            |
| Dependence on voltage                             | uvolt       |                               | 2.47            |
| losses in the line (leak)                         | uleak       |                               | 22.05           |
| Uncertainty of calibration gas                    | ucalib      |                               | 22.05           |
| Uncertainty in factor                             | uf          |                               | 51.83           |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.93 all +ves  | Criteria<br>sum <4% range<br>38.18448021 |
| 0 all -ves   |  |
| 0.93 largest   |  |
| Value to use for intereference uncertainty                           | uint 0.93                                |

| Measurement uncertainty |                           |        |         |
|-------------------------|---------------------------|--------|---------|
| Combined uncertainty    |                           | 32.25  | mg/m3   |
| Expanded uncertainty    | k = 2                     | 64.50  | mg/m3   |
| Expanded uncertainty    |                           | 124.78 | mg/m3   |
| Expanded uncertainty    | expressed with a level of | 0.00   | % ELV   |
| Expanded uncertainty    | expressed with a level of | 124.78 | mg.m-3  |
| Expanded uncertainty    | expressed with a level of | 6.54   | % value |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

Uncert Sheets

Class Organics Uncert

Run 1

Uncertainty calculation for TOC

|                        |       |                                  |                  |   |             |
|------------------------|-------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 20    | mg.m-3                           | Reference oxygen | 5 | % by volume |
| Measured concentration | 13.52 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities   | Symbol | Value       | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv |
|---|--------|-------------|----------------------|-----------------|---------------------------|-------------------|
| Sampled Volume  | Vm     | 0.011690058 | uVm                  | 0.001 m3        | 8.55                      |                   |
| Sampled gas Temperature   | Tm     | 288         | uTm                  | 2 k             | 0.69                      |                   |
| Sampled gas Pressure  | pm     | 100.6       | upm                  | 1 kPa           | 0.99                      |                   |
| Sampled gas Humidity  | Hm     | 0           | uHm                  | 1 % by volume   | 1.00                      |                   |
| Oxygen content  | O2,m   | 6.02        | uO2,m                | 0.1 % by volume | 1.66                      |                   |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |        |             |                      |                 |                           |                   |
| Leak  | L      | 0           |                      | %               |                           | 0.00              |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM    | 0           |                      | mg              | #REF!                     |                   |

Intermediate calculations

|                          |        |                   |    |                    |   |      |
|--------------------------|--------|-------------------|----|--------------------|---|------|
| Factor for std conds     | fs     | 0.94              |    |                    |   |      |
| uncertainty components   | symbol | sensitivity coeff |    | u (in units of fs) |   |      |
|                          | pm     | 0.009             |    | 0.009              |   |      |
|                          | Hm     | 0.009             |    | 0.009              |   |      |
|                          | Tm     | 0.003             |    | 0.007              |   |      |
|                          | ufs    |                   |    | 0.015              |   | 1.57 |
| Corrected volume         | V      | 0.01              | uV | 0.001 m3           | $V = V_m f_s$                               | 9.22 |
| Factor for O2 correction | fc     | 1.07              |    |                    |   |      |
| uncertainty components   | symbol | sensitivity coeff |    | u                  | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |      |
|                          | O2,m   | 0.07              |    | 0.007              |   |      |
| Factor for O2 Correction | ufc    | 1.07              |    | 0.007              |   | 0.67 |

| Parameter                               | Value | Units       | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|---|-------|-------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions)  | V     | 0.01 m3     | 1228.19        | 1.25 mg.m-3              | 9.22 %           |
| Factor for O2 Correction                | fc    | 1.07        | 12.65          | 0.09 mg.m-3              | 0.67 %           |
| Leak                                    | L     | 0.00 mg.m-3 | 1.00           | 0.00 mg.m-3              | 0.00 %           |
| <b>Combined measurement uncertainty</b> |       |             |                | <b>1.25 mg.m-3</b>       |                  |

Expanded uncertainty as percentage of measured value **18.49** % measured of value expressed with a level of confidence of 95%  
 (Using a coverage factor k=2)

Expanded uncertainty in units of measurement **2.499** mg.m-3



**Uncert Sheets**

Expanded uncertainty as percentage of limit value 0.00 % ELV

$$f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

O<sub>2</sub> Uncert

**Run 1**

**Uncertainty calculation for Gaseous Measurement Oxygen EN14789**

|                        |      |      |                 |      |      |
|------------------------|------|------|-----------------|------|------|
| Limit value            | n/a  | %vol | Calibration gas | 20.9 | %vol |
| Measured concentration | 6.03 | %vol | Full Scale      | 25   | %vol |

| Performance characteristics            | Value |   |                 | specification        |
|--|-------|---|-----------------|----------------------|
| Response time                          | 180   | seconds                                 |                 | < 200 s              |
| Logger sampling interval               | 60    | seconds                                 |                 |                      |
| Measurement period                     | 32    | minutes                                 |                 |                      |
| Number of readings in measurement      | 32    | Assuming 1 minute collected over 1 hour |                 |                      |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev           | <0.2 % range         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev           | <0.4 % range         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-             | <0.3 % volume        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-             | <2% of volume / 24hr |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-             | <2% volume/24hr      |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + 5 l/h         | <1% range            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + 2kPa          | < 1.5 % range        |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + 15K           | <0.3% volume 10 K    |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per | 15                   |
| NO (mg/m3)                             | 300   | 0.02                                    | % by volume per | 300                  |
| NO2 (mg/m3)                            | 30    | 0                                       | % by volume per | 30                   |
| Combined interference                  | 0.56  | % range                                 |                 | <2% range            |
| Dependence on voltage                  | 0.1   | % by volume /10V                        | + 5%            | < 0.1%vol /10 volt   |
| Losses in the line (leak)              | 2     | % of value                              |                 | < 2% of value        |
| Uncertainty of calibration gas         | 0.5   | % of value                              |                 |                      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

|           | range of variation from conditions at calibration |     |                |
|-----------|---|-----|----------------|
|           | min   | max | value at calib |
| flow      | 5   | 15  | 10 l/h         |
| pressure  | 99.00   | 101 | 100 kPa        |
| temp      | 280   | 285 | 285 K          |
| CO2 range | 8   | 15  | 0 % vol        |
| NO range  | 100   | 150 | 0 mg/m3        |
| NO2 range | 5   | 7.5 | 0 mg/m3        |
| Voltage   | 105   | 115 | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | u0dr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.04                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |

Use largest of sum of all positive or all negative influences

**Uncert Sheets**

|                                     |  |  |        |  |  |      |   |
|-------------------------------------|--|--|--------|--|--|------|---|
| NO                                  |  |  |        |  |  | 0.01 | 0.06 all +ves   |
| NO2                                 |  |  |        |  |  | 0.00 | 0 all -ves  |
| Combined interference (from mcerts) |  |  |        |  |  | 0.08 | 0.06 largest  |
| dependence on voltage               |  |  | uvolt  |  |  | 0.03 | Value to use for intereference uncertainty<br>uint 0.06 |
| losses in the line (leak)           |  |  | uleak  |  |  | 0.07 |   |
| Uncertainty of calibration gas      |  |  | ucalib |  |  | 0.02 |   |

|                                |   |  |                        |      |
|--------------------------------|---|--|------------------------|------|
| <b>Measurement uncertainty</b> |   |  | 6.03                   | %vol |
| Combined uncertainty           |   |  | 0.13                   | %vol |
| % of value                     |   |  | 2.22                   | %    |
| Coverage factor k =            | 2   |  |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>4.44 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>0.27 % vol</b>      |      |

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests  
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

corrected drift alert to be based on % full scale

**CO<sub>2</sub> Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement Carbon Dioxide**

|                        |       |      |                 |       |      |
|------------------------|-------|------|-----------------|-------|------|
| Limit value            | n/a   | %vol | Calibration gas | 14.96 | %vol |
| Measured concentration | 11.25 | %vol | Full Scale      | 25    | %vol |

| Performance characteristics       | Value |   |       | specification |
|-----------------------------------|-------|---|-------|---------------|
| Response time                     | 180   | seconds                                 |       | < 200 s       |
| Logger sampling interval          | 60    | seconds                                 |       |               |
| Measurement period                | 32    | minutes                                 |       |               |
| Number of readings in measurement | 32    | Assuming 1 minute collected over 1 hour |       |               |
| Repeatability at zero             | 0.015 | % by volume                             | stdev | <0.2 % range  |
| Repeatability at span level       | 0.014 | % by volume                             | stdev | <0.4 % range  |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

**Uncert Sheets**

|  |       |                     |                 |                      |           |   |     |                |  |
|--|-------|---------------------|-----------------|----------------------|-----------|---|-----|----------------|--|
| Deviation from linearity               | 0.13  | % vol               | +/-             | <0.3 % volume        |           |   |     |                |  |
| Zero drift (during measurement period) | 0     | % vol at zero level | +/-             | <2% of volume / 24hr |           | range of variation from conditions at calibration |     |                |  |
| Span drift (during measurement period) | 0     | % vol at span level | +/-             | <2% volume/24hr      |           | min   | max | value at calib |  |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h     | + 5 l/h         | <1% range            | flow      | 5   | 15  | 10 l/h         |  |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa         | + 2kPa          | < 1.5 % range        | pressure  | 99.00   | 101 | 100 kPa        |  |
| ambient temperature dependence         | -0.07 | % by volume /10K    | + 15K           | <0.3% volume 10 K    | temp      | 280   | 285 | 285 K          |  |
| CO2 (% vol)                            | 15    | 0.07                | % by volume per | 15                   | CO2 range | 8   | 15  | 0 % vol        |  |
| NO (mg/m3)                             | 300   | 0.02                | % by volume per | 300                  | NO range  | 100   | 150 | 0 mg/m3        |  |
| NO2 (mg/m3)                            | 30    | 0                   | % by volume per | 30                   | NO2 range | 5   | 7.5 | 0 mg/m3        |  |
| Combined interference                  | 0.56  | % range             |                 | <2% range            | Voltage   | 105   | 115 | 110 V          |  |
| Dependence on voltage                  | 0.1   | % by volume /10V    | + 5%            | < 0.1%vol /10 volt   |           |   |     |                |  |
| Losses in the line (leak)              | 2     | % of value          |                 | < 2% of value        |           |   |     |                |  |
| Uncertainty of calibration gas         | 0.5   | % of value          |                 |                      |           |   |     |                |  |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | uodr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.04                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |
| NO  |             |                               | 0.01                 |
| NO2   |             |                               | 0.00                 |
| Combined interference (from mcerts)               |             |                               | 0.08                 |
| dependence on voltage                             | uvolt       |                               | 0.03                 |
| losses in the line (leak)                         | uleak       |                               | 0.13                 |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.03                 |

**Use largest of sum of all positive or all negative influences**

|               |
|---------------|
| 0.06 all +ves |
| 0 all -ves    |
| 0.06 largest  |

**Value to use for intereference uncertainty**

|      |      |
|------|------|
| uint | 0.06 |
|------|------|

|                                |   |                        |      |
|--------------------------------|---|------------------------|------|
| <b>Measurement uncertainty</b> |   | 11.25                  | %vol |
| Combined uncertainty           |   | 0.18                   | %vol |
| % of value                     |   | 1.56                   | %    |
| Coverage factor k =            | 2   |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> | <b>3.11 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> | <b>0.35 % vol</b>      |      |

Requirement for SRM is that Uncertaintny should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

**Uncert Sheets**

Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

**Moisture Uncert**

| Run 1   |                  |  |   |                         |  |   |      |
|---|------------------|--|---|-------------------------|--|---|------|
| Uncertainty calculation for Moisture  |                  |  |   |                         |  |   |      |
| Limit value (ELV)   | 0                | mg.m <sup>-3</sup>                           | Reference oxygen                        | 5                       | % by volume  | Measurement Equation<br>$c = \frac{m}{V} f_c$ |      |
| Measured concentration  | 8.54             | mg.m <sup>-3</sup> (at reference conditions) |   |                         |  |   |      |
| Measured Quantities   | Symbol           | Value  | Standard uncertainty                    | Units                   | Uncertainty as percentage                                    | Uncertainty at lv                             |      |
| Sampled Volume  | V <sub>m</sub>   | 0.06   | uV <sub>m</sub>                         | 0.001 m <sup>3</sup>    |  | 1.67  |      |
| Sampled gas Temperature   | T <sub>m</sub>   | 273  | uT <sub>m</sub>                         | 2 k                     |  | 0.73  |      |
| Sampled gas Pressure  | p <sub>m</sub>   | 101.3  | up <sub>m</sub>                         | 1 kPa                   |  | 0.99  |      |
| Sampled gas Humidity  | H <sub>m</sub>   | 0  | uH <sub>m</sub>                         | 1 % by volume           |  | 1.00  |      |
| Oxygen content  | O <sub>2,m</sub> | 6.02   | uO <sub>2,m</sub>                       | 0.1 % by volume         |  | 1.66  |      |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |  |   |                         |  |   |      |
| Leak  | L                | 0.001  |   | %                       |  | 0.00  |      |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM              | 0  |   | mg                      | #REF!  |   |      |
| Intermediate calculations   |                  |  |   |                         |  |   |      |
| Factor for std conds  | fs               | 1.00   |   |                         |  |   |      |
| uncertainty components  | symbol           | sensitivity coeff                            |   | u (in units of fs)      |  |   |      |
|   | p <sub>m</sub>   | 0.010  |   | 0.010                   | $f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$ |   |      |
|   | H <sub>m</sub>   | 0.010  |   | 0.010                   |  |   |      |
|   | T <sub>m</sub>   | 0.004  |   | 0.007                   |  |   |      |
|   | ufs              |  |   | 0.016                   |  |   | 1.58 |
| Corrected volume  | V                | 0.06   | uV                                      | 0.001 m <sup>3</sup>    |  | $V = V_m f_s$                                 | 2.30 |
| Factor for O2 correction  | fc               | 1.07   |   |                         |  |   |      |
| uncertainty components  | symbol           | sensitivity coeff                            |   | u                       | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$                  |   |      |
|   | O <sub>2,m</sub> | 0.07   |   | 0.007                   |  |   |      |
| Factor for O2 Correction  | ufc              | 1.07   |   | 0.007                   |  | 0.67  |      |
| Parameter   | Value            | Units  | Sensitivity cc Uncertainty contribution |                         | Uncertainty as %   |   |      |
| Corrected Volume (standard conditions)  | V                | 0.06 m <sup>3</sup>                          | 142.28                                  | 0.20 mg.m <sup>-3</sup> | 2.30 %   |   |      |

**Uncert Sheets**

|   |    |                         |      |                               |        |
|---|----|-------------------------|------|-------------------------------|--------|
| Factor for O2 Correction                | fc | 1.07                    | 7.99 | 0.06 mg.m <sup>-3</sup>       | 0.67 % |
| Leak                                    | L  | 0.00 mg.m <sup>-3</sup> | 1.00 | 0.00 mg.m <sup>-3</sup>       | 0.00 % |
| <b>Combined measurement uncertainty</b> |    |                         |      | <b>0.20 mg.m<sup>-3</sup></b> |        |

|  |                                    |                     |  |
|--|------------------------------------|---------------------|--|
| Expanded uncertainty as percentage of measured value | <input type="text" value="4.79"/>  | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | <input type="text" value="0.409"/> | mg.m <sup>-3</sup>  |  |
| Expanded uncertainty as percentage of limit value    | <input type="text" value="0.00"/>  | % ELV               |  |



CONCEPT LIFE SCIENCES  
DELIVERING SCIENCE

Concept Life Sciences is a trading name of  
Concept Life Sciences Analytical & Development  
Services Limited registered in England and  
Wales (No 2514788)

# Concept Life Sciences

## Certificate of Analysis

Hadfield House  
Hadfield Street  
Cornbrook  
Manchester  
M16 9FE  
Tel : 0161 874 2400  
Fax : 0161 874 2404

**Report Number:** 835558-1

**Date of Report:** 06-Aug-2019

**Customer:** Air Scientific  
Unit 32 Degranville Court  
Dublin Road  
Trim  
Co. Meath  
Ireland.

**Customer Contact:** Project Management

**Customer Job Reference:** KNLATL110719

**Date Job Received at Concept:** 19-Jul-2019

**Date Analysis Started:** 22-Jul-2019

**Date Analysis Completed:** 06-Aug-2019

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

Customers are responsible for information provided where, if incorrect, it could affect the validity of the results.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with QMSection 15 of the Concept Life Sciences, Analytical Services Quality Manual



1549

Report checked  
and authorised by :  
David Plachcinski  
Customer Service Advisor

Issued by :  
David Plachcinski  
Customer Service Advisor

|  |        |      |       |        |              |             |             |              |             |  |
|--|--------|------|-------|--------|--------------|-------------|-------------|--------------|-------------|--|
| Concept Reference: 835558                              |        |      |       |        |              |             |             |              |             |  |
| Customer Reference: KNLATL110719                       |        |      |       |        |              |             |             |              |             |  |
| Impinger(DI water)      Analysed as Impinger(DI water) |        |      |       |        |              |             |             |              |             |  |
| Misc   |        |      |       |        |              |             |             |              |             |  |
| Concept Reference                                      |        |      |       |        | 835558 001   | 835558 002  | 835558 003  | 835558 007   | 835558 008  |  |
| Customer Sample Reference                              |        |      |       |        | KH01 HCL 1+2 | KH01 HCL 3  | KH01 HCL B  | KH03 HCL 1+2 | KH03 HCL 3  |  |
| Test Sample  |        |      |       |        | AR           | AR          | AR          | AR           | AR          |  |
| Date Sampled   |        |      |       |        | 17-JUL-2019  | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019  | 17-JUL-2019 |  |
| Determinand  | Method | LOD  | Units | Symbol |              |             |             |              |             |  |
| Hydrogen Chloride                                      | IC     | 0.05 | mg/l  | SU     | 0.30         | <0.05       | 0.25        | 5.6          | <0.05       |  |
| Volume   | Vol    | 1    | ml    | U      | 140          | 130         | 140         | 140          | 140         |  |

|  |        |      |       |        |              |             |             |             |             |  |
|--|--------|------|-------|--------|--------------|-------------|-------------|-------------|-------------|--|
| Concept Reference: 835558                              |        |      |       |        |              |             |             |             |             |  |
| Customer Reference: KNLATL110719                       |        |      |       |        |              |             |             |             |             |  |
| Impinger(DI water)      Analysed as Impinger(DI water) |        |      |       |        |              |             |             |             |             |  |
| Misc   |        |      |       |        |              |             |             |             |             |  |
| Concept Reference                                      |        |      |       |        | 835558 011   | 835558 012  | 835558 015  | 835558 016  | 835558 019  |  |
| Customer Sample Reference                              |        |      |       |        | KH04 HCL 1+2 | KH04 HCL 3  | F1 HCL 1+2  | F1 HCL 3    | F2 HCL 1+2  |  |
| Test Sample  |        |      |       |        | AR           | AR          | AR          | AR          | AR          |  |
| Date Sampled   |        |      |       |        | 17-JUL-2019  | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 |  |
| Determinand  | Method | LOD  | Units | Symbol |              |             |             |             |             |  |
| Hydrogen Chloride                                      | IC     | 0.05 | mg/l  | SU     | 0.50         | <0.05       | 0.50        | <0.05       | 0.15        |  |
| Volume   | Vol    | 1    | ml    | U      | 140          | 140         | 140         | 130         | 150         |  |

|  |        |      |       |        |             |  |  |  |  |  |
|--|--------|------|-------|--------|-------------|--|--|--|--|--|
| Concept Reference: 835558                              |        |      |       |        |             |  |  |  |  |  |
| Customer Reference: KNLATL110719                       |        |      |       |        |             |  |  |  |  |  |
| Impinger(DI water)      Analysed as Impinger(DI water) |        |      |       |        |             |  |  |  |  |  |
| Misc   |        |      |       |        |             |  |  |  |  |  |
| Concept Reference                                      |        |      |       |        | 835558 020  |  |  |  |  |  |
| Customer Sample Reference                              |        |      |       |        | F2 HCL 3    |  |  |  |  |  |
| Test Sample  |        |      |       |        | AR          |  |  |  |  |  |
| Date Sampled   |        |      |       |        | 17-JUL-2019 |  |  |  |  |  |
| Determinand  | Method | LOD  | Units | Symbol |             |  |  |  |  |  |
| Hydrogen Chloride                                      | IC     | 0.05 | mg/l  | SU     | <0.05       |  |  |  |  |  |
| Volume   | Vol    | 1    | ml    | U      | 120         |  |  |  |  |  |

|  |                                |      |       |        |             |             |             |             |             |  |
|--|--------------------------------|------|-------|--------|-------------|-------------|-------------|-------------|-------------|--|
| Concept Reference: 835558  |                                |      |       |        |             |             |             |             |             |  |
| Customer Reference: KNLATL110719   |                                |      |       |        |             |             |             |             |             |  |
| Impinger (sodium hydroxide)      Analysed as Impinger (sodium hydroxide) |                                |      |       |        |             |             |             |             |             |  |
| Miscellaneous  |                                |      |       |        |             |             |             |             |             |  |
| Concept Reference  |                                |      |       |        | 835558 004  | 835558 005  | 835558 006  | 835558 009  | 835558 010  |  |
| Customer Sample Reference  |                                |      |       |        | KH01 HF 1+2 | KH01 HF 3   | KH01 HF B   | KH03 HF 1+2 | KH03 HF 3   |  |
| Test Sample  |                                |      |       |        | AR          | AR          | AR          | AR          | AR          |  |
| Date Sampled   |                                |      |       |        | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 |  |
| Determinand  | Method                         | LOD  | Units | Symbol |             |             |             |             |             |  |
| Hydrogen Fluoride  | IC (acetate separation method) | 0.05 | mg/l  | SU     | 0.28        | <0.05       | <0.05       | <0.05       | <0.05       |  |
| Volume   | Vol                            | 1    | ml    | U      | 140         | 140         | 140         | 140         | 140         |  |

|   |                                |            |              |               |             |             |             |             |             |
|---|--------------------------------|------------|--------------|---------------|-------------|-------------|-------------|-------------|-------------|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger (sodium hydroxide)</b> Analysed as Impinger (sodium hydroxide)<br><b>Miscellaneous</b> |                                |            |              |               |             |             |             |             |             |
| <b>Concept Reference</b>  |                                |            |              |               | 835558 013  | 835558 014  | 835558 017  | 835558 018  | 835558 021  |
| <b>Customer Sample Reference</b>  |                                |            |              |               | KH04 HF 1+2 | KH04 HF 3   | F1 HF 1+2   | F1 HF 3     | F2 HF 1+2   |
| <b>Test Sample</b>  |                                |            |              |               | AR          | AR          | AR          | AR          | AR          |
| <b>Date Sampled</b>   |                                |            |              |               | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 |
| <b>Determinand</b>  | <b>Method</b>                  | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |             |             |             |             |
| Hydrogen Fluoride   | IC (acetate separation method) | 0.05       | mg/l         | SU            | <0.05       | <0.05       | <0.05       | <0.05       | <0.05       |
| Volume  | Vol                            | 1          | ml           | U             | 140         | 130         | 140         | 140         | 140         |

|   |                                |            |              |               |             |
|---|--------------------------------|------------|--------------|---------------|-------------|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger (sodium hydroxide)</b> Analysed as Impinger (sodium hydroxide)<br><b>Miscellaneous</b> |                                |            |              |               |             |
| <b>Concept Reference</b>  |                                |            |              |               | 835558 022  |
| <b>Customer Sample Reference</b>  |                                |            |              |               | F2 HF 3     |
| <b>Test Sample</b>  |                                |            |              |               | AR          |
| <b>Date Sampled</b>   |                                |            |              |               | 17-JUL-2019 |
| <b>Determinand</b>  | <b>Method</b>                  | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |
| Hydrogen Fluoride   | IC (acetate separation method) | 0.05       | mg/l         | SU            | 0.08        |
| Volume  | Vol                            | 1          | ml           | U             | 130         |

|  |               |            |              |               |             |
|--|---------------|------------|--------------|---------------|-------------|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>Misc</b> |               |            |              |               |             |
| <b>Concept Reference</b>   |               |            |              |               | 835558 023  |
| <b>Customer Sample Reference</b>   |               |            |              |               | 7899119272  |
| <b>Test Sample</b>   |               |            |              |               | AR          |
| <b>Date Sampled</b>  |               |            |              |               | 17-JUL-2019 |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |
| Total VOC as C   | GC/MS         | 1          | µg           | N             | <1          |



| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>EPA Suite 2018</b> |               |                    |                    |                    |     |     |     |
|--|---------------|--------------------|--------------------|--------------------|-----|-----|-----|
| <b>Concept Reference</b>   |               | <b>835558 024</b>  | <b>835558 025</b>  | <b>835558 026</b>  |     |     |     |
| <b>Customer Sample Reference</b>   |               | <b>7899119275</b>  | <b>7899119276</b>  | <b>7899119280</b>  |     |     |     |
| <b>Test Sample</b>   |               | <b>AR</b>          | <b>AR</b>          | <b>AR</b>          |     |     |     |
| <b>Date Sampled</b>  |               | <b>17-JUL-2019</b> | <b>17-JUL-2019</b> | <b>17-JUL-2019</b> |     |     |     |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b>         | <b>Units</b>       | <b>Symbol</b>      |     |     |     |
| Acetone  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Benzene  | GC/MS         | 1                  | µg                 | U                  | <1  | <1  | <1  |
| Carbon tetrachloride   | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Chloroform   | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Cyclohexane  | GC/MS         | 20                 | µg                 | U                  | <20 | <20 | <20 |
| Cyclohexanone  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Dichloromethane  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Ethanol  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Ethyl acetate  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Heptane  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Hexane   | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Meta/Para-Xylene   | GC/MS         | 1                  | µg                 | U                  | <1  | <1  | <1  |
| Methyl ethyl ketone  | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Methyl iso butyl ketone  | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Ortho-Xylene   | GC/MS         | 1                  | µg                 | U                  | <1  | <1  | <1  |
| Propan-2-ol  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Tetrachloroethylene  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Tetrahydrofuran  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Toluene  | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Trichloroethylene  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |

### Index to symbols used in 835558-1

| Value | Description                     |
|-------|---------------------------------|
| AR    | As Received                     |
| S     | Analysis was subcontracted      |
| U     | Analysis is UKAS accredited     |
| N     | Analysis is not UKAS accredited |



## Test Certificate

Date 31/07/2019

|                    |   |                        |                   |
|--------------------|---|------------------------|-------------------|
| <b>Client</b>      | Air Scientific (TM)<br>Unit 32 De Granville Court<br>Dublin Road<br>Trim<br>Co Meath<br>Ireland | <b>Order No.</b>       | KNLATL1170719     |
|                    |   | <b>Certificate No.</b> | <b>WK19-5573</b>  |
|                    |   | <b>Issue No.</b>       | 1                 |
| <b>Contact</b>     | Amanda  | <b>Date Received</b>   | 22/07/2019        |
| <b>Description</b> | 8 Filters and Washes for TPM  | <b>Technique</b>       | Gravimetric Stack |

| Sample No.               | 1059782  | B     | Method |
|--------------------------|----------|-------|--------|
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059783  | BW    | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |
| Sample No.               | 1059784  | KH01  | Method |
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059785  | KH01W | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |
| Sample No.               | 1059786  | KH03  | Method |
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059787  | KH03W | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |
| Sample No.               | 1059788  | KH04  | Method |
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059789  | KH04W | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |




## Test Certificate

Date 31/07/2019

---

|               |                     |                        |           |
|---------------|---------------------|------------------------|-----------|
| <b>Client</b> | Air Scientific (TM) | <b>Certificate No.</b> | WK19-5573 |
|               |                     | <b>Issue No.</b>       | 1         |

Tested By Alessia Tamburri Date 30/07/2019

Approved By  Date 31/07/2019  
Joanne Dewhurst  
Operational

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited  
(N) Analysis is not UKAS Accredited

Concentration values (mg/m<sup>3</sup> and ppm) are not covered by the scope of UKAS accreditation.  
Results stated as ml are referring to the sample volume.

RPS Laboratories terms and conditions apply - a copy is available on request.

Analysis carried out on samples 'as received'

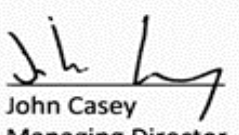
This document may not be reproduced other than in full, except with the written approval of the issuing laboratory.



Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH04  
Facility Location: Knickharley Facility  
Rev.No: 1



|   |   |
|---|---|
| <b>Report Title</b>                                   | Air Emissions Compliance Monitoring Emissions Report  |
| <b>Company address</b>                                | Air Scientific Ltd., 32 DeGranville Court, Dublin road,<br>Trim, Co. Meath  |
| <b>Stack Emissions Testing Report Commissioned by</b> | Knockharley Landfill  |
| <b>Facility Name</b>                                  | Knickharley Facility  |
| <b>Contact Person</b>                                 | Mr Sean O Callaghan   |
| <b>EPA Licence Number</b>                             | WL0146-02   |
| <b>Licence Holder</b>                                 | Knockharley Landfill, KH04  |
| <b>Stack Reference Number</b>                         | KH04  |
| <b>Dates of the Monitoring Campaign</b>               | 17/07/2019  |
| <b>Job Reference Number</b>                           | KNLATL1170719 / 2019432   |
| <b>Report Written By</b>                              | Amanda Sheridan   |
| <b>Report Approved by</b>                             | Dr. John Casey  |
| <b>Stack Testing Team</b>                             | Dr. John Casey, Amanda Sheridan   |
| <b>Report Date</b>                                    | 15/08/2019  |
| <b>Report Type</b>                                    | Test Report Compliance Monitoring   |
| <b>Version</b>  | 1   |
| <b>Signature of Approver</b>                          | <br>John Casey<br>Managing Director |

## Contents

|  |    |
|--|----|
| 1. Executive Summary .....   | 4  |
| I. Monitoring Objectives .....   | 4  |
| Overall Aim of the monitoring Campaign .....                               | 4  |
| Special Requirements .....   | 4  |
| Target Parameters .....  | 4  |
| Emission Limit Values .....  | 5  |
| Reference Conditions .....   | 5  |
| Overall Results .....  | 6  |
| Accreditation details .....  | 7  |
| Monitoring Dates & Times .....   | 8  |
| Monitoring, Equipment & Analytical Methods .....                           | 9  |
| Sampling Deviations .....  | 11 |
| Reference Documents .....  | 11 |
| Suitability of sampling location .....                                     | 12 |
| Process details .....  | 13 |
| Stack diagram .....  | 14 |
| 2. APPENDICES .....  | 15 |
| II. Appendix I - Monitoring Personnel & Equipment .....                    | 15 |
| Stack Emissions Monitoring Personnel .....                                 | 15 |
| III. Appendix II - Stack Details & flow characteristics .....              | 16 |
| Preliminary stack survey calculations .....                                | 16 |
| IV. Appendix III - Individual parameter sampling details and results ..... | 22 |
| Total Particulate Matter: Sampling details and results .....               | 22 |
| Total Particulates Quality Assurance .....                                 | 23 |
| Carbon Monoxide Quality Assurance .....                                    | 24 |
| Carbon Monoxide Results & Sampling details .....                           | 27 |
| Carbon Monoxide Trend .....  | 33 |
| Carbon Monoxide Measurement Uncertainty .....                              | 34 |
| Oxides of Nitrogen Quality Assurance .....                                 | 35 |
| Oxides of Nitrogen Results & Sampling details .....                        | 37 |
| Oxides of Nitrogen Trend .....   | 41 |
| Oxides of Nitrogen Measurement Uncertainty .....                           | 43 |
| Hydrogen Chloride Sampling Details & Results .....                         | 45 |
| Hydrogen Chloride Quality Assurance .....                                  | 46 |
| Hydrogen Chloride Results & Measurement Uncertainty .....                  | 48 |
| Hydrogen Fluoride Sampling Details & Results .....                         | 50 |
| Hydrogen Fluoride Quality Assurance .....                                  | 51 |
| Hydrogen Fluoride Results & Measurement Uncertainty .....                  | 53 |
| Sulphur Dioxide Quality Assurance .....                                    | 54 |
| Sulphur Dioxide Sampling Details & Results .....                           | 55 |
| Sulphur Dioxide Trend .....  | 64 |
| Sulphur Dioxide Results & Measurement Uncertainty .....                    | 70 |

Document No.: KNLATL1170719 / 2019432

EPA Licence No.: WL0146-02

Visit No: 1

Licence Holder: Knockharley Landfill, KH04

Year: 2019

Facility Location: Knickharley Facility

Office: Trim

Rev.No: 1

T A Luft Organics ..... 82

Oxygen Quality Assurance ..... 84

Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH04  
Facility Location: Knickharley Facility  
Rev.No: 1

|  |    |
|--|----|
| Oxygen Trend .....                               | 91 |
| Carbon Dioxide Quality Assurance .....           | 92 |
| Carbon Dioxide Sampling Details & Results .....  | 92 |
| Carbon Dioxide Trend .....                       | 94 |
| Moisture Results & Measurement Uncertainty ..... | 96 |
| <br>   |    |
| Uncertainty Sheets .....                         | 99 |

*Opinions and interpretations expressed herein are outside the scope of Air Scientific Limited INAB accreditation.  
This test report shall not be reproduced, without the written approval of Air Scientific Limited. All sampling  
and reporting is completed in accordance with Environmental Protection Agency Air Guidance Note 2 requirements.*



Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH04  
Facility Location: Knickharley Facility  
Rev.No: 1

## 1. Executive Summary

### I. Monitoring Objectives

#### Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

#### Special Requirements

There were no special requirements.

#### Target Parameters

|   |
|---|
| Total Particulate Matter (TPM)              |
| Carbon Monoxide (CO)                        |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> |
| Hydrogen Chloride (HCL)                     |
| Hydrogen Fluoride (HF)                      |
| T A Luft Organics                           |
| Sulphur Dioxide (SO <sub>2</sub> )          |
| Stack Gas Temperature                       |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )   |
| Oxygen (O <sub>2</sub> )                    |
| Carbon Dioxide (CO <sub>2</sub> )           |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

### Emission Limit Values

| Emission Limit Values / Mass Emissions Limit Values | mg.m <sup>-3</sup> | kg.h <sup>-1</sup> |
|---|--------------------|--------------------|
| TPM   | 130                | -                  |
| CO  | 1400               | -                  |
| NOx as NO <sub>2</sub>                              | 500                | -                  |
| HCL   | 50                 | -                  |
| HF  | 5                  | -                  |
| T A Luft Organics                                   | 20                 | -                  |
| SO <sub>2</sub>                                     | -                  | -                  |
| Stack Gas Temperature                               | -                  | -                  |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )           | 3,000              | -                  |

### Reference Conditions

| Reference Condition | Value  |
|---------------------|--------|
| Oxygen Reference %  | 5      |
| Temperature K       | 273.15 |
| Total Pressure kPa  | 101.3  |
| Moisture Correction | Yes    |

Executive Summary

Overall Results

| Parameter                         | Concentration                   | Result  | MU +/- | Blanks | Limit | Compliant | Mass Emission      | Run 1 | Dates      | Time on  | Time off | O2 Ref. (%) | Accreditation | LOD  |
|-----------------------------------|---------------------------------|---------|--------|--------|-------|-----------|--------------------|-------|------------|----------|----------|-------------|---------------|------|
|                                   | Units                           |         |        |        |       |           | Units              |       |            |          |          |             |               |      |
| TPM EN13284-1:2017                | mg.m <sup>-3</sup>              | <1.41   | 0.81   | <1.34  | 130   | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 14:50    | 15:20:00 | 5           | Yes           | 0.95 |
| CO EN15058:2017                   | mg.m <sup>-3</sup>              | 997.08  | 56.02  | -      | 1400  | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 10:46:00 | 11:19:00 | 5           | Yes           | <1.7 |
| NOx EN14792:2017                  | mg.m <sup>-3</sup>              | 373.2   | 28.24  | -      | 500   | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 10:46:00 | 11:19:00 | 5           | Yes           | <1.8 |
| HCL EN1911:2010                   | mg.m <sup>-3</sup>              | 2.15    | 0.16   | 0.53   | 50    | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 11:12    | 11:48:00 | 5           | Yes           | 0.3  |
| HF EN15713:2006                   | mg.m <sup>-3</sup>              | <0.27   | 0.02   | <0.09  | 5     | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 11:49:00 | 12:24:00 | 5           | Yes           | 0.26 |
| Total TA Luft VOC EN13649:2014    | mg.m <sup>-3</sup>              | <13.47  | 2.35   | <0.08  | 150   | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 12:15:00 | 12:48:00 | 5           | Yes           | 0.08 |
| Class I EN13649:2014              | mg.m <sup>-3</sup>              | <3.5    | 0.61   | -      | 20    | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 12:15:00 | 12:48:00 | 5           | Yes           | 0.08 |
| Class II EN13649:2014             | mg.m <sup>-3</sup>              | <4.01   | 0.7    | -      | 100   | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 12:15:00 | 12:48:00 | 5           | Yes           | 0.08 |
| Class III EN13649:2014            | mg.m <sup>-3</sup>              | <5.97   | 1.04   | -      | 150   | Yes       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 12:15:00 | 12:48:00 | 5           | Yes           | 0.08 |
| SO <sub>2</sub> CEN/TS 17021:2017 | mg.m <sup>-3</sup>              | 1937.82 | 117.87 | -      | -     | N/A       | kg.h <sup>-1</sup> | -     | 17/07/2019 | 10:46:00 | 11:19:00 | 5           | Yes           | <6.1 |
| Oxygen (%) EN14789:2017           | % v/v                           | 5.85    | 0.13   | -      | -     | N/A       | -                  | -     | 17/07/2019 | 10:46:00 | 11:19:00 | 5           | Yes           | -    |
| CO <sub>2</sub> ISO12039:2001     | % v/v                           | 11.24   | 0.35   | -      | -     | N/A       | -                  | -     | 17/07/2019 | 10:46:00 | 11:19:00 | 5           | Yes           | -    |
| H <sub>2</sub> O EN14790:2017     | % v/v                           | 8.5     | 0.41   | -      | -     | N/A       | -                  | -     | 17/07/2019 | 10:24:00 | 10:54:00 | 5           | Yes           | -    |
| Stack Gas Temperature             | K                               | 693.15  | -      | -      | -     | N/A       | -                  | -     | 17/07/2019 | 14:41:00 | 14:51:00 | 5           | Yes           | -    |
| Stack Gas Velocity EN16911:2013   | m.s <sup>-1</sup>               | 15.14   | 0.57   | -      | -     | N/A       | -                  | -     | 17/07/2019 | 14:41:00 | 14:51:00 | 5           | Yes           | -    |
| Volumetric Flow Rate              | m <sup>3</sup> .h <sup>-1</sup> | 2,465   | 303    | -      | 3,000 | Yes       | -                  | -     | -          | -        | -        | 5           | Yes           | -    |
| Volumetric Flow Rate (Ref)        | m <sup>3</sup> .h <sup>-1</sup> | 2,333   | -      | -      | 3,000 | Yes       | -                  | -     | -          | -        | -        | 5           | Yes           | -    |

Accreditation details

|                                |          |
|--------------------------------|----------|
| Air Scientific Limited         | INAB319T |
| External Analytical Laboratory | UKAS1549 |
| Other                          | UKAS0605 |



## Executive Summary

## Monitoring Dates &amp; Times

| Parameter                                   | Run   | Location ID | Sampling Dates | Sampling Time On | Sampling Time Off | Duration (mins.) |
|---|-------|-------------|----------------|------------------|-------------------|------------------|
| Total Particulate Matter (TPM)              | Run 1 | KH04        | 17/07/2019     | 14:50            | 15:20:00          | -                |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Carbon Monoxide (CO)                        | Run 1 | KH04        | 17/07/2019     | 10:46:00         | 11:19:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> | Run 1 | KH04        | 17/07/2019     | 10:46:00         | 11:19:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Chloride (HCL)                     | Run 1 | A2-1        | 17/07/2019     | 11:12            | 11:48:00          | -                |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Fluoride (HF)                      | Run 1 | KH04        | 17/07/2019     | 11:49:00         | 12:24:00          | 00:35:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| T A Luft Organics                           | Run 1 | KH04        | 17/07/2019     | 12:15:00         | 12:48:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Sulphur Dioxide (SO <sub>2</sub> )          | Run 1 | KH04        | 17/07/2019     | 10:46:00         | 11:19:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxygen (%)                                  | Run 1 | KH04        | 17/07/2019     | 10:46:00         | 11:19:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Water Vapour (%)                            |       | KH04        | 17/07/2019     | 10:24:00         | 10:54:00          | 00:30:00         |
| Stack Gas Temperature                       |       | KH04        | 17/07/2019     | 14:41:00         | 14:51:00          | 00:10:00         |
| Stack Gas Velocity                          |       | KH04        | 17/07/2019     | 14:41:00         | 14:51:00          | 00:10:00         |
| Carbon Dioxide (%)                          | Run 1 | KH04        | 17/07/2019     | 10:46:00         | 11:19:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

Executive Summary

Monitoring, Equipment & Analytical Methods

| Parameter                          | Monitoring        |                     |                    |             | Analysis              |               |
|------------------------------------|-------------------|---------------------|--------------------|-------------|-----------------------|---------------|
|                                    | Standard          | Technical Procedure | Accredited Testing | Testing Lab | Analytical Technique  | INAB Analysis |
| Total Particulate Matter (TPM)     | EN13284-1:2017    | SOP 2000            | Yes                | RPS         | Gravimetric           | -             |
| Carbon Monoxide (CO)               | EN15058:2017      | SOP 2004            | Yes                | AirSci      | NCIR By Horiba PG-250 | -             |
| Oxides of Nitrogen (NOx)           | EN14792:2017      | SOP 2002            | Yes                | AirSci      | Chemiluminescence     | -             |
| Hydrogen Chloride (HCL)            | EN1911:2010       | SOP 2014            | Yes                | SAL         | Ion Chromatography    | -             |
| Hydrogen Fluoride (HF)             | EN15713:2006      | SOP 2024            | Yes                | SAL         | Ion Chromatography    | -             |
| T A Luft Organics                  | EN13649:2014      | SOP 2019            | Yes                | SAL         | GC/MS                 | -             |
| Sulphur Dioxide (SO <sub>2</sub> ) | CEN/TS 17021:2017 | SOP 2046            | Yes                | AirSci      | NDIR Absorption       | -             |
| Oxygen (%)                         | EN14789:2017      | SOP 2008            | Yes                | AirSci      | Paramagnetic          | -             |
| Carbon Dioxide                     | ISO12039:2001     | SOP 2045            | Yes                | AirSci      | NDIR                  | -             |
| Water Vapour (%)                   | EN14790:2017      | SOP 2007            | Yes                | AirSci      | Gravimetric           | -             |
| Stack Gas Temperature              | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Thermocouple          | -             |
| Stack Gas Velocity                 | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Pitot tubes           | -             |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

### List of Equipment

| ID           | Item of Equipment                        | Manufacturer        | Serial No.          |
|--------------|--|---------------------|---------------------|
| ASLTM12EQ505 | SKC Aircheck Sampler                     | SKC                 | 826085              |
| ASLTM12EQ512 | Horiba PG2500 Portable Gas Analyzer      | Horiba              | 41343020031         |
| ASLTM12EQ517 | Testo 400 Gas Pressure Vacuum and Flow   | Testo               | 00828828/305        |
| ASLTM12EQ520 | Buhler Sample Gas Cooler                 | Buhler Technologies | 100063602044367-001 |
| ASLTM12EQ522 | Ohaus Scales                             | Ohaus               | 8732189114          |
| ASLTM12EQ526 | Knob weights (200,500,1000mg)            | KERN & Sohn GmbH    | G1117388            |
| ASLTM13EQ509 | 10 metre industrial heated sample line   | Neptech             | 13B088              |
| ASLTM14EQ506 | Stanley 5m Measuring Tape                | Stanley             | 30-696              |
| ASLTM14EQ512 | GemRed Electronic Level 0 to 180 Degrees | GemRed              | 8088                |
| ASLTM14EQ513 | ISO Stack Sampling Machine               | TCR Tecora          | 070205976 & 049039P |
| ASLTM14EQ514 | Mass flow meter                          | Siargo              | A3J04316            |
| ASLTM14EQ516 | 6" Digital Calliper                      | Stanley             | 052013w             |
| ASLTM14EQ518 | Mini Probe                               | TRC Tecora          | N/A                 |
| ASLTM14EQ519 | S TYPE PITOT TUBE                        | Tecora              | 33011               |
| ASLTM14EQ522 | S TYPE PITOT TUBE                        | TRC Tecora          | 323                 |
| ASLTM15EQ502 | Mass flow meter                          | Siargo              | A3J04318            |
| ASLTM15EQ505 | Mass flow meter                          | Siargo              | A1K05286            |
| ASLTM16EQ503 | K type thermocouple                      | TCR Tecora          | Tra20162208/01      |
| ASLTM18EQ509 | Bios Defender                            | Bios                | N/A                 |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Sampling Deviations**

| <b>Parameter</b>   | <b>Deviation</b>   |
|--------------------|--|
| <b>Standard ID</b> | EN16911:2013 – flow rates in accordance with MID6911-1   |
| <b>Standard ID</b> | EN13284-1 Sampling on one plane at one point only due to access restrictions   |
| <b>Standard ID</b> | HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4). |
| <b>Standard ID</b> | -  |

**Reference Documents**

|                                     |         |
|-------------------------------------|---------|
| <b>Risk Assessment (RA)</b>         | SOP1011 |
| <b>Site Review (SR)</b>             | SOP1015 |
| <b>Site Specific Protocol (SSP)</b> | SOP1015 |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

**Executive Summary**

**Suitability of sampling location**

| General Information | Value     |
|---------------------|-----------|
| Permanent/Temporary | Temporary |
| Inside/ Outside     | Outside   |

| Platform Details   |       |         |
|--|-------|---------|
| Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements      | Value | Comment |
| Sufficient Working area to manipulate probe and measuring instruments          | Yes   | -       |
| Platform has 2 handrails (approx. 0.5m & 1.0 m high)                           | Yes   | -       |
| Platform has vertical base boards (approx. 0.25 m high)                        | Yes   | -       |
| Platform has chains / self closing gates at top of ladders                     | Yes   | -       |
| There are no obstructions present which hamper insertion of sampling equipment | No    | -       |
| Safe Access Available  | Yes   | -       |
| Easy Access Available  | Yes   | -       |

| Sampling Location / Platform Improvement Recommendations |
|--|
| None   |

| BSEN 15259 Homogeneity Test Requirements   |
|--|
| 1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack |

**Process details**

| Parameter                           |            |
|-------------------------------------|------------|
| Process status                      | Normal     |
| Capacity (per/hour) (if applicable) | As Normal  |
| Continuous or Batch Process         | Continuous |
| Feedstock                           | LFG        |
| Abatement System                    | No         |
| Abatement Systems Running Status    | N/A        |
| Fuel                                | Gas        |
| Plume Appearance                    | No         |
| Other information                   | None       |



Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

The process information below has been supplied by the client and as such ASL assume no responsibility or liability for any errors or omissions in the content of this Process Detail Form. The information provided in this form is provided on an 'as is' basis with no guarantees of completeness, accuracy or reliability.

| Licensee     |                     |                      |                     |
|--------------|---------------------|----------------------|---------------------|
| Reg. number  | WL0146-02           | Contractor           | Air Scientific Ltd. |
| Site Contact | Mr Sean O Callaghan | Contractor's contact | Amanda Sheridan     |
| Role         |                     | Role                 | -                   |
| Signature    |                     | Signature            | -                   |

| Emissions point       |     | -               |                            |     |                                   |   |
|-----------------------|-----|-----------------|----------------------------|-----|-----------------------------------|---|
| Type of process       |     | Load of process | Abatement system           |     | List of Solvents used per process |   |
| Rotogravure Printing  | -   | as normal       | Bag filter                 | -   | -                                 | - |
| Cement Plant          | -   |                 | Electrostatic precipitator | -   | -                                 | - |
| Electrical generation | -   |                 | Cyclone                    | -   | -                                 | - |
| Steam boiler          | -   |                 | Thermal oxidiser           | -   | -                                 | - |
| Other                 | Yes |                 | Active carbon bed          | -   | -                                 | - |
|                       |     |                 | NSCR                       | -   | -                                 | - |
|                       |     |                 | SCR                        | -   | -                                 | - |
|                       |     |                 | Dry scrubber               | -   | -                                 | - |
|                       |     |                 | Wet scrubber               | -   | -                                 | - |
|                       |     |                 | Lime injection             | -   | -                                 | - |
|                       |     |                 | Biofilter                  | -   | -                                 | - |
|                       |     |                 | None                       | Yes | -                                 | - |
|                       |     |                 | Other:                     | -   | -                                 | - |

Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH04  
Facility Location: Knickharley Facility  
Rev.No: 1

**Executive Summary**

**Stack diagram**



Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**2. APPENDICES**

**II. Appendix I - Monitoring Personnel & Equipment**

**Stack Emissions Monitoring Personnel**

|                    |                        |                                       |
|--------------------|------------------------|---------------------------------------|
| <b>Team Leader</b> | <b>Name</b>            | Dr. John Casey                        |
|                    | <b>Qualifications</b>  | PhD. (Eng.), MSc. (Agr.), B. Agr. Sc. |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Technician</b>  | <b>Name</b>            | Amanda Sheridan                       |
|                    | <b>Qualifications</b>  | B.A.                                  |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Team Leader</b> | <b>Name</b>            | -                                     |
|                    | <b>Qualifications</b>  | -                                     |
|                    | <b>System approval</b> | -                                     |
|                    |                        | -                                     |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**III. Appendix II - Stack Details & flow characteristics**

**Preliminary stack survey calculations**

| <b>General Stack Details</b>                |              |              |
|---|--------------|--------------|
| <b>Stack details</b>                        | <b>Units</b> | <b>Value</b> |
| Date of survey                              |              | 17/07/2019   |
| Time of survey                              |              | 14:41        |
| Type  |              | Circular     |
| Stack Diameter / Depth, D                   | m            | 0.4          |
| Stack Width, W                              | m            | -            |
| Average Stack Gas Temp., Ta                 | C            | 420          |
| Average Static Pressure, P static           | kPa          | 0.1          |
| Average Barometric Pressure, Pb             | kPa          | 101          |
| Type of Pitot                               |              | S            |
| Are Water Droplets Present?                 |              | No           |
| Average Pitot Tube Calibration Coeff, Cp    |              | 0.848        |
| Negative flow                               |              | No           |
| Highly homogeneous flow stream/gas velocity |              | Yes          |

|                           |    |          |
|---------------------------|----|----------|
| Sample Port Size          | mm | 60       |
| Initial Pitot Leak Check  | Pa | 450      |
| Final Pitot Leak Check    | Pa | 454      |
| Orientation of Duct       |    | Vertical |
| Pitot Tube Cp             |    | 0.998    |
| Number of Lines Available |    | 2        |
| Number of Lines Used      |    | 2        |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

| Sampling Line A |                      |      |         |                |            |                |
|-----------------|----------------------|------|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa   | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | 0.02                 | -    | -       | -              | -          | -              |
| 2               | 0.06                 | 69   | 420     | 13.9           | -          | <15            |
| 3               | 0.12                 | 73   | 420     | 14.3           | -          | <15            |
| 4               | 0.28                 | 84   | 420     | 15.3           | -          | <15            |
| 5               | 0.34                 | 97   | 420     | 16.5           | -          | <15            |
| 6               | 0.38                 | -    | -       | -              | -          | -              |
| 7               | -                    | -    | -       | -              | -          | -              |
| 8               | -                    | -    | -       | -              | -          | -              |
| 9               | -                    | -    | -       | -              | -          | -              |
| 10              | -                    | -    | -       | -              | -          | -              |
| Average         | -                    | 80.8 | 420     | 15.01          | -          | <15            |
| Min             | -                    | 69   | 420     | 13.9           | -          | <15            |
| Max             | -                    | 97   | 420     | 16.49          | -          | <15            |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

| Sampling Line B |                      |      |         |                |            |                |
|-----------------|----------------------|------|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa   | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | 0.02                 | -    | -       | -              | -          | -              |
| 2               | 0.06                 | 71   | 420     | 14.1           | -          | <15            |
| 3               | 0.12                 | 79   | 420     | 14.9           | -          | <15            |
| 4               | 0.28                 | 88   | 420     | 15.7           | -          | <15            |
| 5               | 0.34                 | 96   | 420     | 16.4           | -          | <15            |
| 6               | 0.38                 | -    | -       | -              | -          | -              |
| 7               | -                    | -    | -       | -              | -          | -              |
| 8               | -                    | -    | -       | -              | -          | -              |
| 9               | -                    | -    | -       | -              | -          | -              |
| 10              | -                    | -    | -       | -              | -          | -              |
| Average         | -                    | 83.5 | 420     | 15.27          | -          | <15            |
| Min             | -                    | 71   | 420     | 14.1           | -          | <15            |
| Max             | -                    | 96   | 420     | 16.4           | -          | <15            |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

| Component                      | Conc. ppm | Conc. Dry % v/v | Conc. Wet % v/v | Molar Mass |
|--------------------------------|-----------|-----------------|-----------------|------------|
| Carbon Dioxide CO <sub>2</sub> | -         | 11.2            | -               | 44.01      |
| Oxygen O <sub>2</sub>          | -         | 5.85            | -               | 32         |
| Nitrogen N <sub>2</sub>        | -         | 82.95           | -               | 28.1       |
| Moisture (H <sub>2</sub> O)    | -         | -               | 8.5             | 18.02      |
| <b>Reference Conditions</b>    |           |                 |                 |            |
| Temperature                    | °C        | 273.15          |                 |            |
| Total Pressure                 | kPa       | 101.3           |                 |            |
| Moisture                       | %         | -               |                 |            |
| Oxygen (Dry)                   | %         | 5               |                 |            |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

| Stack Gas Composition & Molecular Weights |              |                             |                 |                       |                                |                 |                       |                                |
|---|--------------|-----------------------------|-----------------|-----------------------|--------------------------------|-----------------|-----------------------|--------------------------------|
| Component                                 | Molar Mass M | Density Kg/m <sup>3</sup> p | Conc. Dry % v/v | Dry Volume Fraction r | Dry Conc. kg/m <sup>3</sup> pi | Conc. wet % v/v | Wet Volume Fraction r | Wet Conc. kg/m <sup>3</sup> pi |
| Carbon Dioxide CO <sub>2</sub>            | 44.01        | 1.96                        | 11.2            | 0.112                 | 0.22                           | 10.25           | 0.1                   | 0.2                            |
| Oxygen O <sub>2</sub>                     | 32           | 1.43                        | 5.85            | 0.0585                | 0.08                           | 5.35            | 0.05                  | 0.08                           |
| Nitrogen N <sub>2</sub>                   | 28.1         | 1.25                        | 82.95           | 0.8295                | 1.04                           | 75.9            | 0.76                  | 0.95                           |
| Moisture (H <sub>2</sub> O)               | 18.02        | 0.8                         | -               | -                     | -                              | 8.5             | 0.09                  | 0.07                           |
| where $p = M/22.41$                       |              |                             |                 |                       |                                |                 |                       |                                |
| $p_i = r \times p$                        |              |                             |                 |                       |                                |                 |                       |                                |



Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

| Calculation of Stack Gas Densities  |                    |        |
|---|--------------------|--------|
| Determinant   | Units              | Result |
| Dry Density (STP), P STD  | kg.m <sup>-3</sup> | 1.344  |
| Wet Density (STP), P STW  | kg.m <sup>-3</sup> | 1.301  |
| Dry Density (Actual), P Actual  | kg.m <sup>-3</sup> | 0.528  |
| Average wet Density (Actual), P Actual W  | kg.m <sup>-3</sup> | 0.511  |
| <b>Where</b>  |                    |        |
| P STD = sum of component concentrations, kg/m <sup>3</sup> (excluding water vapour)               |                    |        |
| $P_{STW} = (P_{STD} + p_{i \text{ of } H_2O}) / (1 + (p_{i \text{ of } H_2O} / 0.8036))$          |                    |        |
| $P_{actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times (P_a / T_a)$                            |                    |        |
| $P_{actual \ W} \text{ (at each sampling point)} = P_{STW} \times (T_s / P_s) \times (P_a / T_a)$ |                    |        |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

| Sampling Plane Validation Criteria     | Value | Units   | Requirement | Compliance | Method       |
|--|-------|---------|-------------|------------|--------------|
| Lowest Differential Pressure           | 69    | Pa      | >5 Pa       | Yes        | EN16911:2013 |
| Lowest Gas Velocity                    | 13.9  | m/s     | -           | N/A        | -            |
| Highest Gas Velocity                   | 16.49 | m/s     | -           | N/A        | -            |
| Ratio of Above                         | 1.19  | :1      | <3:1        | Yes        | EN16911:2013 |
| Mean Velocity                          | 15.14 | m/s     | -           | N/A        | -            |
| Angle of flow with regard to duct axis | <15   | degrees | < 15        | Yes        | EN16911:2013 |
| No local negative flow                 | No    | -       | -           | Yes        | -            |
| Homogeneous flow stream/gas velocity   | Yes   | -       | -           | Yes        | -            |

| Calculation of stack Gas Velocity, V  |             |
|---|-------------|
| Velocity at Traverse Point, $V = K_{cp} * \text{Sqrt}((2 * DP) / \text{Density})$ | 321.2563282 |
| <b>Where</b>  |             |
| $K_{pt}$ = Pitot tube calibration coefficient                                     | 0.848       |
| Compressibility correction factor, assumed at a constant 0.998                    | 0.998       |

| Gas Volumetric Flowrate               | Units        | Result |
|---------------------------------------|--------------|--------|
| Gas Volumetric Flow Rate (Actual)     | $m^3.h^{-1}$ | 6850   |
| Gas Volumetric Flow Rate (STP, Wet)   | $m^3.h^{-1}$ | 2694   |
| Gas Volumetric Flowrate (STP, Dry)    | $m^3.h^{-1}$ | 2465   |
| Gas Volumetric Flowrate REF to Oxygen | $m^3.h^{-1}$ | 2333   |

|  |      |  |      |  |     |
|--|------|--|------|--|-----|
| Standard uncertainty of velocity (m/s) | 0.29 | Expanded uncertainty of velocity (m/s) | 0.57 | Volume flow rate expanded uncertainty ( $m^3/hr$ ) | 303 |
|--|------|--|------|--|-----|

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

IV. Appendix 3 - Individual parameter sampling details and results

**Total Particulate Matter Sampling details and results**

|                             |         |                                 |                     |          |                |
|-----------------------------|---------|---------------------------------|---------------------|----------|----------------|
| Run 1                       |         |                                 | Time On             | 14:50    |                |
| Stack ID                    | KH04    |                                 | Time Off            | 15:20:00 |                |
| Filter ID                   | KH04    |                                 | Uncertainty Data    |          |                |
| Start Dry Gas Meter         | -       | m <sup>3</sup>                  | Temperature at Pump | 16.4     | Deg C          |
| Finish Dry Gas Meter        | -       | m <sup>3</sup>                  | Pressure at Pump    | 101      | kPa            |
| Average Stack Temperature   | 420     | °C                              | Air Volume at Pump  | 0.389    | m <sup>3</sup> |
| Moisture Content            | 8.5     | %                               | Humidity at Pumps   | 0.1      | %              |
| Stack Flow Rate STP, Dry    | 2465    | m <sup>3</sup> .h <sup>-1</sup> | Filter Weight       | <0.04    | mg             |
| Volume of Air Sampled       | 0.37    | m <sup>3</sup> (VgN)            | Front End Weight    | <0.5     | mg             |
|                             |         |                                 |                     |          |                |
| Balance Calibration         | Weight  |                                 |                     |          |                |
| 300.0                       | -       | g                               |                     |          |                |
| 500.0                       | -       | g                               |                     |          |                |
| 1000.0                      | -       | g                               |                     |          |                |
| Inpinger Weights            | Initial | Final                           | Difference          |          |                |
| 1                           | -       | -                               | -                   |          |                |
| 2                           | -       | -                               | -                   |          |                |
| 3                           | -       | -                               | -                   |          |                |
| 4                           | -       | -                               | -                   |          |                |
| Volume of Air Sampled       | 0.37    | Nm <sup>3</sup>                 |                     |          |                |
| Moisture Content (EN 14790) | 0       | %                               |                     |          |                |
|                             |         |                                 |                     |          |                |
| Leak Check Results          | Result  |                                 | % Leak              |          |                |
| Before Blank                | 0.1     | l/min                           | 0.3                 |          |                |
| After Blank                 | 0.1     | l/min                           | 0.3                 |          |                |
| Before Sample 1             | 0.1     | l/min                           | 0.3                 |          |                |
| After Sample 1              | 0.3     | l/min                           | 1                   |          |                |
| Average Flow Rate           | 29.1    | l/min                           | 1                   |          |                |
| Standard Maximum            | 0.582   | l/min                           | 2%                  |          |                |
| Back Pressure               | -       | bar                             | -                   |          |                |
| Leak check acceptable       | Yes     |                                 | Yes/No              |          |                |
| Water droplets present      | No      |                                 | Yes/No              |          |                |
|                             |         |                                 |                     |          |                |
| Standard Criteria to be Met | Result  | Standard Requirement            |                     |          |                |
| Angle of Flow               | <15     | <15 Degrees                     |                     |          |                |
| Negative Flow in the Stack  | None    | None                            |                     |          |                |
| Pitot Pressure Difference   | >5Pa    | >5Pa                            |                     |          |                |
| Ratio of Flow Measurement   | 1.41    | <3:1                            |                     |          |                |

|   |               |                         |                             |                    |  |
|---|---------------|-------------------------|-----------------------------|--------------------|--|
| <b>Pitot Tube Leak Check</b>                  | <b>Result</b> |                         |                             |                    |  |
| Positive Pressure                             | Pass          |                         |                             |                    |  |
| Negative Pressure                             | Pass          |                         |                             |                    |  |
| <b>Number of Ports</b>                        |               |                         |                             |                    |  |
|   | 2             |                         |                             |                    |  |
| <b>Straight length before sample point</b>    | > 5           | > 5 Hydraulic Diameters |                             |                    |  |
| <b>Straight length after sample point</b>     | > 5           | > 5 Hydraulic Diameters |                             |                    |  |
| <b>Sample Calculations</b>                    |               |                         |                             |                    |  |
| <b>Blank (Filter and Front Wash Combined)</b> |               |                         |                             |                    |  |
|   | <0.54         | mg                      |                             |                    |  |
| <b>Sample 1 (Filter and Front Combined)</b>   |               |                         |                             |                    |  |
|   | <0.54         | mg                      |                             |                    |  |
| <b>Volume of Air Sampled</b>                  | 0.4           | Nm <sup>3</sup>         |                             |                    |  |
| <b>Blank Result</b>                           | <1.34         | mg.m <sup>-3</sup>      |                             |                    |  |
| <b>Sample Result</b>                          | <1.34         | mg.m <sup>-3</sup>      |                             |                    |  |
| <b>Emission Limit Value</b>                   | 130           | mg.m <sup>-3</sup>      |                             |                    |  |
| <b>Blank as Percentage of ELV</b>             |               |                         |                             |                    |  |
|   | 1             | %                       | <b>Standard Requirement</b> | <b>&lt;10% ELV</b> |  |
| <b>Isokinetic Criterion Compliance</b>        |               |                         |                             |                    |  |
| Isokinetic Variation                          | %             | -0.12                   |                             |                    |  |
| Allowable Isokinetic Range                    | %             | 95-115                  |                             |                    |  |
| Iso Kineticity Acceptable                     | -             | Yes                     |                             |                    |  |

**Total Particulates Quality Assurance**

| Stack ID                       | KH04           |                         |       |       |       |       |       |
|--------------------------------|----------------|-------------------------|-------|-------|-------|-------|-------|
| Parameter                      | Units          | Run 1                   | Run 2 | Run 3 | Blank | Blank | Blank |
| Sampling Times                 | -              | 14:50                   | -     | -     | -     | -     | -     |
| Sampling Dates                 | -              | 17/07/2019              | -     | -     | -     | -     | -     |
| Sampling Device                | -              | Basic                   | -     | -     | -     | -     | -     |
| Volume Sampled (REF.)          | m <sup>3</sup> | 0.37                    | -     | -     | -     | -     | -     |
| Filter ID Number               | -              | KH04                    | -     | -     | -     | -     | -     |
| Probe rinse ID                 | -              | KH04 W                  | -     | -     | -     | -     | -     |
| Total Filter Mass              | mg             | <0.04                   | -     | -     | -     | -     | -     |
| Probe Rinse Solids Mass        | mg             | <0.5                    | -     | -     | -     | -     | -     |
| Total Mass Collected           | mg             | <0.54                   | -     | -     | -     | -     | -     |
| <b>General information</b>     |                |                         |       |       |       |       |       |
| Standard                       | ISEN13284-1    |                         |       |       |       |       |       |
| Technical Procedure            | -              | SOP 2000                | -     | -     | -     | -     | -     |
| Probe Material                 | -              | SS                      | -     | -     | -     | -     | -     |
| Filter Housing                 | -              | SS                      | -     | -     | -     | -     | -     |
| Positioning of Filter          | -              | In-stack                | -     | -     | -     | -     | -     |
| Filter Size and Material       | -              | 25mm filter, 6mm nozzle | -     | -     | -     | -     | -     |
| Number of Sampling lines used  | -              | 1                       | -     | -     | -     | -     | -     |
| Number of Sampling Points used | -              | 1                       | -     | -     | -     | -     | -     |

**Carbon Monoxide Quality Assurance**

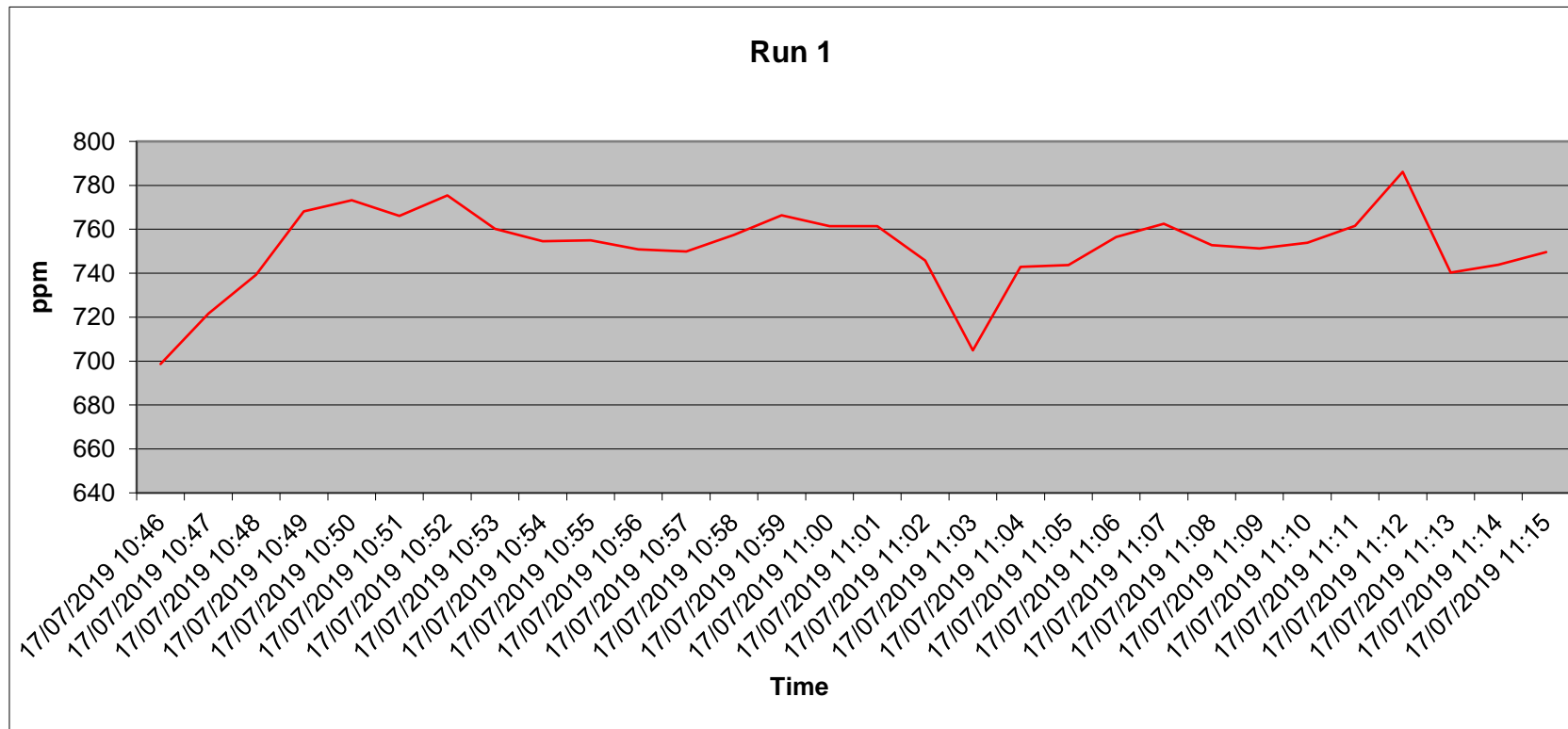
| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | KH04              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 10:45        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 1000         | -            | -            |
| Span Gas Value                 | ppm               | 616          | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 1            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 4            | -            | -            |
| Zero Drift                     | ppm               | -3           | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 30.75        | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.49        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 615          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 618          | -            | -            |
| Span Drift                     | ppm               | -3           | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 30.75        | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.49        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 616          | -            | -            |
| Recorded Conc. down Line       | ppm               | 618          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |

**Carbon Monoxide Results & Sampling Details**

| Parameter     | Units              | Run 1  | Run 2 | Run 3 | Mean |
|---------------|--------------------|--------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 943.54 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 56.02  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | 2.33   | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | EN15058       |
| Technical Procedure              | SOP2004       |
| Probe material                   | SS            |
| Filtration Type/Size             | PTFE          |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM18ING515 |
| Span Gas Expiry Date             | 22-Dec        |
| Span Gas Start Pressure (bar)    | 50            |
| Gas Cylinder Concentration (ppm) | 616           |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | KH04          |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 5             |

### Carbon Monoxide Trend





**Carbon Monoxide Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.36-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 1000      | -     | -     |
| Measured Reading   | ppm                | 754.83    | -     | -     |
| <b>Measured Quantities</b>   |                    |           |       |       |
| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.9       | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.14      | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.12     | -     | -     |
| Cross-sensitivity  | %                  | 0.08      | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
| <b>Parameter</b>   |                    |           |       |       |
| Parameter  | Units              | Run 1     | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 11.62     | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 23.24     | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 56.02     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 4         | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 56.02     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 5.94      | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |

## Oxides of Nitrogen Quality Assurance

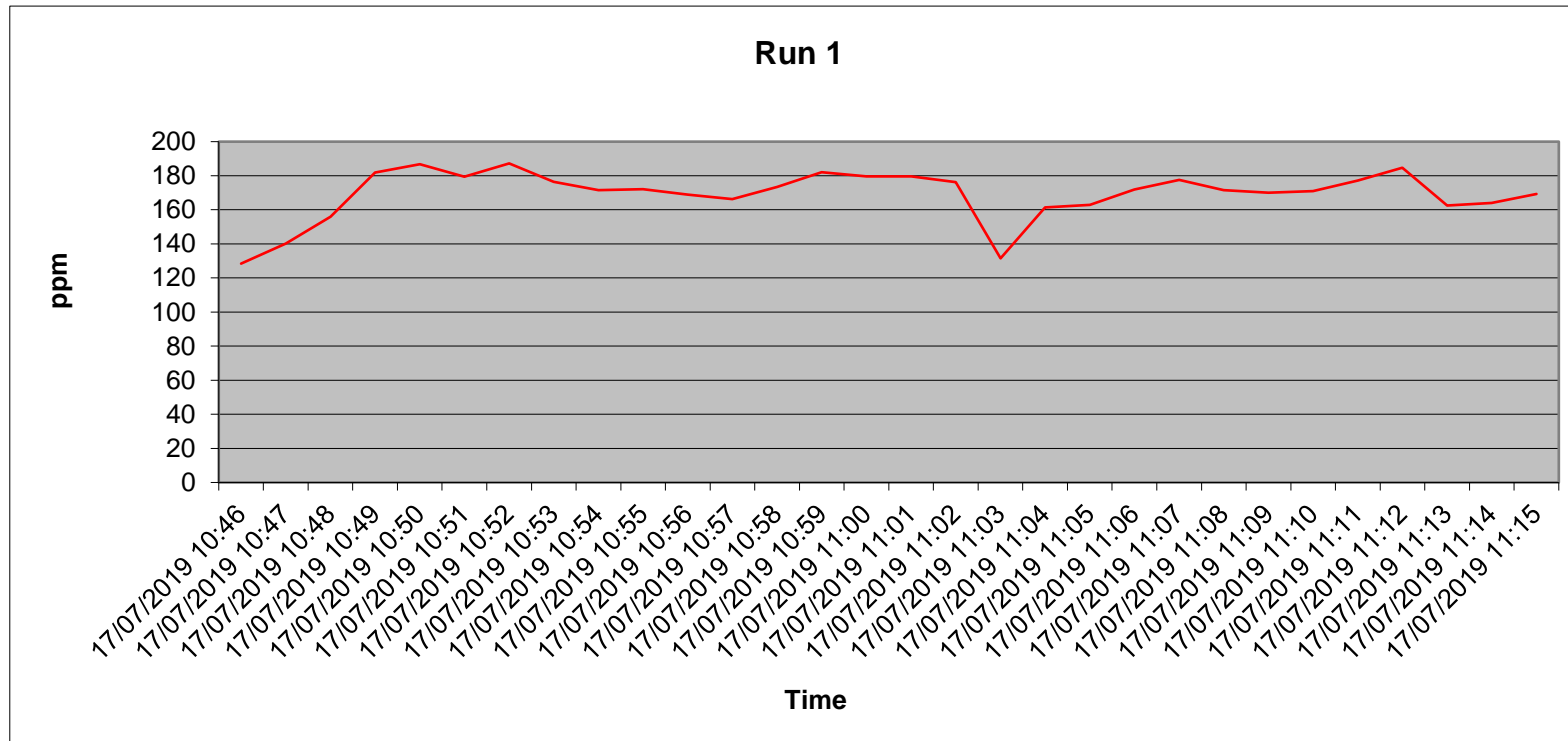
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | KH04              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 10:45        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 250          | -            | -            |
| Span Gas Value                 | ppm               | 160.7        | -            | -            |
| Acceptable Gas Range           | -                 | Yes          | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.6          | -            | -            |
| Zero Drift                     | ppm               | -0.5         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 8.01         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.31        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 160.1        | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 160.6        | -            | -            |
| Span Drift                     | ppm               | -0.5         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 8.01         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.31        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 160.7        | -            | -            |
| Recorded Conc. down Line       | ppm               | 160.6        | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |

**Oxides of Nitrogen Results & Sampling Details**

| Parameter     | Units              | Run 1  | Run 2 | Run 3 | Mean |
|---------------|--------------------|--------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 353.16 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 28.24  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | 0.87   | -     | -     | -    |

| General Sampling Information          |               |
|---------------------------------------|---------------|
| Parameter                             | Value         |
| Standard                              | EN14792       |
| Technical Procedure                   | SOP2002       |
| Probe material                        | SS            |
| Filtration Type/Size                  | PTFE          |
| Heated Head Filter Used               | Yes           |
| Heated Line Temperature               | 180           |
| Date & Result of last converter check | 95.3          |
| Span Gas Reference Number             | ASLTM18ING503 |
| Span Gas Expiry Date                  | 19-Nov        |
| Span Gas Start Pressure (bar)         | 30            |
| Gas Cylinder Concentration (ppm)      | 160.7         |
| Span Gas Uncertainty (%)              | <2            |
| Zero Gas Type                         | N             |
| Number of Sampling Lines Used         | 1             |
| Number of Sampling Points Used        | 1             |
| Sample Point I.D's                    | KH04          |
| Reference Conditions                  |               |
| Temperature (K)                       | 273.15        |
| Pressure (kPa)                        | 101.3         |
| Gas (Wet or Dry)                      | Dry           |
| Oxygen                                | 5             |

### Oxides of Nitrogen Trend



**Oxides of Nitrogen Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.87-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 250       | -     | -     |
| Measured Reading   | ppm                | 172.02    | -     | -     |
| <b>Measured Quantities</b>   |                    |           |       |       |
| Nonlinearity   | %                  | 1.4       | -     | -     |
| Temperature Dependent Zero drift   | %                  | -0.04     | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.25     | -     | -     |
| Cross-sensitivity  | %                  | 0.5       | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
| Mass Flow Controllers (Dilution) Uncertainty   | %                  | <1        | -     | -     |
| NOx Converter Efficiency   | %                  | 95.3      | -     | -     |
| <b>Parameter</b>   |                    |           |       |       |
| Combined uncertainty   | mg.m <sup>-3</sup> | 10.43     | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 20.87     | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 28.24     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 5.65      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 28.24     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 8         | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

### Hydrogen Chloride Sampling Details & Results

|                               |              |                 |
|-------------------------------|--------------|-----------------|
| <b>Stack ID</b>               | A2-1         | <b>Run 1</b>    |
| <b>Sample ID</b>              | KH04 HCL 1+2 | <b>mls</b>      |
| <b>Impinger 1 ID</b>          | KH04 HCL 1+2 | 260             |
| <b>Impinger 2 ID</b>          | -            | 0               |
| <b>Impinger 3 ID</b>          | KH04 HCL 3   | 145             |
| <b>Time on</b>                | 11:12        |                 |
| <b>Time off</b>               | 11:48        |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 1.98         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ502 |                 |
| Calibration Rate Before Test: | 1.98         | l/min           |
| Calibration Rate After Test:  | 1.98         | l/min           |
| Average sample Volume:        | 1.98         | l/min           |
| Sample Test Time:             | 34           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.06732      | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.06732      | Nm <sup>3</sup> |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

### Hydrogen Chloride Quality Assurance

| Stack ID                     | A2-1               | Run 1      | Run 2 | Run 3 |
|------------------------------|--------------------|------------|-------|-------|
| Date                         | 17/07/2019         | -          | -     | -     |
| Start time                   |                    | 11:12      | -     | -     |
| Finish Time                  |                    | 11:48:00   | -     | -     |
| <b>Leak test results</b>     |                    |            |       |       |
| Leak test results            | Units              | Run 1      | Run 2 | Run 3 |
| Mean Sampling Rate           | l/min              | 1.98       | -     | -     |
| Pre-sampling leak rate       | l/min              | 0.01       | -     | -     |
| Post-sampling leak rate      | l/min              | 0.01       | -     | -     |
| Leak rate                    | l/min              | 0          | -     | -     |
| Acceptable leak rate (<2%)   | Y/N                | Yes        | -     | -     |
| <b>Filtration</b>            |                    |            |       |       |
| Filter Material              |                    | N/A        | -     | -     |
| Filter Size                  | mm                 | N/A        | -     | -     |
| Max. Filter Temp             | degrees            | N/A        | -     | -     |
| Absorbers Type               | Glass/PTFE/ Other  | PTFE       | -     | -     |
| Absorption Solution          |                    | Di H2O     | -     | -     |
| <b>Absorption Efficiency</b> |                    |            |       |       |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 137.25     | -     | -     |
| Impinger 3                   | µg                 | 7.25       | -     | -     |
| Absorption efficiency        | %                  | 95         | -     | -     |
| Acceptable Absorption Eff.   | >95% (Y/N)         | Y          | -     | -     |
| <b>Blank sample</b>          |                    |            |       |       |
| Blank sample ID              |                    | KH01 HCL B | -     | -     |
| Blank result                 | mg.m <sup>-3</sup> | 0.53       | -     | -     |
| Acceptable Blank             | <10% ELV (Y/N)     | Y          | -     | -     |
| <b>Testing laboratory</b>    |                    |            |       |       |
| Laboratory Name              |                    | UKAS1549   | -     | -     |
| Test certificate Number      |                    | 835558     | -     | -     |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Hydrogen Chloride Results & Measurement Uncertainty**

|                         |        |                    |
|-------------------------|--------|--------------------|
| <b>Stack ID</b>         | A2-1   | <b>Run 1</b>       |
| <b>Date</b>             | -      |                    |
| <b>Start time</b>       | 11:12  |                    |
| <b>Finish Time</b>      | 11:48  |                    |
| <b>Results</b>          |        |                    |
| Laboratory Result       | 137.25 | µg                 |
| Impinger final Volume   | 405    | ml                 |
| Factor                  | -      |                    |
| Concentration           | 0.14   | mg                 |
| Sample Volume           | 0.067  | Nm <sup>3</sup>    |
| Emissions Concentration | 2.04   | mg.m <sup>-3</sup> |
| Mass Emissions          | -      | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0.08  | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 7.87  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.16  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.32  | -     | -     | -    |



Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

**Hydrogen Fluoride Sampling Details & Results**

| Sampling Details              |              | Run 1           |
|-------------------------------|--------------|-----------------|
| Stack ID                      | KH04         |                 |
| Time on                       | 11:49        |                 |
| Time off                      | 12:24        |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 2.12         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ505 |                 |
| Calibration Rate Before Test: | 2.12         | l/min           |
| Calibration Rate After Test:  | 2.12         | l/min           |
| Average sample Volume:        | 2.12         | l/min           |
| Sample Test Time:             | 35           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.0742       | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.0742       | Nm <sup>3</sup> |

## Hydrogen Fluoride Quality Assurance

| Stack ID                     | KH04               | Run 1     | Run 2 | Run 3 |
|------------------------------|--------------------|-----------|-------|-------|
| Date                         | 17/07/2019         | -         | -     | -     |
| Start time                   |                    | 11:49:00  | -     | -     |
| Finish Time                  |                    | 12:24:00  | -     | -     |
| <b>Leak test results</b>     |                    |           |       |       |
|                              | Units              | Run 1     | Run 2 | Run 3 |
| Mean Sampling Rate           | l/min              | 2.12      | -     | -     |
| Pre-sampling leak rate       | l/min              | 0.01      | -     | -     |
| Post-sampling leak rate      | l/min              | 0.01      | -     | -     |
| Leak rate                    | l/min              | 0         | -     | -     |
| Acceptable leak rate (<2%)   | Y/N                | Yes       | -     | -     |
| <b>Filtration</b>            |                    |           |       |       |
| Filter Material              |                    | N/A       | -     | -     |
| Filter Size                  | mm                 | N/A       | -     | -     |
| Max. Filter Temp             | degrees            | N/A       | -     | -     |
| Absorbers Type               | Glass/PTFE/ Other  | Glass     | -     | -     |
| Absorption Solution          |                    | 0.1m NaOH | -     | -     |
| <b>Absorption Efficiency</b> |                    |           |       |       |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 19        | -     | -     |
| Impinger 3                   | µg                 | 6.5       | -     | -     |
| Absorption efficiency        | %                  | 66        | -     | -     |
| Acceptable Absorption Eff.   | >95% (Y/N)         | N         | -     | -     |
| <b>Blank sample</b>          |                    |           |       |       |
| Blank sample ID              |                    | KH01 HF B | -     | -     |
| Blank result                 | mg.m <sup>-3</sup> | <0.09     | -     | -     |
| Acceptable Blank             | <10% ELV (Y/N)     | Y         | -     | -     |
| <b>Testing laboratory</b>    |                    |           |       |       |
| Laboratory Name              |                    | UKAS1549  | -     | -     |
| Test certificate Number      |                    | 835558    | -     | -     |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

### Hydrogen Fluoride Results & Measurement Uncertainty

|                         |          |                    |
|-------------------------|----------|--------------------|
| <b>Stack ID</b>         | KH04     | <b>Run 1</b>       |
| <b>Date</b>             | -        |                    |
| <b>Start time</b>       | 11:49:00 |                    |
| <b>Finish Time</b>      | 12:24:00 |                    |
| <b>Results</b>          |          |                    |
| Laboratory Result       | 19       | µg                 |
| Impinger final Volume   | 380      | ml                 |
| Factor                  | -        |                    |
| Concentration           | 0.02     | mg                 |
| Sample Volume           | 0.07     | Nm <sup>3</sup>    |
| Emissions Concentration | 0.26     | mg.m <sup>-3</sup> |
| Mass Emissions          | -        | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0.01  | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 7.77  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.02  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.4   | -     | -     | -    |

**Sulphur Dioxide Quality Assurance**

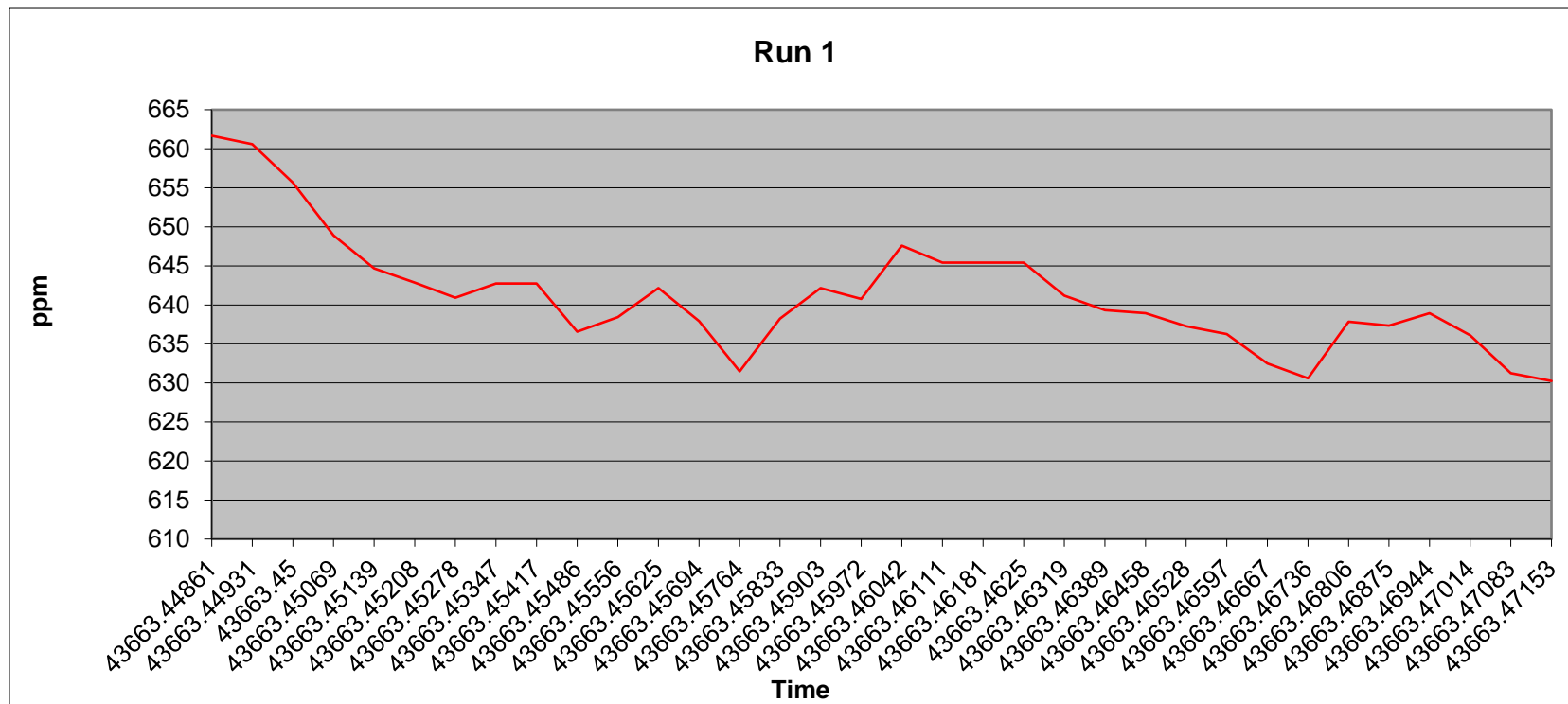
| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | KH04              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 10:45        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 1000         | -            | -            |
| Span Gas Value                 | ppm               | 733          | -            | -            |
| Acceptable Gas Range           | -                 | -            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 2            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 9            | -            | -            |
| Zero Drift                     | ppm               | -7           | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 36.5         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.96        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 730          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 742          | -            | -            |
| Span Drift                     | ppm               | -12          | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 36.5         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -1.64        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 733          | -            | -            |
| Recorded Conc. down Line       | ppm               | 742          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |

**Sulphur Dioxide Results & Sampling Details**

| Parameter     | Units              | Run 1   | Run 2 | Run 3 | Mean |
|---------------|--------------------|---------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 1833.76 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 117.87  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | 4.52    | -     | -     | -    |

| General Sampling Information          |               |
|---------------------------------------|---------------|
| Parameter                             | Value         |
| Standard                              | CEN/TS 17021  |
| Technical Procedure                   | SOP 2046      |
| Probe material                        | SS            |
| Filtration Type/Size                  | PTFE          |
| Heated Head Filter Used               | Yes           |
| Heated Line Temperature               | 180           |
| Date & Result of last converter check | -             |
| Span Gas Reference Number             | ASLTM18ING512 |
| Span Gas Expiry Date                  | Aug-19        |
| Span Gas Start Pressure (bar)         | 60            |
| Gas Cylinder Concentration (ppm)      | 733           |
| Span Gas Uncertainty (%)              | <2            |
| Zero Gas Type                         | N             |
| Number of Sampling Lines Used         | 1             |
| Number of Sampling Points Used        | 1             |
| Sample Point I.D's                    | KH04          |
| Reference Conditions                  |               |
| Temperature (K)                       | 273.15        |
| Pressure (kPa)                        | 101.3         |
| Gas (Wet or Dry)                      | Dry           |
| Oxygen                                | 5             |

### Sulphur Dioxide Trend



Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

**Sulphur Dioxide Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
|--|--------------------|--------------|-------|-------|
| Certified Range of Analyser  | ppm                | 2.14 to 1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 1000         | -     | -     |
| Measured Reading   | ppm                | 641.18       | -     | -     |
|  |                    |              |       |       |
| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.8          | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.8          | -     | -     |
| Temperature Dependent Span drift   | %                  | 2            | -     | -     |
| Cross-sensitivity  | %                  | 1.5          | -     | -     |
| Leak   | %                  | 0            | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2 %         | -     | -     |
|  |                    |              |       |       |
| Parameter  | Units              | Run 1        | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 30.98        | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 61.97        | -     | -     |
|  |                    |              |       |       |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 117.87       | -     | -     |
|  |                    |              |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | -            | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 117.87       | -     | -     |
|  |                    |              |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 6.43         | -     | -     |
|  |                    |              |       |       |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |              |       |       |



**T A Luft Organics**

| <b>Title:</b>                 | <b>Determination of Speciated Organic Compounds</b> |                   |       | <b>Run 1</b>    |
|-------------------------------|---|-------------------|-------|-----------------|
| Method:                       | EN 13649  | -                 | -     | -               |
| Client:                       | Knockharley Landfill                                | -                 | 12:15 | <b>Time on</b>  |
| Log Sheet Complete by:        | Amanda Sheridan                                     | -                 | 12:48 | <b>Time off</b> |
| Test Date:                    | 17/07/2019  | -                 | -     | -               |
| Laboratory Used:              | UKAS1549  | -                 | -     | -               |
| Certificate Numbers:          | 835558  | -                 | -     | -               |
| Stack Reference:              | KH04  | -                 | -     | -               |
| <b>Leak Check Results</b>     |   |                   |       |                 |
| Prior to test:                | 0.0001  | l/min             | -     | -               |
| Post Test:                    | 0.0001  | l/min             | -     | -               |
| Sample Volume Flow Rate:      | 0.3974  | l/min             | -     | -               |
| Standard Requirement:         | <2  | %                 | -     | -               |
| Test Result:                  | 0   | %                 | -     | -               |
| Test Status                   | Pass  | -                 | -     | -               |
| <b>Calibration Details</b>    |   |                   |       |                 |
| Pump Number:                  | ASLTM12EQ505  | -                 | -     | -               |
| Calibration Unit:             | ASLTM18E509   | -                 | -     | -               |
| Calibration Rate Before Test: | 0.3974  | litres per minute | -     | -               |
| Calibration Rate After Test:  | 0.3974  | litres per minute | -     | -               |
| Average sample Volume:        | 0.3974  | litres per minute | -     | -               |
| Sample Test Time:             | 33  | minutes           | -     | -               |
| Pump Gas Temperature:         | 15  | °C                | -     | -               |
| Pump Sample Pressure:         | 101   | kPa               | -     | -               |
| Actual Sample Volume:         | 0.01311   | m <sup>3</sup>    | -     | -               |
| Normalised Gas Volume:        | 0.01239   | Nm <sup>3</sup>   | -     | -               |
| <b>Tube Details</b>           |   |                   |       |                 |
| Tube Type:                    | 226-09  | -                 | -     | -               |
| Tube Identification Number:   | 7899119280  | -                 | -     | -               |
| Blank Identification Number:  | 7899119272  | -                 | -     | -               |
| Blank Result                  | <0.08   | mg/m <sup>3</sup> | -     | -               |

| <b>Test Details</b>              |                |                          |              |              |
|----------------------------------|----------------|--------------------------|--------------|--------------|
| Adsorption Tube Temperature:     | 15             | °C                       | -            | -            |
| Max Temperature Allowable:       | 40             | °C                       | -            | -            |
| <b>Stack Flow Rates</b>          |                |                          |              |              |
| Diameter:                        | 0.4            | m                        | -            | -            |
| Average Velocity:                | 15.14          | m/s                      | -            | -            |
| Average Temperature:             | 420            | °C                       | -            | -            |
| Average Pressure:                | 101            | kPa                      | -            | -            |
| Actual Flow Rate:                | 6850           | m <sup>3</sup> /Hr       | -            | -            |
| Normalised Flow Rate:            | 2465           | Nm <sup>3</sup> /Hr      | -            | -            |
| <b>Speciated Organic Results</b> |                |                          |              |              |
| <b>Class I</b>                   | <b>ug/tube</b> | <b>mg/Nm<sup>3</sup></b> | <b>kg/hr</b> |              |
| Chloroform                       | <5             | < 0.40                   | < 0.0010     | -            |
| Benzene                          | <1             | 0.08                     | < 0.0002     | -            |
| Dichloromethane (DCM)            | <10            | 0.81                     | < 0.0020     | -            |
| Tetrachloroethylene              | <10            | 0.81                     | < 0.0020     | -            |
| Trichloroethylene                | <10            | 0.81                     | < 0.0020     | -            |
| Carbon Tetrachloride             | <5             | 0.4                      | < 0.0010     | -            |
| Limit of detection               | -              | -                        | -            | -            |
| <b>Class II</b>                  | <b>ug/tube</b> | <b>mg/Nm<sup>3</sup></b> | <b>kg/hr</b> |              |
| Toluene                          | <5             | 0.4                      | 0.001        | -            |
| M+P Xylene                       | <1             | 0.08                     | 0.0002       | -            |
| Cyclohexane                      | <20            | 1.61                     | 0.004        | -            |
| Cyclohexanone                    | <10            | 0.81                     | 0.002        | -            |
| O-Xylene                         | <1             | 0.08                     | 0.0002       | -            |
| Tetrahydrofuran                  | <10            | 0.81                     | 0.002        | -            |
| Limit of detection               | -              | -                        | -            | -            |
| <b>Class III</b>                 | <b>ug/tube</b> | <b>mg/Nm<sup>3</sup></b> | <b>kg/hr</b> |              |
| Ethanol                          | <10            | 0.81                     | 0.002        | -            |
| Ethyl Acetate                    | <10            | 0.81                     | 0.002        | -            |
| Heptane                          | <10            | 0.81                     | 0.002        | -            |
| Hexane                           | <10            | 0.81                     | 0.002        | -            |
| Methyl-iso-butyl Ketone          | <5             | 0.4                      | 0.001        | -            |
| Methyl Ethyl Ketone              | <5             | 0.4                      | 0.001        | -            |
| Propan-2-ol                      | <10            | 0.81                     | 0.002        | -            |
| Acetone                          | <10            | 0.81                     | 0.002        | -            |
| Limit of detection               | -              | -                        | -            | -            |
| <b>Total Class I</b>             | 3.31           | <b>mg/Nm<sup>3</sup></b> | 0.008        | <b>kg/hr</b> |
| <b>Total Class II</b>            | 3.79           | <b>mg/Nm<sup>3</sup></b> | 0.009        | <b>kg/hr</b> |

Document No.: KNLATL1170719 / 2019432

EPA Licence No.: WL0146-02

Visit No: 1

Licence Holder: Knockharley Landfill, KH04

Year: 2019

Facility Location: Knickharley Facility

Office: Trim

Rev.No: 1

|                                    |       |                    |       |       |
|------------------------------------|-------|--------------------|-------|-------|
| Total Class III                    | 5.65  | mg/Nm <sup>3</sup> | 0.014 | kg/hr |
| Total Organics                     | 12.75 | mg/Nm <sup>3</sup> | 0.031 | kg/hr |
| <i>Subtracted less than values</i> |       |                    |       |       |
| Total Class I                      | 3.31  | mg/Nm <sup>3</sup> |       |       |
| Total Class II                     | 3.79  | mg/Nm <sup>3</sup> |       |       |
| Total Class III                    | 5.65  | mg/Nm <sup>3</sup> |       |       |
| Total Organics                     | 12.75 | mg/Nm <sup>3</sup> |       |       |

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

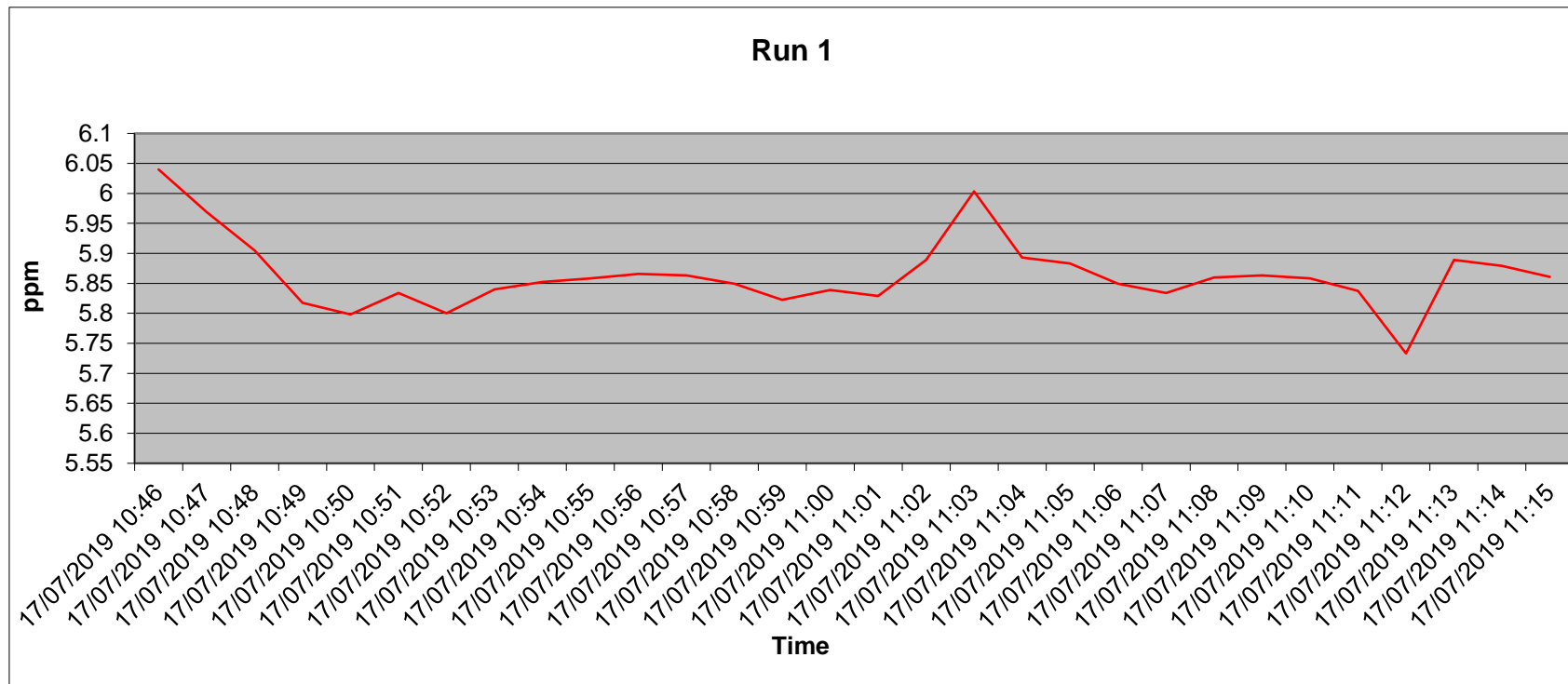
| <i>Non-detected less than values</i> |   |                          |  |  |
|--------------------------------------|---|--------------------------|--|--|
| Total Class I                        | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |
| Total Class II                       | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |
| Total Class III                      | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |
| Total Organics                       | 0 | <i>mg/Nm<sup>3</sup></i> |  |  |

| Parameter   | Units               | Run 1 |
|---|---------------------|-------|
| Combined Uncertainty                              | mg.m <sup>-3</sup>  | 1.11  |
| Expanded uncertainty                              | % of measured value | 17.48 |
| Expanded uncertainty in units                     | mg.m <sup>-3</sup>  | 2.23  |
| Expanded uncertainty as percentage of limit value | % Of ELV            | 0     |

**Oxygen Quality Assurance**

| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | KH04              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 10:45        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 25           | -            | -            |
| Span Gas Value                 | ppm               | 20.9         | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0.1          | -            | -            |
| Zero Drift                     | %                 | 0            | -            | -            |
| Allowable Zero Drift (5%)      | %                 | 1.05         | -            | -            |
| Zero Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 20.9         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 21           | -            | -            |
| Span Drift                     | %                 | -0.1         | -            | -            |
| Allowable Span Drift (5%)      | %                 | 1.05         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | %                 | 20.9         | -            | -            |
| Recorded Conc. down Line       | %                 | 21           | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |
| Combined uncertainty           | % vol             | 0.13         | -            | -            |
| % of value                     | %                 | 2.26         | -            | -            |
| Expanded uncertainty           | % of value        | 4.53         | -            | -            |
| Expanded uncertainty           | % vol             | 0.27         | -            | -            |

### Oxygen trend



**Carbon Dioxide Quality Assurance**

| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | KH04              |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 10:45        | -            | -            |
| Sampling Dates                 | -                 | 17/07/2019   | -            | -            |
| Instrument Range               | ppm               | 20           | -            | -            |
| Span Gas Value                 | ppm               | 14.96        | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.4          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0.3          | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0.6          | -            | -            |
| Zero Drift                     | %                 | -0.3         | -            | -            |
| Allowable Zero Drift (4%)      | %                 | 0.6          | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 14.9         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 15           | -            | -            |
| Span Drift                     | %                 | -0.1         | -            | -            |
| Allowable Span Drift (4%)      | %                 | 0.6          | -            | -            |
| Span Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 14.96        | -            | -            |
| Recorded Conc. down Line       | ppm               | 15           | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 15           | -            | -            |
| Combined uncertainty           | % vol             | 0.17         | -            | -            |
| % of value                     | %                 | 1.56         | -            | -            |
| Expanded uncertainty           | % of value        | 3.11         | -            | -            |
| Expanded uncertainty           | % vol             | 0.35         | -            | -            |

Document No.: KNLATL1170719 / 2019432  
 Visit No: 1  
 Year: 2019  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, KH04  
 Facility Location: Knickharley Facility  
 Rev.No: 1

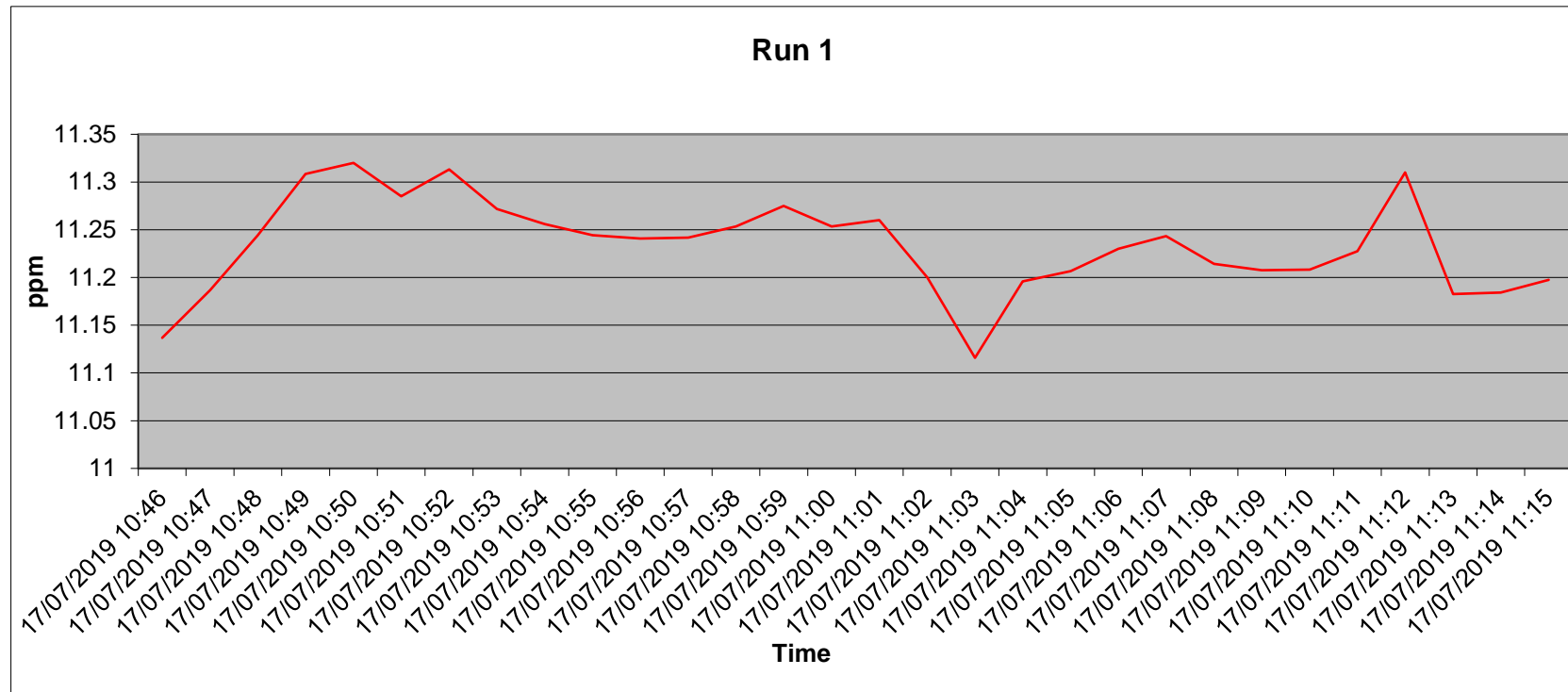
**Carbon Dioxide Results & Sampling Details**

| Parameter     | Units | Run 1 | Run 2 | Run 3 | Mean |
|---------------|-------|-------|-------|-------|------|
| Concentration | %     | 11.24 | -     | -     | -    |
| Uncertainty   | %     | 0.35  | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | ISO12039      |
| Technical Procedure              | SOP 2045      |
| Probe material                   | SS            |
| Filtration Type/Size             | Ceramic       |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM18ING525 |
| Span Gas Expiry Date             | 22-Dec        |
| Span Gas Start Pressure (bar)    | 50            |
| Gas Cylinder Concentration (ppm) | 14.96         |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | KH04          |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 5             |



### Carbon Dioxide Trend



Document No.: KNLATL1170719 / 2019432  
Visit No: 1  
Year: 2019  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, KH04  
Facility Location: Knickharley Facility  
Rev.No: 1

Document No.: KNLATL1170719 / 2019432

Visit No: 1

Year: 2019

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, KH04

Facility Location: Knickharley Facility

Rev.No: 1

**Moisture Results & Sampling Details**

|   |                                  |                 |                            |       |       |
|---|----------------------------------|-----------------|----------------------------|-------|-------|
| <b>Title:</b>   | <b>Determination of Moisture</b> |                 |                            |       |       |
| <b>Method:</b>  | EN 14790                         |                 |                            |       |       |
| <b>Stack Name</b>   | KH04                             | <b>Time off</b> | <b>Temperature at Pump</b> | 0     | Deg C |
| <b>Test Time</b>  | 10:24                            | 10:54           | <b>Pressure at Pump</b>    | 101.3 | kPa   |
| <b>Dry Gas Meter Reading Before</b>                         | -                                | m <sup>3</sup>  | <b>Humidity at Pumps</b>   | 0.1   | %     |
| <b>Dry Gas Meter Reading After</b>                          | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Volume of Air Sampled</b>                                | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Normalised Air Volume Sampled</b>                        | 0.06                             | Nm <sup>3</sup> |                            |       |       |
| <b>Leak Rate</b>  | 0.001                            |                 |                            |       |       |
| <b>Balance Calibration</b>                                  |                                  |                 |                            |       |       |
|   | <b>Weight</b>                    |                 |                            |       |       |
| 200.0   | 200                              | g               |                            |       |       |
| 1000.0  | 1000                             | g               |                            |       |       |
| <b>Inpinger Weights</b>                                     |                                  |                 |                            |       |       |
|   | <b>Initial</b>                   | <b>Final</b>    | <b>Difference</b>          |       |       |
| 1   | 484.9                            | 487             | 2.1                        |       |       |
| 2   | 439.1                            | 440.7           | 1.6                        |       |       |
| 3   | 454.5                            | 455             | 0.5                        |       |       |
| 4   | 644.2                            | 644.5           | 0.3                        |       |       |
| <b>Volume of Air Sampled</b>                                | 0.06                             | Nm <sup>3</sup> | <b>4.5</b>                 |       |       |
| <b>Moisture Content (EN 14790)</b>                          | 8.5                              | %               |                            |       |       |
| <b>Combined uncertainty</b>                                 |                                  |                 |                            |       |       |
|   |                                  | 0.2             | %                          |       |       |
| <b>Expanded uncertainty as percentage of measured value</b> |                                  |                 |                            |       |       |
|   |                                  | 4.79            | % measured value           |       |       |
| <b>Expanded uncertainty in units of measurement</b>         |                                  |                 |                            |       |       |
|   |                                  | 0.41            | %                          |       |       |
| <b>Expanded uncertainty as percentage of limit value</b>    |                                  |                 |                            |       |       |
|   |                                  | -               | % ELV                      |       |       |

Uncert Sheets

TPM Uncert

Run 1

Uncertainty calculation for EN 13284 Determination of low range mass concentration of dust, Manual Gravimetric Method

Stack Name: KH04

Measurement Equation

$$c = \frac{m}{V} f_c$$

|                        |      |                    |                           |   |             |
|------------------------|------|--------------------|---------------------------|---|-------------|
| Limit value (ELV)      | 130  | mg.m <sup>-3</sup> | Reference oxygen          | 5 | % by volume |
| Measured concentration | 1.34 | mg.m <sup>-3</sup> | (at reference conditions) |   |             |

| Measured Quantities   | Symbol           | Value | Standard uncertainty | Units                | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|------------------|-------|----------------------|----------------------|---------------------------|-------------------|--------------------|
| Sampled Volume  | V <sub>m</sub>   | 0.389 | uV <sub>m</sub>      | 0.001 m <sup>3</sup> | 0.26                      |                   | <=2%               |
| Sampled gas Temperature   | T <sub>m</sub>   | 289.4 | uT <sub>m</sub>      | 2 k                  | 0.69                      |                   | <=1%               |
| Sampled gas Pressure  | p <sub>m</sub>   | 101   | up <sub>m</sub>      | 1 kPa                | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | H <sub>m</sub>   | 0.1   | uH <sub>m</sub>      | 1 % by volume        | 1000.00                   |                   | <=1%               |
| Oxygen content  | O <sub>2,m</sub> | 0     | uO <sub>2,m</sub>    | 0.1 % by volume      | 0.00                      |                   | <=5%               |
| Mass particulate  | m                | 0.54  | um                   | 0.16 mg              | 29.10                     | 0.30              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |       |                      |                      |                           |                   |                    |
| Leak  | L                | 1.03  |                      | %                    | 1.03                      |                   | <=2%               |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM              | 0.5   |                      | mg                   | 92.59259259               |                   | <=10%              |

| Intermediate calculations |                  |                   |                    |   |      |
|---------------------------|------------------|-------------------|--------------------|---|------|
| Factor for std cond       | fs               | 0.94              |                    |   |      |
| uncertainty components    | symbol           | sensitivity coeff | u (in units of fs) |   |      |
|                           | p <sub>m</sub>   | 0.009             | 0.009              |   |      |
|                           | H <sub>m</sub>   | 0.009             | 0.009              |   |      |
|                           | T <sub>m</sub>   | 0.003             | 0.006              |   |      |
|                           | ufs              |                   | 0.015              |   | 1.57 |
| Corrected volume          | V                | 0.37              | uV                 | 0.006 m <sup>3</sup>                        | 1.59 |
|                           |                  |                   |                    | $V = V_m f_s$                               |      |
| Factor for O2 correction  | fc               | 0.76              |                    |   |      |
| uncertainty components    | symbol           | sensitivity coeff | u                  |   |      |
|                           | O <sub>2,m</sub> | 0.04              | 0.004              |   |      |
| Factor for O2 Correction  | ufc              | 0.76              | 0.004              |   | 0.48 |
|                           |                  |                   |                    | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |      |

| Parameter                               | Value | Units                   | Sensitivity cc | Uncertainty contribution      | Uncertainty as % |
|---|-------|-------------------------|----------------|-------------------------------|------------------|
| Corrected Volume (standard conditions)  | V     | 0.37 m <sup>3</sup>     | 3.65           | 0.02 mg.m <sup>-3</sup>       | 1.59 %           |
| Mass                                    | m     | 0.54 mg                 | 2.47           | 0.39 mg.m <sup>-3</sup>       | 29.10 %          |
| Factor for O2 Correction                | fc    | 0.76                    | 1.75           | 0.01 mg.m <sup>-3</sup>       | 0.48 %           |
| Leak                                    | L     | 0.01 mg.m <sup>-3</sup> | 1.00           | 0.01 mg.m <sup>-3</sup>       | 0.60 %           |
| Uncollected mass                        | UCM   | 0.29 mg                 | 2.47           | 0.71 mg.m <sup>-3</sup>       | 53.46 %          |
| <b>Combined measurement uncertainty</b> |       |                         |                | <b>0.81 mg.m<sup>-3</sup></b> |                  |

**Uncert Sheets**

|  |        |                     |  |
|--|--------|---------------------|--|
| Expanded uncertainty as percentage of measured value | 121.78 | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | 1.63   | mg.m <sup>-3</sup>  |  |
| Expanded uncertainty as percentage of limit value    | 1.25   | % ELV               |  |

Note: Enter values into green boxes  
 Developed for the STA by R Robinson, NPL

$$f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

**CO Uncert**

**Uncertainty calculation for Gaseous Measurement CO**

|                        |        |                           |            |        |
|------------------------|--------|---------------------------|------------|--------|
| Limit value            | 1400   | mg/m3 (corre Cal gas conc | 770        | mg.m-3 |
| Measured concentration | 943.54 | mg/m3                     | Full Scale | 1000   |
| Measured concentration | 943.54 | mg/m3 (Corrected)         |            |        |

| Correction for reference conditions |          |             |           |               |                |
|-------------------------------------|----------|-------------|-----------|---------------|----------------|
|                                     |          | O2, %       | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 5.00        | 0.00      | 101.30        | 273.00         |
|                                     | measured | 5.85        | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35        | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.06        | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.02        | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | <b>1.06</b> | uf        | <b>0.03</b>   |                |

| Performance characteristics           | Value |                       | specification    |
|---------------------------------------|-------|-----------------------|------------------|
| Response time                         | 180   | seconds               | 180.000          |
| Logger sampling interval              | 60    | seconds               |                  |
| Measurement period                    | 34    | minutes               |                  |
| Number of readings in measurement     | 34    |                       |                  |
| Repeatability at zero                 | 0.25  | % full scale          | <1 % range       |
| Repeatability at span level           | 0.15  | % full scale          | <2 % range       |
| Deviation from linearity(lack of fit) | 0.7   | % of value            | <2 % range       |
| Zero drift                            | -3.75 | mg/m3                 | <2% range / 24hr |
| Span drift                            | -3.75 | mg/m3                 | <2% range/24hr   |
| volume or pressure flow dependence    | 0.02  | % of full scale/3 kPa | <2 % / 3 kPa     |
| atmospheric pressure dependence       | 0.8   | % of full scale/2 kPa | <3% / 2 kPa      |
| ambient temperature dependence        | 0.01  | % full scale/10K      | <3% range / 10 K |
| N2O (mg/m3)                           | 20    | 0.2                   | mg/m3            |
| CO2 (% vol)                           | 15    | 0.2                   | mg/m3            |
| CH4 (mg/m3)                           | 40    | 0.7                   | mg/m3            |
| H2O (% vol)                           | 20    | 0.2                   | mg/m3            |
| dependence on voltage                 | 0.1   | % full scale/10V      | <2% range        |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | min    | max    | value at calib |       |
|-----------|--------|--------|----------------|-------|
| flow      | 95.00  | 105    | 100            | kPa   |
| pressure  | 100.76 | 100.92 | 100.88         | kPa   |
| temp      | 287    | 288.5  | 287.5          | K     |
| N2O range | 0      | 40     | 0              | mg/m3 |
| CO2 range | 0      | 15     | 0              | %vol  |
| CH4 range | 0      | 57     | 0              | mg/m3 |
| H2O range | 0      | 1      | 0              | %vol  |
| Voltage   | 93     | 121    | 110            | V     |

**Uncert Sheets**

|   |      |            |                    |
|---|------|------------|--------------------|
| losses in the line (leak)                         | 0.00 | % of value | < 0.1%vol /10 volt |
| Uncertainty of calibration gas                    | 2    | % of value | < 2% of value      |
| <b>Performance characteristic</b>                 |      |            |                    |
| Standard deviation of repeatability at zero       |      | ur0        | for mean           |
| Standard deviation of repeatability at span level |      | urs        | for mean           |
| Lack of fit                                       |      | ufit       |                    |
| Drift   |      | u0dr       |                    |
| volume or pressure flow dependence                |      | uspres     |                    |
| atmospheric pressure dependence                   |      | uapres     |                    |
| ambient temperature dependence                    |      | utemp      |                    |
| N2O (mg/m3)                                       |      | uintenf    |                    |
| CO2 (% vol)                                       |      | uintenf    |                    |
| CH4 (mg/m3)                                       |      | uintenf    |                    |
| H2O (% vol)                                       |      | uintenf    |                    |
| Dependence on voltage                             |      | uvolt      |                    |
| losses in the line (leak)                         |      | uleak      |                    |
| Uncertainty of calibration gas                    |      | ucalib     |                    |
| Uncertainty in factor                             |      | uf         |                    |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.93 all +ves  | Criteria<br>sum <4% range<br>18.87083333 |
| 0 all -ves   |  |
| 0.93 largest   |  |
| <b>Value to use for intereference uncertainty</b>                    |  |
| uint   | 0.93                                     |

|   |   |                     |              |
|---|---|---------------------|--------------|
| <b>Measurement uncertainty</b>            |   |                     |              |
| Combined uncertainty                      |   | 11.62               | mg/m3        |
| Expanded uncertainty                      | k = 2                                       | 23.24               | mg/m3        |
| <b>Uncertainty corrected to std conds</b> |   | <b>56.02</b>        | <b>mg/m3</b> |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>4.00 % ELV</b>   |              |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>56.02 mg.m-3</b> |              |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>5.94 % value</b> |              |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

**NOx Uncert**

**Uncertainty calculation for Gaseous Measurement NOx EN14792**

Uncert Sheets

**RUN 1**

|                        |        |                           |          |              |
|------------------------|--------|---------------------------|----------|--------------|
| Limit value            | 500    | mg/m3 (corre Cal gas conc | 329.9171 | mg.m-3 (NO2) |
| Measured concentration | 172    | ppm                       |          |              |
| Measured concentration | 353.16 | mg/m3 (101.3 Full Scale   | 513.25   | mg/m3 (NO2)  |
| Measured concentration | 353.16 | mg/m3 (Corrected)         |          |              |

|              |        |
|--------------|--------|
| NO/NO2 ratio | 100.00 |
|--------------|--------|

|              |           |
|--------------|-----------|
| Gas          | NO        |
| Full Scale   | 250 ppm   |
| Cal gas conc | 160.7 ppm |
| Conversion   | 2.053     |

| Correction for reference conditions |          |       |           |               |                |
|-------------------------------------|----------|-------|-----------|---------------|----------------|
|                                     |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 5.00  | 0.00      | 101.30        | 273.00         |
|                                     | measured | 5.85  | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35  | 0.00      | 0.00          | 1.00           |
| Factors                             |          | 1.06  | 1.00      | 1.00          | 1.01           |
| Uncertainty in factor               |          | 0.02  | 0.00      | 0.00          | 0.00           |
| Correction Factor                   |          | 1.06  | uf        | 0.02          |                |

| Performance characteristics           | Value |                    | specification      |
|---------------------------------------|-------|--------------------|--------------------|
| Response time                         | 180   | seconds            | 180.000            |
| Logger sampling interval              | 60    | seconds            |                    |
| Measurement period                    | 34    | minutes            |                    |
| Number of readings in measurement     | 34    |                    |                    |
| Repeatability at zero                 | 0.03  | % full scale       | <1 % range         |
| Repeatability at span level           | 0.06  | % full scale       | <2 % range         |
| Deviation from linearity(lack of fit) | 0.2   | % of value         | <2 % range         |
| Zero drift                            | 0.8   | mg/m3              | <2% range / 24hr   |
| Span drift                            | 1.48  | mg/m3              | <2% range/24hr     |
| volume or pressure flow dependence    | 0     | %of full scale/kPa | <2 % / kPa         |
| atmospheric pressure dependence       | 0     | %of value /kPa     | <3% / kPa          |
| ambient temperature dependence        | 0.3   | % full scale/10K   | <3% range / 10 K   |
| NH3 (mg/m3)                           | 20    | 0.0                | mg/m3              |
| CO2 (% vol)                           | 15    | 0.2                | mg/m3              |
| H2O (% vol)                           | 30    | 0.0                | mg/m3              |
| dependence on voltage                 | 0.1   | % full scale/10V   | <2% range          |
| losses in the line (leak)             | 0     | % of value         | < 0.1%vol /10 volt |
| Converter efficiency                  | 95.3  | %                  | >95%               |
| Uncertainty of calibration gas        | 2     | % of value         | < 2% of value      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | ranges |       |                |
|-----------|--------|-------|----------------|
|           | min    | max   | value at calib |
| flow      | 95.00  | 105   | 100 kPa        |
| pressure  | 101.30 | 101.3 | 101.3 kPa      |
| temp      | 289    | 289   | 289 K          |
| NH3 range | 0      | 0     | 0 mg/m3        |
| CO2 range | 0      | 15    | 0 %vol         |
| H2O range | 0      | 0     | 0 %vol         |
| Voltage   | 93     | 121   | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.05            |
| Lack of fit                                       | ufit        |                               | 0.41            |
| Drift   | u0dr        |                               | 0.00            |
| volume or pressure flow dependence                | uspres      |                               | 0.00            |
| atmospheric pressure dependence                   | uapres      |                               | 0.00            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| NH3   | uinterf     |                               | 0.00            |
| CO2 (% vol)                                       | uinterf     |                               | 0.12            |

|   |                           |
|---|---------------------------|
| Use largest of sum of all positive or all negative influences |                           |
| 0.12 all +ves   | Criteria<br>sum <4% range |
| 0 all -ves  |                           |

**Uncert Sheets**

|                                |  |  |         |  |  |  |      |   |             |
|--------------------------------|--|--|---------|--|--|--|------|---|-------------|
| H2O (% vol)                    |  |  | uinterf |  |  |  | 0.00 | 0.12 largest                              | 7.063187609 |
| Dependence on voltage          |  |  | uvolt   |  |  |  | 0.44 | Value to use for intereferece uncertainty |             |
| losses in the line (leak)      |  |  | uleak   |  |  |  | 0.00 | uint                                      | 0.12        |
| Uncertainty of calibration gas |  |  | ucalib  |  |  |  | 4.08 |   |             |
| converter efficiency           |  |  | uceff   |  |  |  | 9.58 |   |             |
| Uncertainty in factor          |  |  | uf      |  |  |  | 8.72 |   |             |

|   |                           |   |       |         |
|---|---------------------------|---|-------|---------|
| <b>Measurement uncertainty</b>                        |                           |   |       |         |
| Combined uncertainty                                  |                           |   | 10.43 | mg/m3   |
| Expanded uncertainty                                  | k =                       | 2 | 20.87 | mg/m3   |
| <b>Uncertainty corrected to std conds</b>             |                           |   |       |         |
|   |                           |   | 28.24 | mg/m3   |
| Expanded uncertainty                                  | expressed with a level of |   | 5.65  | % ELV   |
| Expanded uncertainty                                  | expressed with a level of |   | 28.24 | mg.m-3  |
| <b>Expanded uncertainty expressed with a level of</b> |                           |   |       |         |
|   |                           |   | 8.00  | % value |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

corrected drift to be based on mg/m3 reading and the correction alert to be based on % full scale

**HCL Uncert**

QGU-009-2013 Uncertainty calculation for HCL

v2

|                        |      |                                  |                  |   |             |
|------------------------|------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 50   | mg.m-3                           | Reference oxygen | 5 | % by volume |
| Measured concentration | 2.04 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities     | Symbol | Value   | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|-------------------------|--------|---------|----------------------|-----------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas      | Vm     | 0.06732 | uVm                  | 0.001 m3        | 1.49                      |                   | <=2%               |
| Sampled gas Temperature | Tm     | 273     | uTm                  | 2 k             | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure    | pm     | 101.3   | upm                  | 1 kPa           | 0.99                      |                   | <=1%               |
| Sampled gas Humidity    | Hm     | 0       | uHm                  | 1 % by volume   | 1.00                      |                   | <=1%               |
| Oxygen content          | O2,m   | 5.85    | uO2,m                | 0.1 % by volume | 1.71                      |                   | <=5%               |



**Uncert Sheets**

|   |    |        |     |        |      |      |                         |
|---|----|--------|-----|--------|------|------|-------------------------|
| Concentration in impinger   | C  | 0.55   | uC  | 0.0165 | mg/l | 3.00 | <5%                     |
| Impinger solution volume  | VS | 405    | uVS | 0.001  | l    | 0.00 | <1%                     |
| Mass SO2  | m  | 222.75 | um  | 6.68   | mg   | 3.00 | 0.12 <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |    |        |     |        |      |      |                         |
| Leak  | L  | 2      |     | %      |      | 2.00 | <=2%                    |

|                           |        |                   |                    |       |  |   |      |
|---------------------------|--------|-------------------|--------------------|-------|--|---|------|
| Intermediate calculations |        |                   |                    |       |  |   |      |
| Factor for std conds      | fs     | 1.00              |                    |       |  |   |      |
| uncertainty components    | symbol | sensitivity coeff | u (in units of fs) |       |  |   |      |
|                           | ρm     | 0.010             | 0.010              |       | $f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$ |   |      |
|                           | Hm     | 0.010             | 0.010              |       |  |   |      |
|                           | Tm     | 0.004             | 0.007              |       |  |   |      |
|                           | ufs    |                   | 0.016              |       |  | 1.58  |      |
| Corrected volume          | V      | 0.07              | uV                 | 0.001 | m <sup>3</sup>                                       | $V = V_m f_s$                               | 2.17 |
| Factor for O2 correction  | fc     | 1.06              |                    |       |  |   |      |
| uncertainty components    | symbol | sensitivity coeff | u                  |       |  | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |      |
|                           | O2,m   | 0.07              | 0.007              |       |  |   |      |
| Factor for O2 Correction  | ufc    | 1.06              | 0.007              |       |  |   | 0.66 |

| Parameter                              | Value | Units               | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|---------------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.07 m <sup>3</sup> | 30.28          | 0.04 mg.m-3              | 2.17 %           |
| Mass                                   | m     | 222.75 mg           | 0.01           | 0.06 mg.m-3              | 3.00 %           |
| Factor for O2 Correction               | fc    | 1.06                | 1.93           | 0.01 mg.m-3              | 0.66 %           |
| Leak                                   | L     | 0.02 mg.m-3         | 1.00           | 0.02 mg.m-3              | 1.15 %           |
| <b>Combined uncertainty</b>            |       |                     |                | <b>0.08 mg.m-3</b>       |                  |

|  |             |                     |  |
|--|-------------|---------------------|--|
| Expanded uncertainty as percentage of measured value | <b>7.87</b> | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | <b>0.16</b> | mg.m-3              |  |
| Expanded uncertainty as percentage of limit value    | <b>0.32</b> | % ELV               |  |

Note: Enter values into green boxes

Developed for the STA by R Robinson, NPL

$$\left[ \rho_m (100 - H_m) 273 \right]$$

Uncert Sheets

$$HFU \left[ f_s = \frac{100 - H_m}{100} \frac{273}{T_m} \frac{\rho_m}{101.3} \right]$$

QGU-009-2013 Uncertainty calculation for HF

v2

|                        |      |                                  |                  |   |             |
|------------------------|------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 5    | mg.m-3                           | Reference oxygen | 5 | % by volume |
| Measured concentration | 0.26 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities   | Symbol | Value  | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|--------|--------|----------------------|-----------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas  | Vm     | 0.0742 | uVm                  | 0.001 m3        | 1.35                      |                   | <=2%               |
| Sampled gas Temperature   | Tm     | 273    | uTm                  | 2 k             | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure  | pm     | 101.3  | upm                  | 1 kPa           | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | Hm     | 0      | uHm                  | 1 % by volume   | 1.00                      |                   | <=1%               |
| Oxygen content  | O2,m   | 5.85   | uO2,m                | 0.1 % by volume | 1.71                      |                   | <=5%               |
| Concentration in impinger   | C      | 0.1    | uC                   | 0.003 mg/l      | 3.00                      |                   | <5%                |
| Impinger solution volume  | VS     | 380    | uVS                  | 0.001 l         | 0.00                      |                   | <1%                |
| Mass SO2  | m      | 38     | um                   | 1.14 mg         | 3.00                      | 0.15              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |        |        |                      |                 |                           |                   |                    |
| Leak  | L      | 2      |                      | %               | 2.00                      |                   | <=2%               |

| Intermediate calculations                   |        |                   |                    |          |      |
|---|--------|-------------------|--------------------|----------|------|
| Factor for std conds                        | fs     | 1.00              |                    |          |      |
| uncertainty components                      | symbol | sensitivity coeff | u (in units of fs) |          |      |
|   | pm     | 0.010             | 0.010              |          |      |
|   | Hm     | 0.010             | 0.010              |          |      |
|   | Tm     | 0.004             | 0.007              |          |      |
|   | ufs    |                   | 0.016              |          | 1.58 |
| Corrected volume                            | V      | 0.07              | uV                 | 0.002 m3 | 2.08 |
| $V = V_m f_s$                               |        |                   |                    |          |      |
| Factor for O2 correction                    | fc     | 1.06              |                    |          |      |
| uncertainty components                      | symbol | sensitivity coeff | u                  |          |      |
|   | O2,m   | 0.07              | 0.007              |          |      |
| Factor for O2 Correction                    | ufc    | 1.06              |                    | 0.007    | 0.66 |
| $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |        |                   |                    |          |      |

| Parameter                              | Value | Units       | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|-------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.07 m3     | 3.45           | 0.01 mg.m-3              | 2.08 %           |
| Mass                                   | m     | 38.00 mg    | 0.01           | 0.01 mg.m-3              | 3.00 %           |
| Factor for O2 Correction               | fc    | 1.06        | 0.24           | 0.00 mg.m-3              | 0.66 %           |
| Leak                                   | L     | 0.00 mg.m-3 | 1.00           | 0.00 mg.m-3              | 1.15 %           |
| <b>Combined uncertainty</b>            |       |             |                | <b>0.01 mg.m-3</b>       |                  |

**Uncert Sheets**

|  |      |                     |  |
|--|------|---------------------|--|
| Expanded uncertainty as percentage of measured value | 7.77 | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | 0.02 | mg.m-3              |  |
| Expanded uncertainty as percentqge of limit value    | 0.40 | % ELV               |  |

Note: Enter values into green boxes

Developed for the STA by R Robinson, NPL

$$SO_2 U_{f_s} = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

**Run 1**

**Uncertainty calculation for Gaseous Measurement SO2 EA M21**

|                        |         |                           |            |        |
|------------------------|---------|---------------------------|------------|--------|
| Limit value            | -       | mg/m3 (corre Cal gas conc | 2096.38    | mg.m-3 |
| Measured concentration | 1833.76 | mg/m3                     | Full Scale | 2860   |
| Measured concentration | 1833.76 | mg/m3 (Corrected)         |            |        |

| Correction for reference conditions |          |             |           |               |                |
|-------------------------------------|----------|-------------|-----------|---------------|----------------|
|                                     |          | O2, %       | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 5.00        | 0.00      | 101.30        | 273.00         |
|                                     | measured | 5.85        | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35        | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.06        | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.02        | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | <b>1.06</b> | uf        | <b>0.03</b>   |                |

| Performance characteristics           | Value |                       | specification    |
|---------------------------------------|-------|-----------------------|------------------|
| Response time                         | 180   | seconds               | 180.000          |
| Logger sampling interval              | 60    | seconds               |                  |
| Measurement period                    | 34    | minutes               |                  |
| Number of readings in measurement     | 34    |                       |                  |
| Repeatability at zero                 | 0.25  | % full scale          | <1 % range       |
| Repeatability at span level           | 0.15  | % full scale          | <2 % range       |
| Deviation from linearity(lack of fit) | 0.7   | % of value            | <2 % range       |
| Zero drift                            | 0     | mg/m3                 | <2% range / 24hr |
| Span drift                            | 0.5   | mg/m3                 | <2% range/24hr   |
| volume or pressure flow dependence    | 0.02  | % of full scale/3 kPa | <2 % / 3 kPa     |
| atmospheric pressure dependence       | 0.8   | % of full scale/2 kPa | <3% / 2 kPa      |
| ambient temperature dependence        | 0.01  | % full scale/10K      | <3% range / 10 K |
| N2O (mg/m3)                           | 20    | 0.2                   | mg/m3            |
| CO2 (% vol)                           | 15    | 0.2                   | mg/m3            |
| CH4 (mg/m3)                           | 40    | 0.7                   | mg/m3            |

|                   |
|-------------------|
| Effect of drift   |
| 0.44 mg/m3        |
| 0.02 % full scale |

|           | min    | max    | value at calib |       |
|-----------|--------|--------|----------------|-------|
| flow      | 95.00  | 105    | 100            | kPa   |
| pressure  | 100.76 | 100.92 | 100.88         | kPa   |
| temp      | 287    | 288.5  | 287.5          | K     |
| N2O range | 0      | 40     | 0              | mg/m3 |
| CO2 range | 0      | 15     | 0              | %vol  |
| CH4 range | 0      | 57     | 0              | mg/m3 |

**Uncert Sheets**

|                                |    |     |                  |                    |           |    |     |     |      |
|--------------------------------|----|-----|------------------|--------------------|-----------|----|-----|-----|------|
| H2O (% vol)                    | 20 | 0.2 | mg/m3            |                    | H2O range | 0  | 1   | 0   | %vol |
| dependence on voltage          |    | 0.1 | % full scale/10V | <2% range          | Voltage   | 93 | 121 | 110 | V    |
| losses in the line (leak)      |    | 2   | % of value       | < 0.1%vol /10 volt |           |    |     |     |      |
| Uncertainty of calibration gas |    | 2   | % of value       | < 2% of value      |           |    |     |     |      |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.74            |
| Lack of fit                                       | ufit        |                               | 7.41            |
| Drift   | u0dr        |                               | 0.25            |
| volume or pressure flow dependence                | uspres      |                               | 0.55            |
| atmopsheric pressure dependence                   | uapres      |                               | 0.70            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| N2O (mg/m3)                                       | uinterf     |                               | 0.23            |
| CO2 (% vol)                                       | uinterf     |                               | 0.12            |
| CH4 (mg/m3)                                       | uinterf     |                               | 0.58            |
| H2O (% vol)                                       | uinterf     |                               | 0.01            |
| Dependence on voltage                             | uvolt       |                               | 2.47            |
| losses in the line (leak)                         | uleak       |                               | 21.17           |
| Uncertainty of calibration gas                    | ucalib      |                               | 21.17           |
| Uncertainty in factor                             | uf          |                               | 48.84           |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.93 all +ves  | Criteria<br>sum <4% range<br>36.67529412 |
| 0 all -ves   |  |
| 0.93 largest   |  |
| Value to use for intereference uncertainty                           | uint 0.93                                |

| Measurement uncertainty |                           |        |         |
|-------------------------|---------------------------|--------|---------|
| Combined uncertainty    |                           | 30.98  | mg/m3   |
| Expanded uncertainty    | k = 2                     | 61.97  | mg/m3   |
| Expanded uncertainty    |                           | 117.87 | mg/m3   |
| Expanded uncertainty    | expressed with a level of | 0.00   | % ELV   |
| Expanded uncertainty    | expressed with a level of | 117.87 | mg.m-3  |
| Expanded uncertainty    | expressed with a level of | 6.43   | % value |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

Uncert Sheets

Class Organics Uncert

Run 1

Uncertainty calculation for TOC

|                        |       |                                  |                  |   |             |
|------------------------|-------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 20    | mg.m-3                           | Reference oxygen | 5 | % by volume |
| Measured concentration | 12.75 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities   | Symbol | Value       | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv |
|---|--------|-------------|----------------------|-----------------|---------------------------|-------------------|
| Sampled Volume  | Vm     | 0.012394354 | uVm                  | 0.001 m3        |                           | 8.07              |
| Sampled gas Temperature   | Tm     | 288         | uTm                  | 2 k             |                           | 0.69              |
| Sampled gas Pressure  | pm     | 100.6       | upm                  | 1 kPa           |                           | 0.99              |
| Sampled gas Humidity  | Hm     | 0           | uHm                  | 1 % by volume   |                           | 1.00              |
| Oxygen content  | O2,m   | 5.85        | uO2,m                | 0.1 % by volume |                           | 1.71              |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |        |             |                      |                 |                           |                   |
| Leak  | L      | 0           |                      | %               |                           | 0.00              |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM    | 0           |                      | mg              | #REF!                     |                   |

Intermediate calculations

|                          |        |                   |    |                    |   |      |
|--------------------------|--------|-------------------|----|--------------------|---|------|
| Factor for std conds     | fs     | 0.94              |    |                    |   |      |
| uncertainty components   | symbol | sensitivity coeff |    | u (in units of fs) |   |      |
|                          | pm     | 0.009             |    | 0.009              |   |      |
|                          | Hm     | 0.009             |    | 0.009              |   |      |
|                          | Tm     | 0.003             |    | 0.007              |   |      |
|                          | ufs    |                   |    | 0.015              |   | 1.57 |
| Corrected volume         | V      | 0.01              | uV | 0.001 m3           | $V = V_m f_s$                               | 8.71 |
| Factor for O2 correction | fc     | 1.06              |    |                    |   |      |
| uncertainty components   | symbol | sensitivity coeff |    | u                  | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |      |
|                          | O2,m   | 0.07              |    | 0.007              |   |      |
| Factor for O2 Correction | ufc    | 1.06              |    | 0.007              |   | 0.66 |

| Parameter                               | Value | Units       | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|---|-------|-------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions)  | V     | 0.01 m3     | 1092.57        | 1.11 mg.m-3              | 8.71 %           |
| Factor for O2 Correction                | fc    | 1.06        | 12.07          | 0.08 mg.m-3              | 0.66 %           |
| Leak                                    | L     | 0.00 mg.m-3 | 1.00           | 0.00 mg.m-3              | 0.00 %           |
| <b>Combined measurement uncertainty</b> |       |             |                | <b>1.11 mg.m-3</b>       |                  |

Expanded uncertainty as percentage of measured value 17.48 % measured of value expressed with a level of confidence of 95%

(Using a coverage factor k=2)

Expanded uncertainty in units of measurement 2.228 mg.m-3

**Uncert Sheets**

Expanded uncertainty as percentage of limit value 0.00 % ELV

$$f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$$

O<sub>2</sub> Uncert

**Run 1**

**Uncertainty calculation for Gaseous Measurement Oxygen EN14789**

|                        |      |      |                 |      |      |
|------------------------|------|------|-----------------|------|------|
| Limit value            | n/a  | %vol | Calibration gas | 20.9 | %vol |
| Measured concentration | 5.85 | %vol | Full Scale      | 25   | %vol |

| Performance characteristics            | Value |   |                 | specification        |
|--|-------|---|-----------------|----------------------|
| Response time                          | 180   | seconds                                 |                 | < 200 s              |
| Logger sampling interval               | 60    | seconds                                 |                 |                      |
| Measurement period                     | 34    | minutes                                 |                 |                      |
| Number of readings in measurement      | 34    | Assuming 1 minute collected over 1 hour |                 |                      |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev           | <0.2 % range         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev           | <0.4 % range         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-             | <0.3 % volume        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-             | <2% of volume / 24hr |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-             | <2% volume/24hr      |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + 5 l/h         | <1% range            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + 2kPa          | < 1.5 % range        |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + 15K           | <0.3% volume 10 K    |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per | 15                   |
| NO (mg/m3)                             | 300   | 0.02                                    | % by volume per | 300                  |
| NO2 (mg/m3)                            | 30    | 0                                       | % by volume per | 30                   |
| Combined interference                  | 0.56  | % range                                 |                 | <2% range            |
| Dependence on voltage                  | 0.1   | % by volume /10V                        | + 5%            | < 0.1%vol /10 volt   |
| Losses in the line (leak)              | 2     | % of value                              |                 | < 2% of value        |
| Uncertainty of calibration gas         | 0.5   | % of value                              |                 |                      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

|           | range of variation from conditions at calibration |     |                |
|-----------|---|-----|----------------|
|           | min   | max | value at calib |
| flow      | 5   | 15  | 10 l/h         |
| pressure  | 99.00   | 101 | 100 kPa        |
| temp      | 280   | 285 | 285 K          |
| CO2 range | 8   | 15  | 0 % vol        |
| NO range  | 100   | 150 | 0 mg/m3        |
| NO2 range | 5   | 7.5 | 0 mg/m3        |
| Voltage   | 105   | 115 | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | u0dr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.04                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |

Use largest of sum of all positive or all negative influences

**Uncert Sheets**

|                                     |  |  |        |  |  |      |   |
|-------------------------------------|--|--|--------|--|--|------|---|
| NO                                  |  |  |        |  |  | 0.01 | 0.06 all +ves   |
| NO2                                 |  |  |        |  |  | 0.00 | 0 all -ves  |
| Combined interference (from mcerts) |  |  |        |  |  | 0.08 | 0.06 largest  |
| dependence on voltage               |  |  | uvolt  |  |  | 0.03 | Value to use for intereference uncertainty<br>uint 0.06 |
| losses in the line (leak)           |  |  | uleak  |  |  | 0.07 |   |
| Uncertainty of calibration gas      |  |  | ucalib |  |  | 0.02 |   |

|                                |   |  |                        |      |
|--------------------------------|---|--|------------------------|------|
| <b>Measurement uncertainty</b> |   |  | 5.85                   | %vol |
| Combined uncertainty           |   |  | 0.13                   | %vol |
| % of value                     |   |  | 2.26                   | %    |
| Coverage factor k =            | 2   |  |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>4.53 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>0.27 % vol</b>      |      |

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests  
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

corrected drift alert to be based on % full scale

**CO<sub>2</sub> Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement Carbon Dioxide**

|                        |       |      |                 |       |      |
|------------------------|-------|------|-----------------|-------|------|
| Limit value            | n/a   | %vol | Calibration gas | 14.96 | %vol |
| Measured concentration | 11.24 | %vol | Full Scale      | 25    | %vol |

| Performance characteristics       | Value |   |       | specification |
|-----------------------------------|-------|---|-------|---------------|
| Response time                     | 180   | seconds                                 |       | < 200 s       |
| Logger sampling interval          | 60    | seconds                                 |       |               |
| Measurement period                | 34    | minutes                                 |       |               |
| Number of readings in measurement | 34    | Assuming 1 minute collected over 1 hour |       |               |
| Repeatability at zero             | 0.015 | % by volume                             | stdev | <0.2 % range  |
| Repeatability at span level       | 0.014 | % by volume                             | stdev | <0.4 % range  |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

**Uncert Sheets**

|  |       |                     |                 |                      |           |   |     |                |  |
|--|-------|---------------------|-----------------|----------------------|-----------|---|-----|----------------|--|
| Deviation from linearity               | 0.13  | % vol               | +/-             | <0.3 % volume        |           |   |     |                |  |
| Zero drift (during measurement period) | 0     | % vol at zero level | +/-             | <2% of volume / 24hr |           | range of variation from conditions at calibration |     |                |  |
| Span drift (during measurement period) | 0     | % vol at span level | +/-             | <2% volume/24hr      |           | min   | max | value at calib |  |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h     | + 5 l/h         | <1% range            | flow      | 5   | 15  | 10 l/h         |  |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa         | + 2kPa          | < 1.5 % range        | pressure  | 99.00   | 101 | 100 kPa        |  |
| ambient temperature dependence         | -0.07 | % by volume /10K    | + 15K           | <0.3% volume 10 K    | temp      | 280   | 285 | 285 K          |  |
| CO2 (% vol)                            | 15    | 0.07                | % by volume per | 15                   | CO2 range | 8   | 15  | 0 % vol        |  |
| NO (mg/m3)                             | 300   | 0.02                | % by volume per | 300                  | NO range  | 100   | 150 | 0 mg/m3        |  |
| NO2 (mg/m3)                            | 30    | 0                   | % by volume per | 30                   | NO2 range | 5   | 7.5 | 0 mg/m3        |  |
| Combined interference                  | 0.56  | % range             |                 | <2% range            | Voltage   | 105   | 115 | 110 V          |  |
| Dependence on voltage                  | 0.1   | % by volume /10V    | + 5%            | < 0.1%vol /10 volt   |           |   |     |                |  |
| Losses in the line (leak)              | 2     | % of value          |                 | < 2% of value        |           |   |     |                |  |
| Uncertainty of calibration gas         | 0.5   | % of value          |                 |                      |           |   |     |                |  |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | uodr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.04                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |
| NO  |             |                               | 0.01                 |
| NO2   |             |                               | 0.00                 |
| Combined interference (from mcerts)               |             |                               | 0.08                 |
| dependence on voltage                             | uvolt       |                               | 0.03                 |
| losses in the line (leak)                         | uleak       |                               | 0.13                 |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.03                 |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.06 all +ves  |  |
| 0 all -ves   |  |
| 0.06 largest   |  |

|   |      |
|---|------|
| <b>Value to use for intereference uncertainty</b> |      |
| uint  | 0.06 |

|  |                        |      |
|--|------------------------|------|
| <b>Measurement uncertainty</b>                                   | 11.24                  | %vol |
| Combined uncertainty   | 0.17                   | %vol |
| % of value   | 1.56                   | %    |
| Coverage factor k =  | 2                      |      |
| <b>Expanded uncertainty expressed with a level of confidence</b> | <b>3.11 % of value</b> |      |
| <b>Expanded uncertainty expressed with a level of confidence</b> | <b>0.35 % vol</b>      |      |

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests



**Uncert Sheets**

Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

**Moisture Uncert**

| Run 1   |                  |  |   |                         |  |   |      |
|---|------------------|--|---|-------------------------|--|---|------|
| Uncertainty calculation for Moisture  |                  |  |   |                         |  |   |      |
| Limit value (ELV)   | 0                | mg.m <sup>-3</sup>                           | Reference oxygen                        | 5                       | % by volume  | Measurement Equation<br>$c = \frac{m}{V} f_c$ |      |
| Measured concentration  | 8.54             | mg.m <sup>-3</sup> (at reference conditions) |   |                         |  |   |      |
| Measured Quantities   | Symbol           | Value  | Standard uncertainty                    | Units                   | Uncertainty as percentage                                    | Uncertainty at lv                             |      |
| Sampled Volume  | V <sub>m</sub>   | 0.06   | uV <sub>m</sub>                         | 0.001 m <sup>3</sup>    |  | 1.67  |      |
| Sampled gas Temperature   | T <sub>m</sub>   | 273  | uT <sub>m</sub>                         | 2 k                     |  | 0.73  |      |
| Sampled gas Pressure  | p <sub>m</sub>   | 101.3  | up <sub>m</sub>                         | 1 kPa                   |  | 0.99  |      |
| Sampled gas Humidity  | H <sub>m</sub>   | 0  | uH <sub>m</sub>                         | 1 % by volume           |  | 1.00  |      |
| Oxygen content  | O <sub>2,m</sub> | 5.85   | uO <sub>2,m</sub>                       | 0.1 % by volume         |  | 1.71  |      |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |  |   |                         |  |   |      |
| Leak  | L                | 0.001  |   | %                       |  | 0.00  |      |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM              | 0  |   | mg                      | #REF!  |   |      |
| Intermediate calculations   |                  |  |   |                         |  |   |      |
| Factor for std conds  | fs               | 1.00   |   |                         |  |   |      |
| uncertainty components  | symbol           | sensitivity coeff                            |   | u (in units of fs)      |  |   |      |
|   | p <sub>m</sub>   | 0.010  |   | 0.010                   | $f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$ |   |      |
|   | H <sub>m</sub>   | 0.010  |   | 0.010                   |  |   |      |
|   | T <sub>m</sub>   | 0.004  |   | 0.007                   |  |   |      |
|   | ufs              |  |   | 0.016                   |  |   | 1.58 |
| Corrected volume  | V                | 0.06   | uV                                      | 0.001 m <sup>3</sup>    |  | $V = V_m f_s$                                 | 2.30 |
| Factor for O2 correction  | fc               | 1.06   |   |                         |  |   |      |
| uncertainty components  | symbol           | sensitivity coeff                            |   | u                       | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$                  |   |      |
|   | O <sub>2,m</sub> | 0.07   |   | 0.007                   |  |   |      |
| Factor for O2 Correction  | ufc              | 1.06   |   | 0.007                   |  | 0.66  |      |
| Parameter   | Value            | Units  | Sensitivity cc Uncertainty contribution |                         | Uncertainty as %   |   |      |
| Corrected Volume (standard conditions)  | V                | 0.06 m <sup>3</sup>                          | 142.28                                  | 0.20 mg.m <sup>-3</sup> | 2.30 %   |   |      |

**Uncert Sheets**

|   |    |                         |      |                               |        |
|---|----|-------------------------|------|-------------------------------|--------|
| Factor for O2 Correction                | fc | 1.06                    | 8.08 | 0.06 mg.m <sup>-3</sup>       | 0.66 % |
| Leak                                    | L  | 0.00 mg.m <sup>-3</sup> | 1.00 | 0.00 mg.m <sup>-3</sup>       | 0.00 % |
| <b>Combined measurement uncertainty</b> |    |                         |      | <b>0.20 mg.m<sup>-3</sup></b> |        |

Expanded uncertainty as percentage of measured value 4.79 % measured of value expressed with a level of confidence of 95%  
(Using a coverage factor k=2)

Expanded uncertainty in units of measurement 0.408 mg.m<sup>-3</sup>

Expanded uncertainty as percentage of limit value 0.00 % ELV



CONCEPT LIFE SCIENCES  
DELIVERING SCIENCE

Concept Life Sciences is a trading name of  
Concept Life Sciences Analytical & Development  
Services Limited registered in England and  
Wales (No 2514788)

# Concept Life Sciences

## Certificate of Analysis

Hadfield House  
Hadfield Street  
Cornbrook  
Manchester  
M16 9FE  
Tel : 0161 874 2400  
Fax : 0161 874 2404

**Report Number:** 835558-1

**Date of Report:** 06-Aug-2019

**Customer:** Air Scientific  
Unit 32 Degranville Court  
Dublin Road  
Trim  
Co. Meath  
Ireland.

**Customer Contact:** Project Management

**Customer Job Reference:** KNLATL110719

**Date Job Received at Concept:** 19-Jul-2019

**Date Analysis Started:** 22-Jul-2019

**Date Analysis Completed:** 06-Aug-2019

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

Customers are responsible for information provided where, if incorrect, it could affect the validity of the results.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with QMSection 15 of the Concept Life Sciences, Analytical Services Quality Manual



1549

Report checked  
and authorised by :  
David Plachcinski  
Customer Service Advisor

Issued by :  
David Plachcinski  
Customer Service Advisor

|  |               |            |              |               |              |             |             |              |             |  |
|--|---------------|------------|--------------|---------------|--------------|-------------|-------------|--------------|-------------|--|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger(DI water)</b> Analysed as Impinger(DI water)<br><b>Misc</b> |               |            |              |               |              |             |             |              |             |  |
| <b>Concept Reference</b>   |               |            |              |               | 835558 001   | 835558 002  | 835558 003  | 835558 007   | 835558 008  |  |
| <b>Customer Sample Reference</b>   |               |            |              |               | KH01 HCL 1+2 | KH01 HCL 3  | KH01 HCL B  | KH03 HCL 1+2 | KH03 HCL 3  |  |
| <b>Test Sample</b>   |               |            |              |               | AR           | AR          | AR          | AR           | AR          |  |
| <b>Date Sampled</b>  |               |            |              |               | 17-JUL-2019  | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019  | 17-JUL-2019 |  |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |              |             |             |              |             |  |
| Hydrogen Chloride  | IC            | 0.05       | mg/l         | SU            | 0.30         | <0.05       | 0.25        | 5.6          | <0.05       |  |
| Volume   | Vol           | 1          | ml           | U             | 140          | 130         | 140         | 140          | 140         |  |

|  |               |            |              |               |              |             |             |             |             |  |
|--|---------------|------------|--------------|---------------|--------------|-------------|-------------|-------------|-------------|--|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger(DI water)</b> Analysed as Impinger(DI water)<br><b>Misc</b> |               |            |              |               |              |             |             |             |             |  |
| <b>Concept Reference</b>   |               |            |              |               | 835558 011   | 835558 012  | 835558 015  | 835558 016  | 835558 019  |  |
| <b>Customer Sample Reference</b>   |               |            |              |               | KH04 HCL 1+2 | KH04 HCL 3  | F1 HCL 1+2  | F1 HCL 3    | F2 HCL 1+2  |  |
| <b>Test Sample</b>   |               |            |              |               | AR           | AR          | AR          | AR          | AR          |  |
| <b>Date Sampled</b>  |               |            |              |               | 17-JUL-2019  | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 |  |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |              |             |             |             |             |  |
| Hydrogen Chloride  | IC            | 0.05       | mg/l         | SU            | 0.50         | <0.05       | 0.50        | <0.05       | 0.15        |  |
| Volume   | Vol           | 1          | ml           | U             | 140          | 140         | 140         | 130         | 150         |  |

|  |               |            |              |               |             |  |  |  |  |  |
|--|---------------|------------|--------------|---------------|-------------|--|--|--|--|--|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger(DI water)</b> Analysed as Impinger(DI water)<br><b>Misc</b> |               |            |              |               |             |  |  |  |  |  |
| <b>Concept Reference</b>   |               |            |              |               | 835558 020  |  |  |  |  |  |
| <b>Customer Sample Reference</b>   |               |            |              |               | F2 HCL 3    |  |  |  |  |  |
| <b>Test Sample</b>   |               |            |              |               | AR          |  |  |  |  |  |
| <b>Date Sampled</b>  |               |            |              |               | 17-JUL-2019 |  |  |  |  |  |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |  |  |  |  |  |
| Hydrogen Chloride  | IC            | 0.05       | mg/l         | SU            | <0.05       |  |  |  |  |  |
| Volume   | Vol           | 1          | ml           | U             | 120         |  |  |  |  |  |

|   |                                |            |              |               |             |             |             |             |             |  |
|---|--------------------------------|------------|--------------|---------------|-------------|-------------|-------------|-------------|-------------|--|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger (sodium hydroxide)</b> Analysed as Impinger (sodium hydroxide)<br><b>Miscellaneous</b> |                                |            |              |               |             |             |             |             |             |  |
| <b>Concept Reference</b>  |                                |            |              |               | 835558 004  | 835558 005  | 835558 006  | 835558 009  | 835558 010  |  |
| <b>Customer Sample Reference</b>  |                                |            |              |               | KH01 HF 1+2 | KH01 HF 3   | KH01 HF B   | KH03 HF 1+2 | KH03 HF 3   |  |
| <b>Test Sample</b>  |                                |            |              |               | AR          | AR          | AR          | AR          | AR          |  |
| <b>Date Sampled</b>   |                                |            |              |               | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 |  |
| <b>Determinand</b>  | <b>Method</b>                  | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |             |             |             |             |  |
| Hydrogen Fluoride   | IC (acetate separation method) | 0.05       | mg/l         | SU            | 0.28        | <0.05       | <0.05       | <0.05       | <0.05       |  |
| Volume  | Vol                            | 1          | ml           | U             | 140         | 140         | 140         | 140         | 140         |  |

|   |                                |            |              |               |             |             |             |             |             |
|---|--------------------------------|------------|--------------|---------------|-------------|-------------|-------------|-------------|-------------|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger (sodium hydroxide)</b> Analysed as Impinger (sodium hydroxide)<br><b>Miscellaneous</b> |                                |            |              |               |             |             |             |             |             |
| <b>Concept Reference</b>  |                                |            |              |               | 835558 013  | 835558 014  | 835558 017  | 835558 018  | 835558 021  |
| <b>Customer Sample Reference</b>  |                                |            |              |               | KH04 HF 1+2 | KH04 HF 3   | F1 HF 1+2   | F1 HF 3     | F2 HF 1+2   |
| <b>Test Sample</b>  |                                |            |              |               | AR          | AR          | AR          | AR          | AR          |
| <b>Date Sampled</b>   |                                |            |              |               | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 | 17-JUL-2019 |
| <b>Determinand</b>  | <b>Method</b>                  | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |             |             |             |             |
| Hydrogen Fluoride   | IC (acetate separation method) | 0.05       | mg/l         | SU            | <0.05       | <0.05       | <0.05       | <0.05       | <0.05       |
| Volume  | Vol                            | 1          | ml           | U             | 140         | 130         | 140         | 140         | 140         |

|   |                                |            |              |               |             |
|---|--------------------------------|------------|--------------|---------------|-------------|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Impinger (sodium hydroxide)</b> Analysed as Impinger (sodium hydroxide)<br><b>Miscellaneous</b> |                                |            |              |               |             |
| <b>Concept Reference</b>  |                                |            |              |               | 835558 022  |
| <b>Customer Sample Reference</b>  |                                |            |              |               | F2 HF 3     |
| <b>Test Sample</b>  |                                |            |              |               | AR          |
| <b>Date Sampled</b>   |                                |            |              |               | 17-JUL-2019 |
| <b>Determinand</b>  | <b>Method</b>                  | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |
| Hydrogen Fluoride   | IC (acetate separation method) | 0.05       | mg/l         | SU            | 0.08        |
| Volume  | Vol                            | 1          | ml           | U             | 130         |

|  |               |            |              |               |             |
|--|---------------|------------|--------------|---------------|-------------|
| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>Misc</b> |               |            |              |               |             |
| <b>Concept Reference</b>   |               |            |              |               | 835558 023  |
| <b>Customer Sample Reference</b>   |               |            |              |               | 7899119272  |
| <b>Test Sample</b>   |               |            |              |               | AR          |
| <b>Date Sampled</b>  |               |            |              |               | 17-JUL-2019 |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b> | <b>Units</b> | <b>Symbol</b> |             |
| Total VOC as C   | GC/MS         | 1          | µg           | N             | <1          |

| <b>Concept Reference:</b> 835558<br><b>Customer Reference:</b> KNLATL110719<br><br><b>Tube (Charcoal 226-09)</b> Analysed as Tube (Charcoal 226-09)<br><b>EPA Suite 2018</b> |               |                    |                    |                    |     |     |     |
|--|---------------|--------------------|--------------------|--------------------|-----|-----|-----|
| <b>Concept Reference</b>   |               | <b>835558 024</b>  | <b>835558 025</b>  | <b>835558 026</b>  |     |     |     |
| <b>Customer Sample Reference</b>   |               | <b>7899119275</b>  | <b>7899119276</b>  | <b>7899119280</b>  |     |     |     |
| <b>Test Sample</b>   |               | <b>AR</b>          | <b>AR</b>          | <b>AR</b>          |     |     |     |
| <b>Date Sampled</b>  |               | <b>17-JUL-2019</b> | <b>17-JUL-2019</b> | <b>17-JUL-2019</b> |     |     |     |
| <b>Determinand</b>   | <b>Method</b> | <b>LOD</b>         | <b>Units</b>       | <b>Symbol</b>      |     |     |     |
| Acetone  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Benzene  | GC/MS         | 1                  | µg                 | U                  | <1  | <1  | <1  |
| Carbon tetrachloride   | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Chloroform   | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Cyclohexane  | GC/MS         | 20                 | µg                 | U                  | <20 | <20 | <20 |
| Cyclohexanone  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Dichloromethane  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Ethanol  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Ethyl acetate  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Heptane  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Hexane   | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Meta/Para-Xylene   | GC/MS         | 1                  | µg                 | U                  | <1  | <1  | <1  |
| Methyl ethyl ketone  | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Methyl iso butyl ketone  | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Ortho-Xylene   | GC/MS         | 1                  | µg                 | U                  | <1  | <1  | <1  |
| Propan-2-ol  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Tetrachloroethylene  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Tetrahydrofuran  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |
| Toluene  | GC/MS         | 5                  | µg                 | U                  | <5  | <5  | <5  |
| Trichloroethylene  | GC/MS         | 10                 | µg                 | U                  | <10 | <10 | <10 |

### Index to symbols used in 835558-1

| Value | Description                     |
|-------|---------------------------------|
| AR    | As Received                     |
| S     | Analysis was subcontracted      |
| U     | Analysis is UKAS accredited     |
| N     | Analysis is not UKAS accredited |



## Test Certificate

Date 31/07/2019

|                    |   |                        |                   |
|--------------------|---|------------------------|-------------------|
| <b>Client</b>      | Air Scientific (TM)<br>Unit 32 De Granville Court<br>Dublin Road<br>Trim<br>Co Meath<br>Ireland | <b>Order No.</b>       | KNLATL1170719     |
|                    |   | <b>Certificate No.</b> | <b>WK19-5573</b>  |
|                    |   | <b>Issue No.</b>       | 1                 |
| <b>Contact</b>     | Amanda  | <b>Date Received</b>   | 22/07/2019        |
| <b>Description</b> | 8 Filters and Washes for TPM  | <b>Technique</b>       | Gravimetric Stack |

| Sample No.               | 1059782  | B     | Method |
|--------------------------|----------|-------|--------|
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059783  | BW    | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |
| Sample No.               | 1059784  | KH01  | Method |
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059785  | KH01W | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |
| Sample No.               | 1059786  | KH03  | Method |
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059787  | KH03W | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |
| Sample No.               | 1059788  | KH04  | Method |
| Total particulate matter | <0.04 mg |       | D9(U)  |
| Sample No.               | 1059789  | KH04W | Method |
| Total particulate matter | <0.5 mg  |       | D9(U)  |




## Test Certificate

Date 31/07/2019

---

|               |                     |                        |           |
|---------------|---------------------|------------------------|-----------|
| <b>Client</b> | Air Scientific (TM) | <b>Certificate No.</b> | WK19-5573 |
|               |                     | <b>Issue No.</b>       | 1         |

Tested By Alessia Tamburri Date 30/07/2019

Approved By  Date 31/07/2019  
Joanne Dewhurst  
Operational

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited  
(N) Analysis is not UKAS Accredited

Concentration values (mg/m<sup>3</sup> and ppm) are not covered by the scope of UKAS accreditation.  
Results stated as ml are referring to the sample volume.

RPS Laboratories terms and conditions apply - a copy is available on request.

Analysis carried out on samples 'as received'

This document may not be reproduced other than in full, except with the written approval of the issuing laboratory.

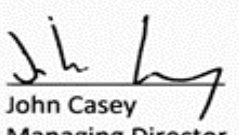




Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F1  
Facility Location: Knockharley Facility  
Rev.No: 1



|   |   |
|---|---|
| <b>Report Title</b>                                   | Air Emissions Compliance Monitoring Emissions Report  |
| <b>Company address</b>                                | Air Scientific Ltd., 32 DeGranville Court, Dublin road,<br>Trim, Co. Meath  |
| <b>Stack Emissions Testing Report Commissioned by</b> | Knockharley Landfill  |
| <b>Facility Name</b>                                  | Knockharley Facility  |
| <b>Contact Person</b>                                 | Mr Sean O Callaghan   |
| <b>EPA Licence Number</b>                             | WL0146-02   |
| <b>Licence Holder</b>                                 | Knockharley Landfill, F1  |
| <b>Stack Reference Number</b>                         | F1  |
| <b>Dates of the Monitoring Campaign</b>               | 06/10/2021  |
| <b>Job Reference Number</b>                           | KNLATL1061021 / 20211664  |
| <b>Report Written By</b>                              | Amanda Sheridan   |
| <b>Report Approved by</b>                             | Dr. John Casey  |
| <b>Stack Testing Team</b>                             | Dr. John Casey, Amanda Sheridan   |
| <b>Report Date</b>                                    | 19/11/2021  |
| <b>Report Type</b>                                    | Test Report Compliance Monitoring   |
| <b>Version</b>  | 1   |
| <b>Signature of Approver</b>                          | <br>John Casey<br>Managing Director |

## Contents

|  |    |
|--|----|
| 1. Executive Summary .....   | 4  |
| I. Monitoring Objectives .....   | 4  |
| Overall Aim of the monitoring Campaign .....                               | 4  |
| Special Requirements .....   | 4  |
| Target Parameters .....  | 4  |
| Emission Limit Values .....  | 5  |
| Reference Conditions .....   | 5  |
| Overall Results .....  | 6  |
| Accreditation details .....  | 7  |
| Monitoring Dates & Times .....   | 8  |
| Monitoring, Equipment & Analytical Methods .....                           | 9  |
| Sampling Deviations .....  | 11 |
| Reference Documents .....  | 11 |
| Suitability of sampling location .....                                     | 12 |
| Process details .....  | 13 |
| Stack diagram .....  | 14 |
| 2. APPENDICES .....  | 15 |
| II. Appendix I - Monitoring Personnel & Equipment .....                    | 15 |
| Stack Emissions Monitoring Personnel .....                                 | 15 |
| III. Appendix II - Stack Details & flow characteristics .....              | 16 |
| Preliminary stack survey calculations .....                                | 16 |
| IV. Appendix III - Individual parameter sampling details and results ..... | 22 |
| Carbon Monoxide Quality Assurance .....                                    | 22 |
| Carbon Monoxide Results & Sampling details .....                           | 25 |
| Carbon Monoxide Trend .....  | 29 |
| Carbon Monoxide Measurement Uncertainty .....                              | 30 |
| Oxides of Nitrogen Quality Assurance .....                                 | 31 |
| Oxides of Nitrogen Results & Sampling details .....                        | 33 |
| Oxides of Nitrogen Trend .....   | 37 |
| Oxides of Nitrogen Measurement Uncertainty .....                           | 38 |
| Total Volatile Organic Carbon Quality Assurance .....                      | 39 |
| Total Volatile Organic Carbon Results and Sampling Details .....           | 41 |
| Total Volatile Organic Carbon Trend .....                                  | 45 |
| Total Volatile Organic Carbon Measurement Uncertainty .....                | 46 |
| Hydrogen Chloride Sampling Details & Results .....                         | 48 |
| Hydrogen Chloride Quality Assurance .....                                  | 49 |
| Hydrogen Chloride Results & Measurement Uncertainty .....                  | 51 |
| Hydrogen Fluoride Sampling Details & Results .....                         | 53 |
| Hydrogen Fluoride Quality Assurance .....                                  | 54 |
| Hydrogen Fluoride Results & Measurement Uncertainty .....                  | 56 |
| Sulphur Dioxide Quality Assurance .....                                    | 57 |
| Sulphur Dioxide Sampling Details & Results .....                           | 59 |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

Sulphur Dioxide Trend ..... 69

Sulphur Dioxide Results & Measurement Uncertainty ..... 71

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F1  
Facility Location: Knockharley Facility  
Rev.No: 1

|  |    |
|--|----|
| Oxygen Quality Assurance .....                   | 73 |
| Oxygen Trend .....                               | 76 |
| Carbon Dioxide Quality Assurance .....           | 77 |
| Carbon Dioxide Sampling Details & Results .....  | 77 |
| Carbon Dioxide Trend .....                       | 79 |
| Moisture Results & Measurement Uncertainty ..... | 81 |
| <br>   |    |
| Uncertainty Sheets .....                         | 84 |

*Opinions and interpretations expressed herein are outside the scope of Air Scientific Limited INAB accreditation.  
This test report shall not be reproduced, without the written approval of Air Scientific Limited. All sampling  
and reporting is completed in accordance with Environmental Protection Agency Air Guidance Note 2 requirements.*

## 1. Executive Summary

### I. Monitoring Objectives

#### Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

#### Special Requirements

There were no special requirements.

#### Target Parameters

|   |
|---|
| Carbon Monoxide (CO)                        |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> |
| Total Volatile Organic Carbon (TOC)         |
| Hydrogen Chloride (HCL)                     |
| Hydrogen Fluoride (HF)                      |
| Sulphur Dioxide (SO <sub>2</sub> )          |
| Stack Gas Temperature                       |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )   |
| Oxygen (O <sub>2</sub> )                    |
| Carbon Dioxide (CO <sub>2</sub> )           |

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F1  
Facility Location: Knockharley Facility  
Rev.No: 1

### Emission Limit Values

| Emission Limit Values / Mass Emissions Limit Values | mg.m <sup>-3</sup> | kg.h <sup>-1</sup> |
|---|--------------------|--------------------|
| CO  | 50                 | -                  |
| NOx as NO <sub>2</sub>                              | 150                | -                  |
| TOC   | 10                 | -                  |
| HCL   | 50                 | -                  |
| HF  | 5                  | -                  |
| SO <sub>2</sub>                                     | -                  | -                  |
| Stack Gas Temperature                               | -                  | -                  |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )           | -                  | -                  |

### Reference Conditions

| Reference Condition | Value  |
|---------------------|--------|
| Oxygen Reference %  | 3      |
| Temperature K       | 273.15 |
| Total Pressure kPa  | 101.3  |
| Moisture Correction | Yes    |

**Executive Summary**

**Overall Results**

| Parameter                         | Concentration                   | Result  | MU +/- | Blanks | Limit | Compliant | Mass Emission      | Result | Limit | Run 1 | Dates      | Time on  | Time off | O2 Ref. (%) | Accreditation | LOD  |
|-----------------------------------|---------------------------------|---------|--------|--------|-------|-----------|--------------------|--------|-------|-------|------------|----------|----------|-------------|---------------|------|
|                                   | Units                           |         |        |        |       |           | Units              |        |       |       |            |          |          |             |               |      |
| CO EN15058:2017                   | mg.m <sup>-3</sup>              | 7.99    | 2.79   | -      | 50    | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 11:45:00 | 12:18:00 | 3           | Yes           | <1.7 |
| NOx EN14792:2017                  | mg.m <sup>-3</sup>              | 43.52   | 3.73   | -      | 150   | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 11:45:00 | 12:18:00 | 3           | Yes           | <1.8 |
| TVOC EN12619:2013                 | mg.m <sup>-3</sup>              | 3.56    | 0.59   | -      | 10    | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 11:45:50 | 12:17:50 | 3           | Yes           | <0.8 |
| HCL EN1911:2010                   | mg.m <sup>-3</sup>              | <0.39   | 0.02   | <0.09  | 50    | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 00:00:00 | 00:00:00 | 3           | Yes           | 0.27 |
| HF EN15713:2006                   | mg.m <sup>-3</sup>              | 0.16    | 0.01   | <0.03  | 5     | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 00:00:00 | 00:00:00 | 3           | Yes           | 0.28 |
| SO <sub>2</sub> CEN/TS 17021:2017 | mg.m <sup>-3</sup>              | 2526.8  | 169.22 | -      | -     | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 11:45:00 | 12:18:00 | 3           | No            | <6.1 |
| Oxygen (%) EN14789:2017           | % v/v                           | 8.48    | 0.15   | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 11:45:00 | 12:18:00 | 3           | Yes           | -    |
| CO <sub>2</sub> ISO12039:2001     | % v/v                           | 12.14   | 0.37   | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 11:45:00 | 12:18:00 | 3           | Yes           | -    |
| H <sub>2</sub> O EN14790:2017     | % v/v                           | 8.2     | 0.4    | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 00:00:00 | 00:00:00 | 3           | Yes           | -    |
| Stack Gas Temperature             | K                               | 1281.15 | -      | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 11:35:00 | 11:40:00 | 3           | Yes           | -    |
| Stack Gas Velocity EN16911:2013   | m.s <sup>-1</sup>               | -       | -      | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 11:35:00 | 11:40:00 | 3           | Yes           | -    |
| Volumetric Flow Rate              | m <sup>3</sup> .h <sup>-1</sup> | -       | -      | -      | -     | N/A       | -                  | -      | -     | -     | -          | -        | -        | 3           | Yes           | -    |
| Volumetric Flow Rate (Ref)        | m <sup>3</sup> .h <sup>-1</sup> | -       | -      | -      | -     | N/A       | -                  | -      | -     | -     | -          | -        | -        | 3           | Yes           | -    |

**Accreditation details**

|                                |          |
|--------------------------------|----------|
| Air Scientific Limited         | INAB319T |
| External Analytical Laboratory | UKAS0605 |
| Other                          | -        |





## Executive Summary

## Monitoring Dates &amp; Times

| Parameter                                   | Run   | Location ID | Sampling Dates | Sampling Time On | Sampling Time Off | Duration (mins.) |
|---|-------|-------------|----------------|------------------|-------------------|------------------|
| Carbon Monoxide (CO)                        | Run 1 | F1          | 06/10/2021     | 11:45:00         | 12:18:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> | Run 1 | F1          | 06/10/2021     | 11:45:00         | 12:18:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Total Volatile Organic Carbon (VOC)         | Run 1 | F1          | 06/10/2021     | 11:45:50         | 12:17:50          | 00:32:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Chloride (HCL)                     | Run 1 | F1          | 06/10/2021     | 00:00:00         | 00:00:00          | 00:00:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Fluoride (HF)                      | Run 1 | F1          | 06/10/2021     | 00:00:00         | 00:00:00          | 00:00:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Sulphur Dioxide (SO <sub>2</sub> )          | Run 1 | F1          | 06/10/2021     | 11:45:00         | 12:18:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxygen (%)                                  | Run 1 | F1          | 06/10/2021     | 11:45:00         | 12:18:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Water Vapour (%)                            |       | F1          | 06/10/2021     | 00:00:00         | 00:00:00          | 00:00:00         |
| Stack Gas Temperature                       |       | F1          | 06/10/2021     | 11:35:00         | 11:40:00          | 00:05:00         |
| Stack Gas Velocity                          |       | F1          | 06/10/2021     | 11:35:00         | 11:40:00          | 00:05:00         |
| Carbon Dioxide (%)                          | Run 1 | F1          | 06/10/2021     | 11:45:00         | 12:18:00          | 00:33:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

### Executive Summary

### Monitoring, Equipment & Analytical Methods

| Parameter                           | Monitoring        |                     |                    |             | Analysis                   |               |
|-------------------------------------|-------------------|---------------------|--------------------|-------------|----------------------------|---------------|
|                                     | Standard          | Technical Procedure | Accredited Testing | Testing Lab | Analytical Technique       | INAB Analysis |
| Carbon Monoxide (CO)                | EN15058:2017      | SOP 2004            | Yes                | AirSci      | NCIR By Horiba PG-250      | -             |
| Oxides of Nitrogen (NOx)            | EN14792:2017      | SOP 2002            | Yes                | AirSci      | Chemiluminescence          | -             |
| Total Volatile Organic Carbon (TOC) | EN12619:2013      | SOP 2009            | Yes                | AirSci      | Flame Ionisation Detection | -             |
| Hydrogen Chloride (HCL)             | EN1911:2010       | SOP 2014            | Yes                | RPS         | Ion Chromatography         | -             |
| Hydrogen Fluoride (HF)              | EN15713:2006      | SOP 2024            | Yes                | RPS         | Ion Chromatography         | -             |
| Sulphur Dioxide (SO <sub>2</sub> )  | CEN/TS 17021:2017 | SOP 2046            | No                 | AirSci      | NDIR Absorption            | -             |
| Oxygen (%)                          | EN14789:2017      | SOP 2008            | Yes                | AirSci      | Paramagnetic               | -             |
| Carbon Dioxide                      | ISO12039:2001     | SOP 2045            | Yes                | AirSci      | Gravimetric                | -             |
| Water Vapour (%)                    | EN14790:2017      | SOP 2007            | Yes                | AirSci      | NDIR                       | -             |
| Stack Gas Temperature               | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Thermocouple               | -             |
| Stack Gas Velocity                  | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Pitot tubes                | -             |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

### List of Equipment

| ID           | Item of Equipment                      | Manufacturer       | Serial No. |
|--------------|--|--------------------|------------|
| ASLTM12EQ511 | 3010 MiniFID                           | Signal Instruments | 17852      |
| ASLTM12EQ513 | Horiba PG2500 Portable Gas Analyzer    | Horiba             | ZVM969TT   |
| ASLTM12EQ526 | Knob weights (200,500,1000mg)          | KERN & Sohn GmbH   | G1117388   |
| ASLTM13EQ509 | 10 metre industrial heated sample line | Neptech            | 13B088     |
| ASLTM14EQ510 | 5 metre heated line                    | Neptech            | 14B052     |
| ASLTM15EQ505 | Mass flow meter                        | Siargo             | A1K05286   |
| ASLTM15EQ508 | My weigh ibalance i1200                | My Weigh           | 7.256.358  |
| ASLTM20EQ504 | K type thermocouple                    | TCR Tecora         | N/A        |
| ASLTM19EQ510 | Mass flow meter                        | Siargo             | N/A        |
| ASLTM19EQ509 | Kimo Manometer                         | Kimo               | N/A        |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

### Sampling Deviations

| Parameter   | Deviation  |
|-------------|--|
| Standard ID | -  |
| Standard ID | HCL Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2) |
| Standard ID | HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).     |
| Standard ID | -  |

### Reference Documents

|                              |         |
|------------------------------|---------|
| Risk Assessment (RA)         | SOP1011 |
| Site Review (SR)             | SOP1015 |
| Site Specific Protocol (SSP) | SOP1015 |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**Executive Summary**

**Suitability of sampling location**

| General Information | Value     |
|---------------------|-----------|
| Permanent/Temporary | Temporary |
| Inside/ Outside     | Outside   |

| Platform Details   |       |         |
|--|-------|---------|
| Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements      | Value | Comment |
| Sufficient Working area to manipulate probe and measuring instruments          | Yes   | -       |
| Platform has 2 handrails (approx. 0.5m & 1.0 m high)                           | Yes   | -       |
| Platform has vertical base boards (approx. 0.25 m high)                        | Yes   | -       |
| Platform has chains / self closing gates at top of ladders                     | Yes   | -       |
| There are no obstructions present which hamper insertion of sampling equipment | No    | -       |
| Safe Access Available  | Yes   | -       |
| Easy Access Available  | Yes   | -       |

| Sampling Location / Platform Improvement Recommendations |
|--|
| None   |

| BSEN 15259 Homogeneity Test Requirements   |
|--|
| 1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack |

**Process details**

| Parameter                           |            |
|-------------------------------------|------------|
| Process status                      | Normal     |
| Capacity (per/hour) (if applicable) | As Normal  |
| Continuous or Batch Process         | Continuous |
| Feedstock                           | LFG        |
| Abatement System                    | No         |
| Abatement Systems Running Status    | N/A        |
| Fuel                                | Gas        |
| Plume Appearance                    | No         |
| Other information                   | None       |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

The process information below has been supplied by the client and as such ASL assume no responsibility or liability for any errors or omissions in the content of this Process Detail Form. The information provided in this form is provided on an 'as is' basis with no guarantees of completeness, accuracy or reliability.

| Licensee     |                     |                      |                     |
|--------------|---------------------|----------------------|---------------------|
| Reg. number  | WL0146-02           | Contractor           | Air Scientific Ltd. |
| Site Contact | Mr Sean O Callaghan | Contractor's contact | Amanda Sheridan     |
| Role         |                     | Role                 | -                   |
| Signature    |                     | Signature            | -                   |

| Emissions point       |     | -               |                            |     |                                   |   |
|-----------------------|-----|-----------------|----------------------------|-----|-----------------------------------|---|
| Type of process       |     | Load of process | Abatement system           |     | List of Solvents used per process |   |
| Rotogravure Printing  | -   | as normal       | Bag filter                 | -   | -                                 | - |
| Cement Plant          | -   |                 | Electrostatic precipitator | -   | -                                 | - |
| Electrical generation | -   |                 | Cyclone                    | -   | -                                 | - |
| Steam boiler          | -   |                 | Thermal oxidiser           | -   | -                                 | - |
| Other                 | Yes |                 | Active carbon bed          | -   | -                                 | - |
|                       |     |                 | NSCR                       | -   | -                                 | - |
|                       |     |                 | SCR                        | -   | -                                 | - |
|                       |     |                 | Dry scrubber               | -   | -                                 | - |
|                       |     |                 | Wet scrubber               | -   | -                                 | - |
|                       |     |                 | Lime injection             | -   | -                                 | - |
|                       |     |                 | Biofilter                  | -   | -                                 | - |
|                       |     |                 | None                       | Yes | -                                 | - |
|                       |     |                 | Other:                     | -   | -                                 | - |

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F1  
Facility Location: Knockharley Facility  
Rev.No: 1

**Executive Summary**

**Stack diagram**



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**2. APPENDICES**

**II. Appendix I - Monitoring Personnel & Equipment**

**Stack Emissions Monitoring Personnel**

|                    |                        |                                       |
|--------------------|------------------------|---------------------------------------|
| <b>Team Leader</b> | <b>Name</b>            | Dr. John Casey                        |
|                    | <b>Qualifications</b>  | PhD. (Eng.), MSc. (Agr.), B. Agr. Sc. |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Technician</b>  | <b>Name</b>            | Amanda Sheridan                       |
|                    | <b>Qualifications</b>  | B.A.                                  |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Team Leader</b> | <b>Name</b>            | -                                     |
|                    | <b>Qualifications</b>  | -                                     |
|                    | <b>System approval</b> | -                                     |
|                    |                        | -                                     |



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**III. Appendix II - Stack Details & flow characteristics**

**Preliminary stack survey calculations**

| <b>General Stack Details</b>                |              |              |
|---|--------------|--------------|
| <b>Stack details</b>                        | <b>Units</b> | <b>Value</b> |
| Date of survey                              |              | 06/10/2021   |
| Time of survey                              |              | 11:35        |
| Type  |              | -            |
| Stack Diameter / Depth, D                   | m            | -            |
| Stack Width, W                              | m            | -            |
| Average Stack Gas Temp., Ta                 | C            | 1008         |
| Average Static Pressure, P static           | kPa          | 0.1          |
| Average Barometric Pressure, Pb             | kPa          | 101.1        |
| Type of Pitot                               |              | -            |
| Are Water Droplets Present?                 |              | -            |
| Average Pitot Tube Calibration Coeff, Cp    |              | -            |
| Negative flow                               |              | -            |
| Highly homogeneous flow stream/gas velocity |              | Yes          |

|                           |    |          |
|---------------------------|----|----------|
| Sample Port Size          | mm | -        |
| Initial Pitot Leak Check  | Pa | -        |
| Final Pitot Leak Check    | Pa | -        |
| Orientation of Duct       |    | Vertical |
| Pitot Tube Cp             |    | 0.998    |
| Number of Lines Available |    | -        |
| Number of Lines Used      |    | -        |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

| Sampling Line A |                      |    |         |                |            |                |
|-----------------|----------------------|----|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | -                    | -  | -       | -              | -          | -              |
| 2               | -                    | -  | -       | -              | -          | -              |
| 3               | -                    | -  | -       | -              | -          | -              |
| 4               | -                    | -  | -       | -              | -          | -              |
| 5               | -                    | -  | -       | -              | -          | -              |
| 6               | -                    | -  | -       | -              | -          | -              |
| 7               | -                    | -  | -       | -              | -          | -              |
| 8               | -                    | -  | -       | -              | -          | -              |
| 9               | -                    | -  | -       | -              | -          | -              |
| 10              | -                    | -  | -       | -              | -          | -              |
| Average         | -                    | -  | -       | -              | -          | -              |
| Min             | -                    | -  | -       | -              | -          | -              |
| Max             | -                    | -  | -       | -              | -          | -              |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

| Sampling Line B |                      |    |         |                |            |                |
|-----------------|----------------------|----|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | -                    | -  | -       | -              | -          | -              |
| 2               | -                    | -  | -       | -              | -          | -              |
| 3               | -                    | -  | -       | -              | -          | -              |
| 4               | -                    | -  | -       | -              | -          | -              |
| 5               | -                    | -  | -       | -              | -          | -              |
| 6               | -                    | -  | -       | -              | -          | -              |
| 7               | -                    | -  | -       | -              | -          | -              |
| 8               | -                    | -  | -       | -              | -          | -              |
| 9               | -                    | -  | -       | -              | -          | -              |
| 10              | -                    | -  | -       | -              | -          | -              |
| Average         | -                    | -  | -       | -              | -          | -              |
| Min             | -                    | -  | -       | -              | -          | -              |
| Max             | -                    | -  | -       | -              | -          | -              |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

| Component                      | Conc. ppm | Conc. Dry % v/v | Conc. Wet % v/v | Molar Mass |
|--------------------------------|-----------|-----------------|-----------------|------------|
| Carbon Dioxide CO <sub>2</sub> | -         | 12.1            | -               | 44.01      |
| Oxygen O <sub>2</sub>          | -         | 8.4             | -               | 32         |
| Nitrogen N <sub>2</sub>        | -         | 79.5            | -               | 28.1       |
| Moisture (H <sub>2</sub> O)    | -         | -               | 8.2             | 18.02      |
| <b>Reference Conditions</b>    |           |                 |                 |            |
| Temperature                    | °C        | 273.15          |                 |            |
| Total Pressure                 | kPa       | 101.3           |                 |            |
| Moisture                       | %         | -               |                 |            |
| Oxygen (Dry)                   | %         | 3               |                 |            |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

| Stack Gas Composition & Molecular Weights |              |                             |                 |                       |                                |                 |                       |                                |
|---|--------------|-----------------------------|-----------------|-----------------------|--------------------------------|-----------------|-----------------------|--------------------------------|
| Component                                 | Molar Mass M | Density Kg/m <sup>3</sup> p | Conc. Dry % v/v | Dry Volume Fraction r | Dry Conc. kg/m <sup>3</sup> pi | Conc. wet % v/v | Wet Volume Fraction r | Wet Conc. kg/m <sup>3</sup> pi |
| Carbon Dioxide CO <sub>2</sub>            | 44.01        | 1.96                        | 12.1            | 0.121                 | 0.24                           | 11.11           | 0.11                  | 0.22                           |
| Oxygen O <sub>2</sub>                     | 32           | 1.43                        | 8.4             | 0.084                 | 0.12                           | 7.71            | 0.08                  | 0.11                           |
| Nitrogen N <sub>2</sub>                   | 28.1         | 1.25                        | 79.5            | 0.795                 | 1                              | 72.98           | 0.73                  | 0.92                           |
| Moisture (H <sub>2</sub> O)               | 18.02        | 0.8                         | -               | -                     | -                              | 8.2             | 0.08                  | 0.07                           |
| where $p = M/22.41$                       |              |                             |                 |                       |                                |                 |                       |                                |
| $p_i = r \times p$                        |              |                             |                 |                       |                                |                 |                       |                                |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

| Calculation of Stack Gas Densities  |                    |        |
|---|--------------------|--------|
| Determinant   | Units              | Result |
| Dry Density (STP), P STD  | kg.m <sup>-3</sup> | 1.354  |
| Wet Density (STP), P STW  | kg.m <sup>-3</sup> | 1.313  |
| Dry Density (Actual), P Actual  | kg.m <sup>-3</sup> | 0.288  |
| Average wet Density (Actual), P Actual W  | kg.m <sup>-3</sup> | 0.279  |
| <b>Where</b>  |                    |        |
| P STD = sum of component concentrations, kg/m <sup>3</sup> (excluding water vapour)               |                    |        |
| $P_{STW} = (P_{STD} + p_{i \text{ of } H_2O}) / (1 + (p_{i \text{ of } H_2O} / 0.8036))$          |                    |        |
| $P_{actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times (P_a / T_a)$                            |                    |        |
| $P_{actual \ W} \text{ (at each sampling point)} = P_{STW} \times (T_s / P_s) \times (P_a / T_a)$ |                    |        |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

| Sampling Plane Validation Criteria     | Value | Units   | Requirement | Compliance | Method       |
|--|-------|---------|-------------|------------|--------------|
| Lowest Differential Pressure           | -     | Pa      | >5 Pa       | N/A        | EN16911:2013 |
| Lowest Gas Velocity                    | -     | m/s     | -           | N/A        | -            |
| Highest Gas Velocity                   | -     | m/s     | -           | N/A        | -            |
| Ratio of Above                         | -     | :1      | <3:1        | N/A        | EN16911:2013 |
| Mean Velocity                          | -     | m/s     | -           | N/A        | -            |
| Angle of flow with regard to duct axis | -     | degrees | < 15        | N/A        | EN16911:2013 |
| No local negative flow                 | -     | -       | -           | N/A        | -            |
| Homogeneous flow stream/gas velocity   | -     | -       | -           | N/A        | -            |

| Calculation of stack Gas Velocity, V  |       |
|---|-------|
| Velocity at Traverse Point, $V = K_{cp} * \text{Sqrt}((2 * DP) / \text{Density})$ | -     |
| <b>Where</b>  |       |
| $K_{pt}$ = Pitot tube calibration coefficient                                     | -     |
| Compressibility correction factor, assumed at a constant 0.998                    | 0.998 |

| Gas Volumetric Flowrate               | Units        | Result |
|---------------------------------------|--------------|--------|
| Gas Volumetric Flow Rate (Actual)     | $m^3.h^{-1}$ | -      |
| Gas Volumetric Flow Rate (STP, Wet)   | $m^3.h^{-1}$ | -      |
| Gas Volumetric Flowrate (STP, Dry)    | $m^3.h^{-1}$ | -      |
| Gas Volumetric Flowrate REF to Oxygen | $m^3.h^{-1}$ | -      |

|  |   |  |   |  |   |
|--|---|--|---|--|---|
| Standard uncertainty of velocity (m/s) | - | Expanded uncertainty of velocity (m/s) | - | Volume flow rate expanded uncertainty ( $m^3/hr$ ) | - |
|--|---|--|---|--|---|

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F1  
Facility Location: Knockharley Facility  
Rev.No: 1

***IV. Appendix 3 - Individual parameter sampling details and results***



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Carbon Monoxide Quality Assurance

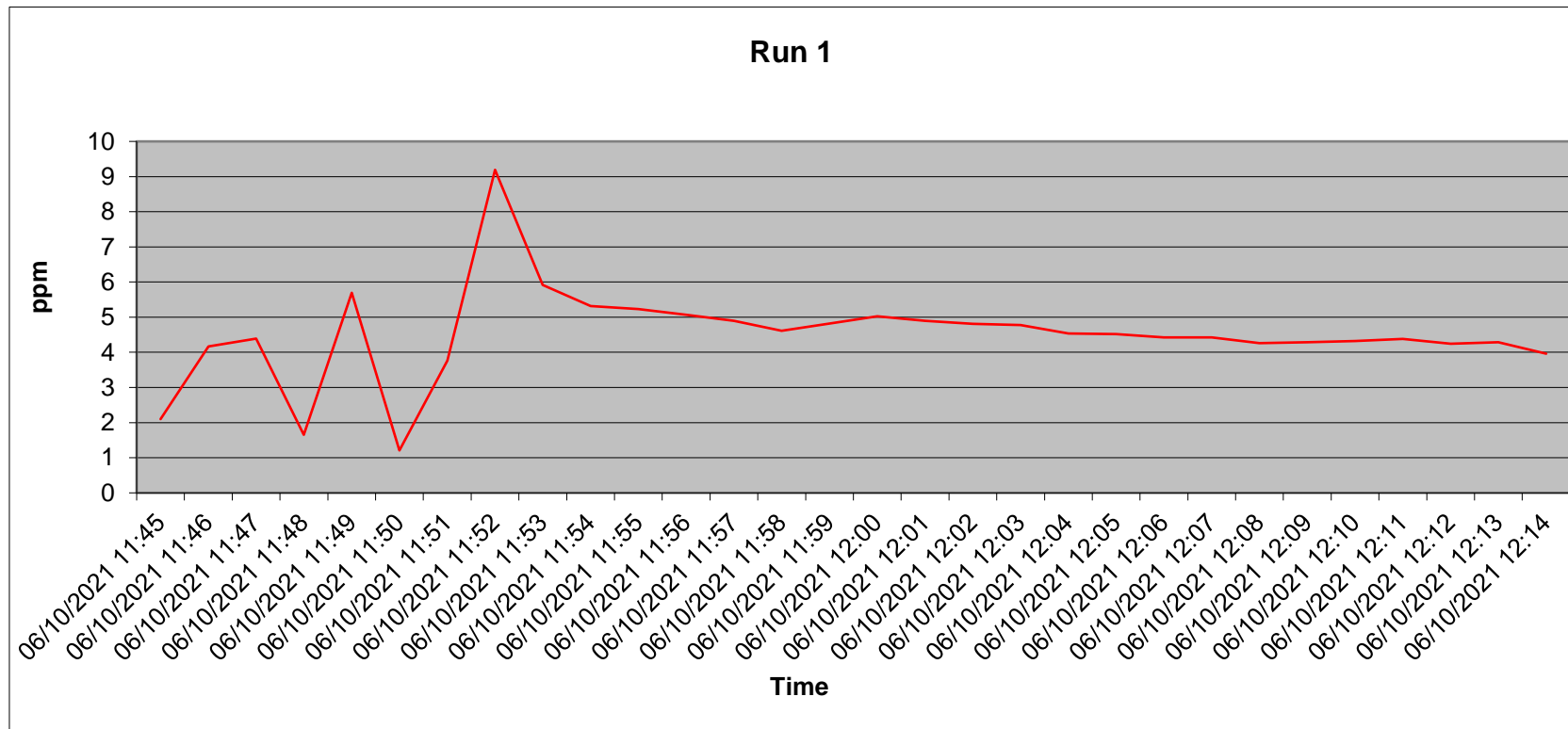
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F1                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 11:45        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 200          | -            | -            |
| Span Gas Value                 | ppm               | 157.5        | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.2          | -            | -            |
| Zero Drift                     | ppm               | -0.1         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 7.88         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.06        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 157.5        | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 157.8        | -            | -            |
| Span Drift                     | ppm               | -0.3         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 7.88         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.19        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 157.5        | -            | -            |
| Recorded Conc. down Line       | ppm               | 157.8        | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |

**Carbon Monoxide Results & Sampling Details**

| Parameter     | Units              | Run 1 | Run 2 | Run 3 | Mean |
|---------------|--------------------|-------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 5.54  | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 2.79  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -     | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | EN15058       |
| Technical Procedure              | SOP2004       |
| Probe material                   | SS            |
| Filtration Type/Size             | PTFE          |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM18ING514 |
| Span Gas Expiry Date             | 22-Dec        |
| Span Gas Start Pressure (bar)    | 50            |
| Gas Cylinder Concentration (ppm) | 157.5         |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | F1            |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 3             |

### Carbon Monoxide Trend



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Carbon Monoxide Measurement Uncertainty

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.36-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 200       | -     | -     |
| Measured Reading   | ppm                | 4.43      | -     | -     |
|  |                    |           |       |       |
| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.9       | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.14      | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.12     | -     | -     |
| Cross-sensitivity  | %                  | 0.08      | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
|  |                    |           |       |       |
| Parameter  | Units              | Run 1     | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 0.95      | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 1.9       | -     | -     |
|  |                    |           |       |       |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 2.79      | -     | -     |
|  |                    |           |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 5.58      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 2.79      | -     | -     |
|  |                    |           |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 50.35     | -     | -     |
|  |                    |           |       |       |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |

## Oxides of Nitrogen Quality Assurance

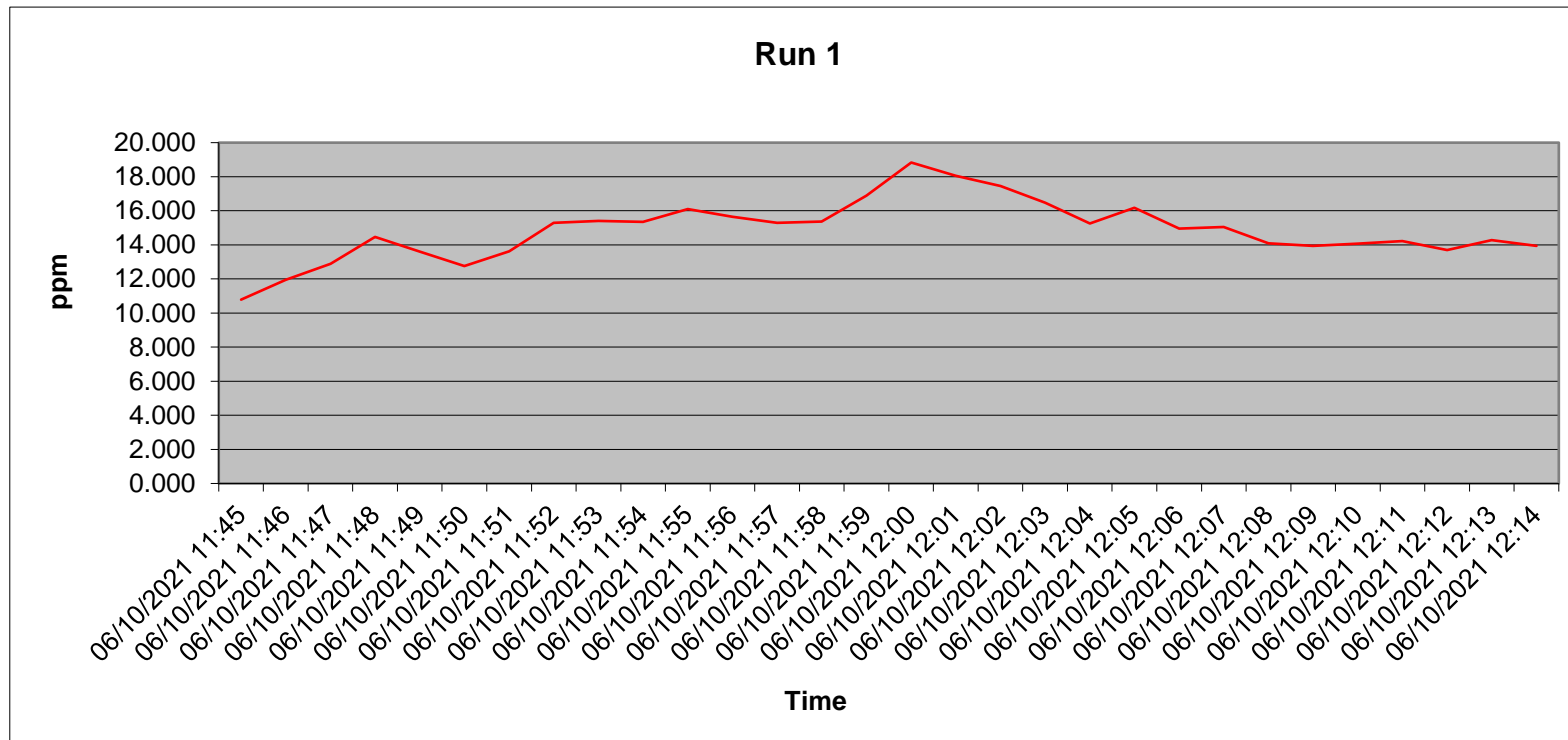
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F1                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 11:45        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 250          | -            | -            |
| Span Gas Value                 | ppm               | 159          | -            | -            |
| Acceptable Gas Range           | -                 | Yes          | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.2          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.3          | -            | -            |
| Zero Drift                     | ppm               | -0.1         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 7.95         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.06        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 159          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 159.3        | -            | -            |
| Span Drift                     | ppm               | -0.3         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 7.95         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.19        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 159          | -            | -            |
| Recorded Conc. down Line       | ppm               | 159.3        | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |

**Oxides of Nitrogen Results & Sampling Details**

| Parameter     | Units              | Run 1 | Run 2 | Run 3 | Mean |
|---------------|--------------------|-------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 30.19 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 3.73  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -     | -     | -     | -    |

| General Sampling Information          |                 |
|---------------------------------------|-----------------|
| Parameter                             | Value           |
| Standard                              | EN14792         |
| Technical Procedure                   | SOP2002         |
| Probe material                        | SS              |
| Filtration Type/Size                  | PTFE            |
| Heated Head Filter Used               | Yes             |
| Heated Line Temperature               | 180             |
| Date & Result of last converter check | 95.5 08/01/2021 |
| Span Gas Reference Number             | ASLTM20ING512   |
| Span Gas Expiry Date                  | 21-Nov          |
| Span Gas Start Pressure (bar)         | 50              |
| Gas Cylinder Concentration (ppm)      | 159             |
| Span Gas Uncertainty (%)              | <2              |
| Zero Gas Type                         | N               |
| Number of Sampling Lines Used         | 1               |
| Number of Sampling Points Used        | 1               |
| Sample Point I.D's                    | F1              |
| Reference Conditions                  |                 |
| Temperature (K)                       | 273.15          |
| Pressure (kPa)                        | 101.3           |
| Gas (Wet or Dry)                      | Dry             |
| Oxygen                                | 3               |

### Oxides of Nitrogen Trend



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Oxides of Nitrogen Measurement Uncertainty

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.87-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 250       | -     | -     |
| Measured Reading   | ppm                | 14.71     | -     | -     |
| <b>Measured Quantities</b>   |                    |           |       |       |
| Nonlinearity   | %                  | 1.4       | -     | -     |
| Temperature Dependent Zero drift   | %                  | -0.04     | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.25     | -     | -     |
| Cross-sensitivity  | %                  | 0.5       | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
| Mass Flow Controllers (Dilution) Uncertainty   | %                  | <1        | -     | -     |
| NOx Converter Efficiency   | %                  | 95.5      | -     | -     |
| <b>Parameter</b>   |                    |           |       |       |
| Combined uncertainty   | mg.m <sup>-3</sup> | 0.98      | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 1.95      | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 3.73      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 2.49      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 3.73      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 12.36     | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**Total Volatile Organic Carbon Quality Assurance**

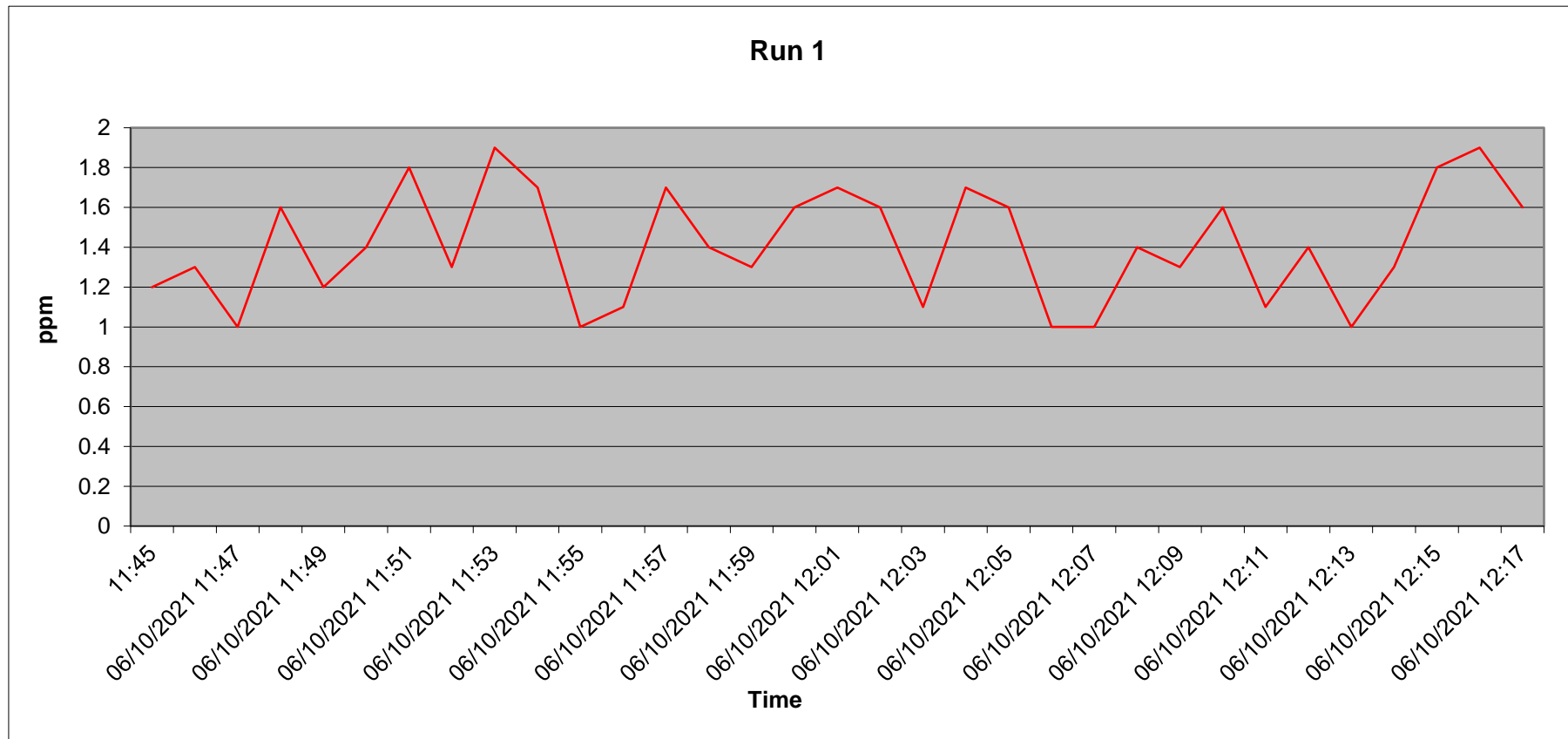
| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | F1                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 11:45        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 100          | -            | -            |
| Span Gas Value                 | ppm               | 80.2         | -            | -            |
| Acceptable Gas Range           | -                 | Yes          | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 194          | -            | -            |
| Average Temperature            | < °C              | 194          | -            | -            |
| Allowable Temperature          | -                 | Yes          | -            | -            |
| Temperature Acceptable         | -                 | 180          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.1          | -            | -            |
| Zero Drift                     | ppm               | -0.1         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 4.01         | -            | -            |
| Zero Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y (<2%)      | -            | -            |
| Zero Drift                     | %                 | -0.12        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 80.2         | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 80.4         | -            | -            |
| Span Drift                     | ppm               | -0.2         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 4.01         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y (<2%)      | -            | -            |
| Span Drift (%)                 | %                 | -0.25        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 80.2         | -            | -            |
| Recorded Conc. down Line       | ppm               | 80.4         | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y (<2%)      | -            | -            |

**Total Volatile Organic Carbon Results and Sampling Details**

| Parameter     | Units              | Run 1 | Run 2 | Run 3 | Mean |
|---------------|--------------------|-------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 2.47  | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 0.59  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -     | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | EN12619       |
| Technical Procedure              | SOP2009       |
| Probe material                   | SS            |
| Filtration Type/Size             | PTFE          |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM20ING516 |
| Span Gas Expiry Date             | 01/06/2025    |
| Span Gas Start Pressure (bar)    | 60            |
| Gas Cylinder Concentration (ppm) | 80.2          |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | ZA            |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | F1            |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 3             |

### Total Volatile Organic Carbon Trend



**Total Volatile Organic Carbon Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1    | Run 2 | Run 3 |
|--|--------------------|----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.6-1680 | -     | -     |
| Operational Range of Analyser  | ppm                | 100      | -     | -     |
| Measured Reading   | ppm                | 1.41     | -     | -     |
| <b>Measured Quantities</b>   |                    |          |       |       |
| Measured Quantities  | Units              | Run 1    | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.068    | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.3      | -     | -     |
| Temperature Dependent Span drift   | %                  | 0.3      | -     | -     |
| Cross-sensitivity  | %                  | -        | -     | -     |
| Leak   | %                  | <2       | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2       | -     | -     |
| <b>Parameter</b>   |                    |          |       |       |
| Parameter  | Units              | Run 1    | Run 2 | Run 3 |
| Measurement uncertainty  | mg.m <sup>-3</sup> | 0.3      | -     | -     |
| Combined uncertainty   | mg.m <sup>-3</sup> | 0.59     | -     | -     |
| <b>Expanded Uncertainty as % of Limit Value</b>  |                    |          |       |       |
| Expanded Uncertainty as % of Limit Value   | %                  | 5.95     | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        |                    |          |       |       |
| Expanded uncertainty expressed with a level of confidence of 95%                               | % of value         | 24.07    | -     | -     |
| Expanded uncertainty expressed with a level of confidence of 95%                               | mg.m <sup>-3</sup> | 0.59     | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |          |       |       |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Hydrogen Chloride Sampling Details & Results

| Stack ID                      | F1           | Run 1           |
|-------------------------------|--------------|-----------------|
| Sample ID                     | F1 HCL 1+2   | mls             |
| Impinger 1 ID                 | F1 HCL 1+2   | 220             |
| Impinger 2 ID                 | -            | 0               |
| Impinger 3 ID                 | F1 HCL 3     | 130             |
| Time on                       | -            |                 |
| Time off                      | -            |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 2.14         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ505 |                 |
| Calibration Rate Before Test: | 2.14         | l/min           |
| Calibration Rate After Test:  | 2.14         | l/min           |
| Average sample Volume:        | 2.14         | l/min           |
| Sample Test Time:             | 30           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.0642       | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.0642       | Nm <sup>3</sup> |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Hydrogen Chloride Quality Assurance

| Stack ID                     | F1                 | Run 1        | Run 2        | Run 3        |
|------------------------------|--------------------|--------------|--------------|--------------|
| Date                         | 06/10/2021         | -            | -            | -            |
| Start time                   |                    | 00:00:00     | -            | -            |
| Finish Time                  |                    | 00:00:00     | -            | -            |
| <b>Leak test results</b>     |                    |              |              |              |
|                              | <b>Units</b>       | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Mean Sampling Rate           | l/min              | 2.14         | -            | -            |
| Pre-sampling leak rate       | l/min              | 0.01         | -            | -            |
| Post-sampling leak rate      | l/min              | 0.01         | -            | -            |
| Leak rate                    | l/min              | 0            | -            | -            |
| Acceptable leak rate (<2%)   | Y/N                | Yes          | -            | -            |
| <b>Filtration</b>            |                    |              |              |              |
| Filter Material              |                    | N/A          | -            | -            |
| Filter Size                  | mm                 | N/A          | -            | -            |
| Max. Filter Temp             | degrees            | N/A          | -            | -            |
| Absorbers Type               | Glass/PTFE/ Other  | PTFE         | -            | -            |
| Absorption Solution          |                    | Di H2O       | -            | -            |
| <b>Absorption Efficiency</b> |                    |              |              |              |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 17.5         | -            | -            |
| Impinger 3                   | µg                 | 6.5          | -            | -            |
| Absorption efficiency        | %                  | 63           | -            | -            |
| Acceptable Absorption Eff.   | >95% (Y/N)         | N            | -            | -            |
| <b>Blank sample</b>          |                    |              |              |              |
| Blank sample ID              |                    | HCL B        | -            | -            |
| Blank result                 | mg.m <sup>-3</sup> | <0.09        | -            | -            |
| Acceptable Blank             | <10% ELV (Y/N)     | Y            | -            | -            |
| <b>Testing laboratory</b>    |                    |              |              |              |
| Laboratory Name              |                    | UKAS0605     | -            | -            |
| Test certificate Number      |                    | 21-12428     | -            | -            |

**Hydrogen Chloride Results & Measurement Uncertainty**

| Stack ID                | F1    | Run 1              |
|-------------------------|-------|--------------------|
| Date                    | -     |                    |
| Start time              | 00:00 |                    |
| Finish Time             | 00:00 |                    |
| <b>Results</b>          |       |                    |
| Laboratory Result       | 17.5  | µg                 |
| Impinger final Volume   | 350   | ml                 |
| Factor                  | -     |                    |
| Concentration           | 0.02  | mg                 |
| Sample Volume           | 0.064 | Nm <sup>3</sup>    |
| Emissions Concentration | 0.27  | mg.m <sup>-3</sup> |
| Mass Emissions          | -     | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0.01  | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 7.98  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.02  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.04  | -     | -     | -    |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Hydrogen Fluoride Sampling Details & Results

| Sampling Details              |              | Run 1           |
|-------------------------------|--------------|-----------------|
| Stack ID                      | F1           |                 |
| Time on                       | -            |                 |
| Time off                      | -            |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 2.12         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ505 |                 |
| Calibration Rate Before Test: | 2.12         | l/min           |
| Calibration Rate After Test:  | 2.12         | l/min           |
| Average sample Volume:        | 2.12         | l/min           |
| Sample Test Time:             | 30           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.0636       | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.0636       | Nm <sup>3</sup> |



Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

### Hydrogen Fluoride Quality Assurance

| Stack ID                     | F1                 | Run 1        | Run 2        | Run 3        |
|------------------------------|--------------------|--------------|--------------|--------------|
| Date                         | 06/10/2021         | -            | -            | -            |
| Start time                   |                    | 00:00:00     | -            | -            |
| Finish Time                  |                    | 00:00:00     | -            | -            |
| <b>Leak test results</b>     |                    |              |              |              |
|                              | <b>Units</b>       | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Mean Sampling Rate           | l/min              | 2.12         | -            | -            |
| Pre-sampling leak rate       | l/min              | 0.01         | -            | -            |
| Post-sampling leak rate      | l/min              | 0.01         | -            | -            |
| Leak rate                    | l/min              | 0            | -            | -            |
| Acceptable leak rate (<2%)   | Y/N                | Yes          | -            | -            |
| <b>Filtration</b>            |                    |              |              |              |
| Filter Material              |                    | N/A          | -            | -            |
| Filter Size                  | mm                 | N/A          | -            | -            |
| Max. Filter Temp             | degrees            | N/A          | -            | -            |
| Absorbers Type               | Glass/PTFE/ Other  | Glass        | -            | -            |
| Absorption Solution          |                    | 0.1m NaOH    | -            | -            |
| <b>Absorption Efficiency</b> |                    |              |              |              |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 7            | -            | -            |
| Impinger 3                   | µg                 | 2.4          | -            | -            |
| Absorption efficiency        | %                  | 66           | -            | -            |
| Acceptable Absorption Eff.   | >95% (Y/N)         | N            | -            | -            |
| <b>Blank sample</b>          |                    |              |              |              |
| Blank sample ID              |                    | HF B         | -            | -            |
| Blank result                 | mg.m <sup>-3</sup> | <0.03        | -            | -            |
| Acceptable Blank             | <10% ELV (Y/N)     | Y            | -            | -            |
| <b>Testing laboratory</b>    |                    |              |              |              |
| Laboratory Name              |                    | UKAS0605     | -            | -            |
| Test certificate Number      |                    | WK21-00753   | -            | -            |

**Hydrogen Fluoride Results & Measurement Uncertainty**

| Stack ID                | F1       | Run 1              |
|-------------------------|----------|--------------------|
| Date                    | -        |                    |
| Start time              | 00:00:00 |                    |
| Finish Time             | 00:00:00 |                    |
| <b>Results</b>          |          |                    |
| Laboratory Result       | 7        | µg                 |
| Impinger final Volume   | 350      | ml                 |
| Factor                  | -        |                    |
| Concentration           | 0.01     | mg                 |
| Sample Volume           | 0.06     | Nm <sup>3</sup>    |
| Emissions Concentration | 0.11     | mg.m <sup>-3</sup> |
| Mass Emissions          | -        | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0     | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 7.99  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.01  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.18  | -     | -     | -    |

## Sulphur Dioxide Quality Assurance

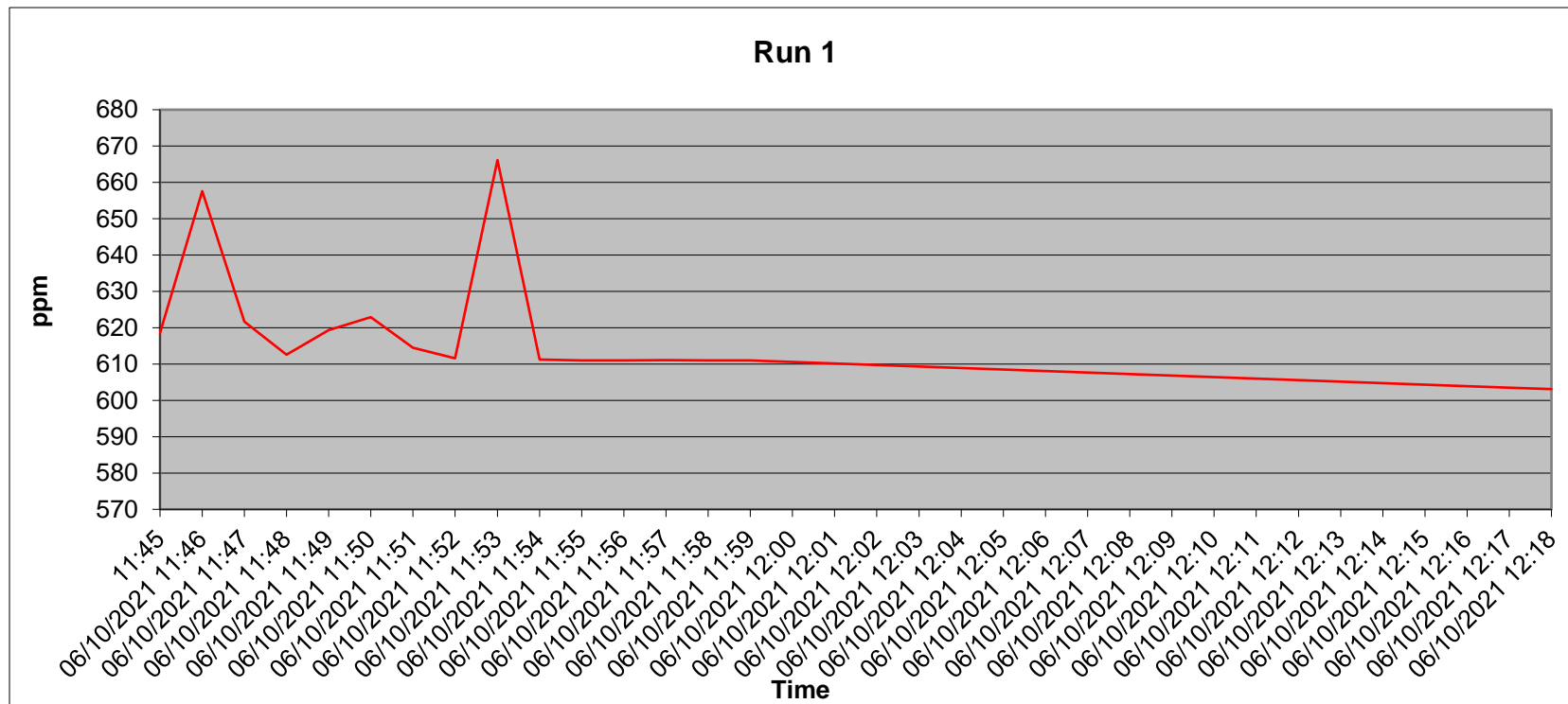
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F1                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 11:45        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 1000         | -            | -            |
| Span Gas Value                 | ppm               | 715          | -            | -            |
| Acceptable Gas Range           | -                 | -            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 2            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 5            | -            | -            |
| Zero Drift                     | ppm               | -3           | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 35.75        | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.42        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 715          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 713          | -            | -            |
| Span Drift                     | ppm               | 2            | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 35.75        | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | 0.28         | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 715          | -            | -            |
| Recorded Conc. down Line       | ppm               | 713          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |

**Sulphur Dioxide Results & Sampling Details**

| Parameter     | Units              | Run 1  | Run 2 | Run 3 | Mean |
|---------------|--------------------|--------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 1753.1 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 169.22 | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -      | -     | -     | -    |

| General Sampling Information          |               |
|---------------------------------------|---------------|
| Parameter                             | Value         |
| Standard                              | CEN/TS 17021  |
| Technical Procedure                   | SOP 2046      |
| Probe material                        | SS            |
| Filtration Type/Size                  | PTFE          |
| Heated Head Filter Used               | Yes           |
| Heated Line Temperature               | 180           |
| Date & Result of last converter check | -             |
| Span Gas Reference Number             | ASLTM19ING507 |
| Span Gas Expiry Date                  | Nov-21        |
| Span Gas Start Pressure (bar)         | 40            |
| Gas Cylinder Concentration (ppm)      | 715           |
| Span Gas Uncertainty (%)              | <2            |
| Zero Gas Type                         | N             |
| Number of Sampling Lines Used         | 1             |
| Number of Sampling Points Used        | 1             |
| Sample Point I.D's                    | F1            |
| Reference Conditions                  |               |
| Temperature (K)                       | 273.15        |
| Pressure (kPa)                        | 101.3         |
| Gas (Wet or Dry)                      | Dry           |
| Oxygen                                | 3             |

### Sulphur Dioxide Trend



Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F1

Facility Location: Knockharley Facility

Rev.No: 1

**Sulphur Dioxide Measurement Uncertainty**

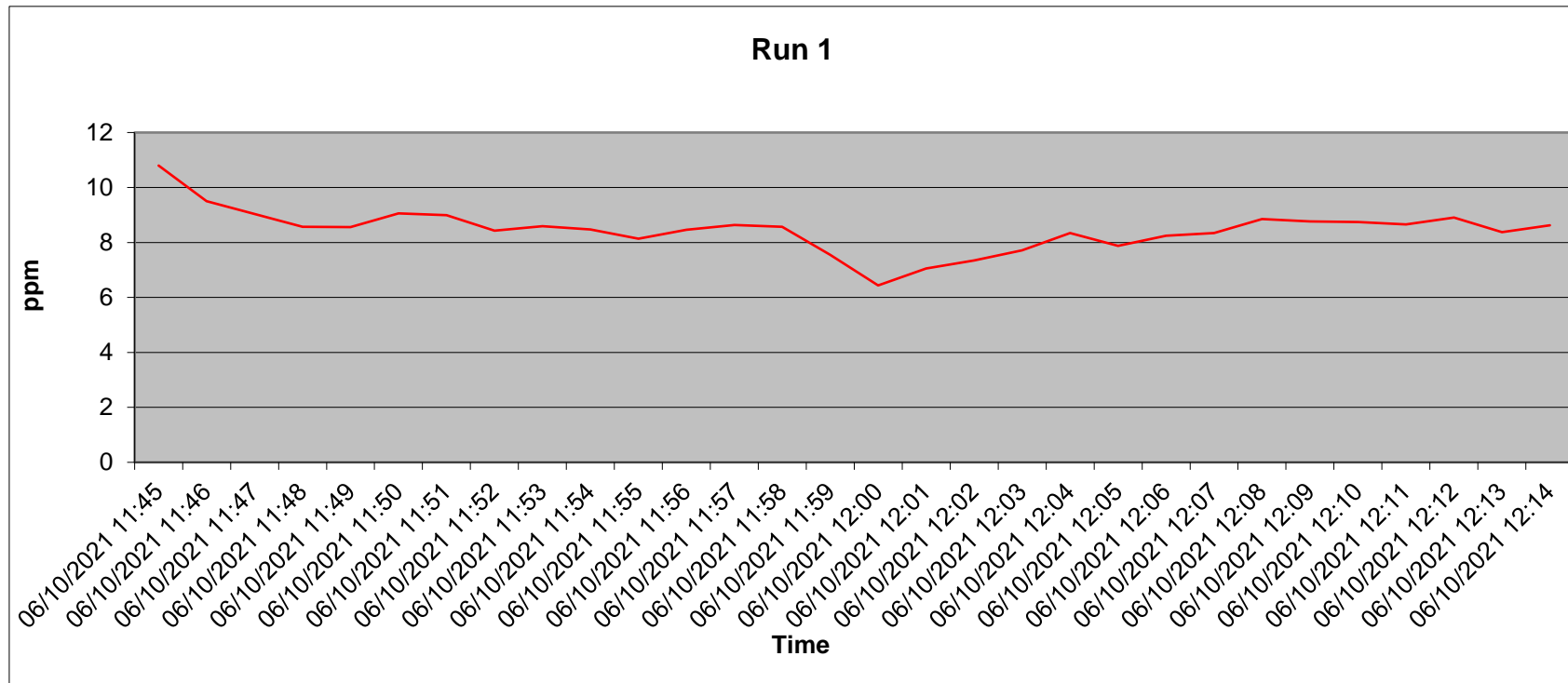
| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
|--|--------------------|--------------|-------|-------|
| Certified Range of Analyser  | ppm                | 2.14 to 1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 1000         | -     | -     |
| Measured Reading   | ppm                | 612.97       | -     | -     |
| <b>Measured Quantities</b>   |                    |              |       |       |
| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.8          | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.8          | -     | -     |
| Temperature Dependent Span drift   | %                  | 2            | -     | -     |
| Cross-sensitivity  | %                  | 1.5          | -     | -     |
| Leak   | %                  | 0            | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2 %         | -     | -     |
| <b>Parameter</b>   |                    |              |       |       |
| Parameter  | Units              | Run 1        | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 29.63        | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 59.27        | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 169.22       | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | -            | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 169.22       | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 9.65         | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |              |       |       |

**Oxygen Quality Assurance**

| <b>Sampling Details</b>                |                   |              |              |              |
|--|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                        | F1                |              |              |              |
| <i>Parameter</i>                       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| <b>Sampling Times</b>                  | -                 | 11:45        | -            | -            |
| <b>Sampling Dates</b>                  | -                 | 06/10/2021   | -            | -            |
| <b>Instrument Range</b>                | ppm               | 25           | -            | -            |
| <b>Span Gas Value</b>                  | ppm               | 20.9         | -            | -            |
| <b>Acceptable Gas Range</b>            | -                 | Y            | -            | -            |
| <i>Quality Assurance</i>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| <b>Conditioning Unit Temperature</b>   | °C                | 2            | -            | -            |
| <b>Average Temperature</b>             | < °C              | 2            | -            | -            |
| <b>Allowable Temperature</b>           | -                 | 4            | -            | -            |
| <b>Temperature Acceptable</b>          | -                 | Y            | -            | -            |
| <b>Pump flow rate</b>                  | l/min             | 0.5          | -            | -            |
| <i>Zero Drift</i>                      | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| <b>Zero Down Sampling Line (Pre)</b>   | %                 | 0.1          | -            | -            |
| <b>Zero Down Sampling Line (Post)</b>  | %                 | 0.1          | -            | -            |
| <b>Zero Drift</b>                      | %                 | 0            | -            | -            |
| <b>Allowable Zero Drift (5%)</b>       | %                 | 1.05         | -            | -            |
| <b>Zero Drift Acceptable (Y/N)</b>     | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <i>Span Drift</i>                      | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| <b>Span Down Sampling Line (Pre)</b>   | %                 | 20.9         | -            | -            |
| <b>Span Down Sampling Line (Post)</b>  | %                 | 20.8         | -            | -            |
| <b>Span Drift</b>                      | %                 | 0.1          | -            | -            |
| <b>Allowable Span Drift (5%)</b>       | %                 | 1.05         | -            | -            |
| <b>Span Drift Acceptable (Y/N)</b>     | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <i>Leak Check</i>                      | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| <b>Span Gas Conc.</b>                  | %                 | 20.9         | -            | -            |
| <b>Recorded Conc. down Line</b>        | %                 | 20.8         | -            | -            |
| <b>Leak check acceptable (&lt; 2%)</b> | (Y/N)             | Y <2%        | -            | -            |
| <i>Test Conditions</i>                 | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| <b>Run Ambient Temperature Range</b>   | °C                | 12           | -            | -            |
| <b>Combined uncertainty</b>            | % vol             | 0.15         | -            | -            |
| <b>% of value</b>                      | %                 | 1.78         | -            | -            |
| <b>Expanded uncertainty</b>            | % of value        | 3.57         | -            | -            |
| <b>Expanded uncertainty</b>            | % vol             | 0.3          | -            | -            |



### Oxygen trend



**Carbon Dioxide Quality Assurance**

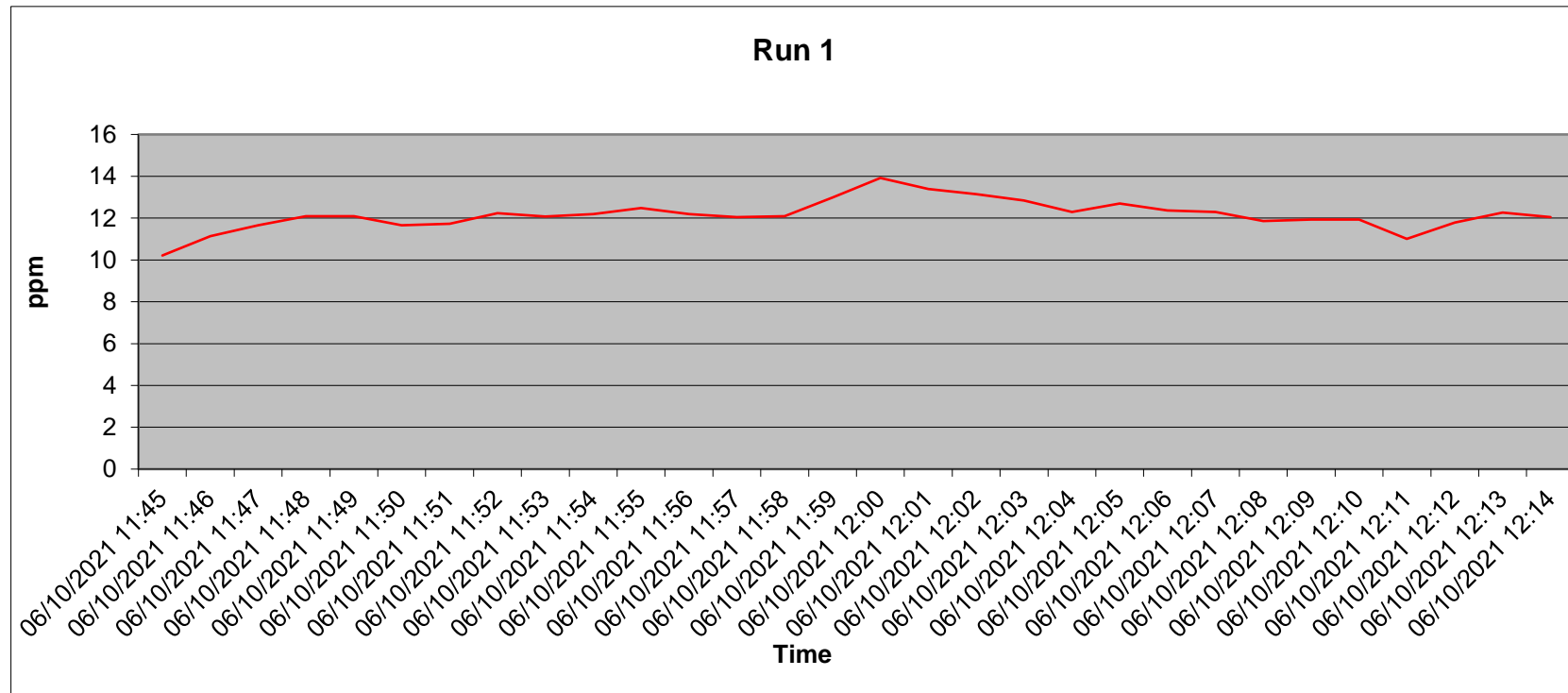
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F1                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 11:45        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 20           | -            | -            |
| Span Gas Value                 | ppm               | 15.5         | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0            | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0            | -            | -            |
| Zero Drift                     | %                 | 0            | -            | -            |
| Allowable Zero Drift (4%)      | %                 | 0.62         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 15.5         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 15.3         | -            | -            |
| Span Drift                     | %                 | 0.2          | -            | -            |
| Allowable Span Drift (4%)      | %                 | 0.62         | -            | -            |
| Span Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 15.5         | -            | -            |
| Recorded Conc. down Line       | ppm               | 15.3         | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |
| Combined uncertainty           | % vol             | 0.18         | -            | -            |
| % of value                     | %                 | 1.51         | -            | -            |
| Expanded uncertainty           | % of value        | 3.02         | -            | -            |
| Expanded uncertainty           | % vol             | 0.37         | -            | -            |

**Carbon Dioxide Results & Sampling Details**

| Parameter     | Units | Run 1 | Run 2 | Run 3 | Mean |
|---------------|-------|-------|-------|-------|------|
| Concentration | %     | 12.14 | -     | -     | -    |
| Uncertainty   | %     | 0.37  | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | ISO12039      |
| Technical Procedure              | SOP 2045      |
| Probe material                   | SS            |
| Filtration Type/Size             | Ceramic       |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM19ING535 |
| Span Gas Expiry Date             | 24-Jun        |
| Span Gas Start Pressure (bar)    | 40            |
| Gas Cylinder Concentration (ppm) | 15.5          |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | F1            |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 3             |

### Carbon Dioxide Trend



Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F1  
Facility Location: Knockharley Facility  
Rev.No: 1

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F1  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Moisture Results & Sampling Details

|   |                                  |                 |                            |       |       |
|---|----------------------------------|-----------------|----------------------------|-------|-------|
| <b>Title:</b>   | <b>Determination of Moisture</b> |                 |                            |       |       |
| <b>Method:</b>  | EN 14790                         |                 |                            |       |       |
| <b>Stack Name</b>   | F1                               | <b>Time off</b> | <b>Temperature at Pump</b> | 0     | Deg C |
| <b>Test Time</b>  | -                                |                 | <b>Pressure at Pump</b>    | 101.3 | kPa   |
| <b>Dry Gas Meter Reading Before</b>                         | -                                | m <sup>3</sup>  | <b>Humidity at Pumps</b>   | 0.1   | %     |
| <b>Dry Gas Meter Reading After</b>                          | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Volume of Air Sampled</b>                                | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Normalised Air Volume Sampled</b>                        | 0.06                             | Nm <sup>3</sup> |                            |       |       |
| <b>Leak Rate</b>  | 0.001                            |                 |                            |       |       |
| <b>Balance Calibration</b>                                  |                                  |                 |                            |       |       |
|   | <b>Weight</b>                    |                 |                            |       |       |
| 200.0   | 200                              | g               |                            |       |       |
| 1000.0  | 1000                             | g               |                            |       |       |
| <b>Inpinger Weights</b>                                     |                                  |                 |                            |       |       |
|   | <b>Initial</b>                   | <b>Final</b>    | <b>Difference</b>          |       |       |
| 1   | 489                              | 491.5           | 2.5                        |       |       |
| 2   | 439.5                            | 440.7           | 1.2                        |       |       |
| 3   | 454.2                            | 454.7           | 0.5                        |       |       |
| 4   | 644.6                            | 644.7           | 0.1                        |       |       |
| <b>Volume of Air Sampled</b>                                | 0.06                             | Nm <sup>3</sup> | <b>4.3</b>                 |       |       |
| <b>Moisture Content (EN 14790)</b>                          | 8.2                              | %               |                            |       |       |
| <b>Combined uncertainty</b>                                 |                                  |                 |                            |       |       |
|   |                                  | 0.2             | %                          |       |       |
| <b>Expanded uncertainty as percentage of measured value</b> |                                  |                 |                            |       |       |
|   |                                  | 4.87            | % measured value           |       |       |
| <b>Expanded uncertainty in units of measurement</b>         |                                  |                 |                            |       |       |
|   |                                  | 0.4             | %                          |       |       |
| <b>Expanded uncertainty as percentage of limit value</b>    |                                  |                 |                            |       |       |
|   |                                  | -               | % ELV                      |       |       |

**Uncert Sheets**

**CO Uncert**

**Uncertainty calculation for Gaseous Measurement CO**

|                        |                              |                |
|------------------------|------------------------------|----------------|
| Limit value            | 50 mg/m3 (corre Cal gas conc | 196.875 mg.m-3 |
| Measured concentration | 5.54 mg/m3 Full Scale        | 200 mg/m3      |
| Measured concentration | 5.54 mg/m3 (Corrected)       |                |

| Correction for reference conditions |          |       |           |               |                |
|-------------------------------------|----------|-------|-----------|---------------|----------------|
|                                     |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 3.00  | 0.00      | 101.30        | 273.00         |
|                                     | measured | 8.48  | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35  | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.44  | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.04  | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | 1.45  | uf        | 0.04          |                |

| Performance characteristics           | Value  |                       | specification      |
|---------------------------------------|--------|-----------------------|--------------------|
| Response time                         | 180    | seconds               | 180.000            |
| Logger sampling interval              | 60     | seconds               |                    |
| Measurement period                    | 34     | minutes               |                    |
| Number of readings in measurement     | 34     |                       |                    |
| Repeatability at zero                 | 0.25   | % full scale          | <1 % range         |
| Repeatability at span level           | 0.15   | % full scale          | <2 % range         |
| Deviation from linearity(lack of fit) | 0.7    | % of value            | <2 % range         |
| Zero drift                            | -0.125 | mg/m3                 | <2% range / 24hr   |
| Span drift                            | -0.375 | mg/m3                 | <2% range/24hr     |
| volume or pressure flow dependence    | 0.02   | % of full scale/3 kPa | <2 % / 3 kPa       |
| atmospheric pressure dependence       | 0.8    | % of full scale/2 kPa | <3% / 2 kPa        |
| ambient temperature dependence        | 0.01   | % full scale/10K      | <3% range / 10 K   |
| N2O (mg/m3)                           | 20     | 0.2                   | mg/m3              |
| CO2 (% vol)                           | 15     | 0.2                   | mg/m3              |
| CH4 (mg/m3)                           | 40     | 0.7                   | mg/m3              |
| H2O (% vol)                           | 20     | 0.2                   | mg/m3              |
| dependence on voltage                 | 0.1    | % full scale/10V      | <2% range          |
| losses in the line (leak)             | 0.00   | % of value            | < 0.1%vol /10 volt |
| Uncertainty of calibration gas        | 2      | % of value            | < 2% of value      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | min    | max    | value at calib |
|-----------|--------|--------|----------------|
| flow      | 95.00  | 105    | 100 kPa        |
| pressure  | 100.76 | 100.92 | 100.88 kPa     |
| temp      | 287    | 288.5  | 287.5 K        |
| N2O range | 0      | 40     | 0 mg/m3        |
| CO2 range | 0      | 15     | 0 %vol         |
| CH4 range | 0      | 57     | 0 mg/m3        |
| H2O range | 0      | 1      | 0 %vol         |
| Voltage   | 93     | 121    | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.05            |
| Lack of fit                                       | ufit        |                               | 0.02            |
| Drift   | u0dr        |                               | 0.00            |
| volume or pressure flow dependence                | uspres      |                               | 0.04            |

**Uncert Sheets**

|                                 |  |  |         |  |  |  |      |  |               |
|---------------------------------|--|--|---------|--|--|--|------|--|---------------|
| atmospheric pressure dependence |  |  | uapres  |  |  |  | 0.05 |  |               |
| ambient temperature dependence  |  |  | utemp   |  |  |  | 0.00 |  |               |
| N2O (mg/m3)                     |  |  | uinterf |  |  |  | 0.23 | <b>Use largest of sum of all positive or all negative influences</b><br>Criteria<br>sum <4% range<br>0.110870099 |               |
| CO2 (% vol)                     |  |  | uinterf |  |  |  | 0.12 |  | 0.93 all +ves |
| CH4 (mg/m3)                     |  |  | uinterf |  |  |  | 0.58 |  | 0 all -ves    |
| H2O (% vol)                     |  |  | uinterf |  |  |  | 0.01 |  | 0.93 largest  |
| Dependence on voltage           |  |  | uvolt   |  |  |  | 0.17 | Value to use for intereference uncertainty<br>uint 0.93  |               |
| losses in the line (leak)       |  |  | uleak   |  |  |  | 0.00 |  |               |
| Uncertainty of calibration gas  |  |  | ucalib  |  |  |  | 0.06 |  |               |
| Uncertainty in factor           |  |  | uf      |  |  |  | 0.23 |  |               |

|   |                           |   |               |
|---|---------------------------|---|---------------|
| <b>Measurement uncertainty</b>                        |                           |   |               |
| Combined uncertainty                                  |                           |   | 0.95 mg/m3    |
| Expanded uncertainty                                  | k =                       | 2 | 1.90 mg/m3    |
| <b>Uncertainty corrected to std conds</b>             |                           |   |               |
|   |                           |   | 2.79 mg/m3    |
| Expanded uncertainty                                  | expressed with a level of |   | 5.58 % ELV    |
| Expanded uncertainty                                  | expressed with a level of |   | 2.79 mg.m-3   |
| <b>Expanded uncertainty expressed with a level of</b> |                           |   |               |
|   |                           |   | 50.35 % value |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

**NOx Uncert**

**Uncertainty calculation for Gaseous Measurement NOx EN14792**

|                        |                               |                      |  |
|------------------------|-------------------------------|----------------------|--|
| <b>RUN 1</b>           |                               |                      |  |
| Limit value            | 150 mg/m3 (corre Cal gas conc | 326.427 mg.m-3 (NO2) |  |
| Measured concentration | 15 ppm                        |                      |  |
| Measured concentration | 30.19 mg/m3 (101.3 Full Scale | 513.25 mg/m3 (NO2)   |  |
| Measured concentration | 30.19 mg/m3 (Corrected)       |                      |  |
| NO/NO2 ratio           | 100.00                        |                      |  |
| Gas                    | NO                            |                      |  |
| Full Scale             | 250 ppm                       |                      |  |
| Cal gas conc           | 159 ppm                       |                      |  |
| Conversion             | 2.053                         |                      |  |

| Correction for reference conditions |          |       |           |               |                |
|-------------------------------------|----------|-------|-----------|---------------|----------------|
|                                     |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 3.00  | 0.00      | 101.30        | 273.00         |
|                                     | measured | 8.48  | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35  | 0.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.44  | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.04  | 0.00      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | 1.45  | uf        | 0.04          |                |



**Uncert Sheets**

| Performance characteristics           | Value |                    | specification      |
|---------------------------------------|-------|--------------------|--------------------|
| Response time                         | 180   | seconds            | 180.000            |
| Logger sampling interval              | 60    | seconds            |                    |
| Measurement period                    | 34    | minutes            |                    |
| Number of readings in measurement     | 34    |                    |                    |
| Repeatability at zero                 | 0.03  | % full scale       | <1 % range         |
| Repeatability at span level           | 0.06  | % full scale       | <2 % range         |
| Deviation from linearity(lack of fit) | 0.2   | % of value         | <2 % range         |
| Zero drift                            | 0.8   | mg/m3              | <2% range / 24hr   |
| Span drift                            | 1.48  | mg/m3              | <2% range/24hr     |
| volume or pressure flow dependence    | 0     | %of full scale/kPa | <2 % / kPa         |
| atmospheric pressure dependence       | 0     | %of value /kPa     | <3% / kPa          |
| ambient temperature dependence        | 0.3   | % full scale/10K   | <3% range / 10 K   |
| NH3 (mg/m3)                           | 20    | 0.0                | mg/m3              |
| CO2 (% vol)                           | 15    | 0.2                | mg/m3              |
| H2O (% vol)                           | 30    | 0.0                | mg/m3              |
| dependence on voltage                 | 0.1   | % full scale/10V   | <2% range          |
| losses in the line (leak)             | 0     | % of value         | < 0.1%vol /10 volt |
| Converter efficiency                  | 95.5  | %                  | >95%               |
| Uncertainty of calibration gas        | 2     | % of value         | < 2% of value      |

| Effect of drift   |
|-------------------|
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | min    | max   | value at calib |       |
|-----------|--------|-------|----------------|-------|
| flow      | 95.00  | 105   | 100            | kPa   |
| pressure  | 101.30 | 101.3 | 101.3          | kPa   |
| temp      | 289    | 289   | 289            | K     |
| NH3 range | 0      | 0     | 0              | mg/m3 |
| CO2 range | 0      | 15    | 0              | %vol  |
| H2O range | 0      | 0     | 0              | %vol  |
| Voltage   | 93     | 121   | 110            | V     |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.05            |
| Lack of fit                                       | ufit        |                               | 0.03            |
| Drift   | u0dr        |                               | 0.00            |
| volume or pressure flow dependence                | uspres      |                               | 0.00            |
| atmospheric pressure dependence                   | uapres      |                               | 0.00            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| NH3   | uintenf     |                               | 0.00            |
| CO2 (% vol)                                       | uintenf     |                               | 0.12            |
| H2O (% vol)                                       | uintenf     |                               | 0.00            |
| Dependence on voltage                             | uvolt       |                               | 0.44            |
| losses in the line (leak)                         | uleak       |                               | 0.00            |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.35            |
| converter efficiency                              | uceff       |                               | 0.78            |
| Uncertainty in factor                             | uf          |                               | 1.22            |

| Use largest of sum of all positive or all negative influences |  |           |
|---|--|-----------|
| 0.12 all +ves   | Criteria<br>sum <4% range<br>0.603890621 |           |
| 0 all -ves  |  |           |
| 0.12 largest  |  |           |
| Value to use for intereference uncertainty                    |  | uint 0.12 |

| Measurement uncertainty | Value | Unit  |
|-------------------------|-------|-------|
| Combined uncertainty    | 0.98  | mg/m3 |

**Uncert Sheets**

|   |                           |   |             |              |
|---|---------------------------|---|-------------|--------------|
| Expanded uncertainty                      | k =                       | 2 | 1.95        | mg/m3        |
| <b>Uncertainty corrected to std conds</b> |                           |   | <b>3.73</b> | <b>mg/m3</b> |
| Expanded uncertainty                      | expressed with a level of |   | 2.49        | % ELV        |
| Expanded uncertainty                      | expressed with a level of |   | 3.73        | mg.m-3       |
| Expanded uncertainty                      | expressed with a level of |   | 12.36       | % value      |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

corrected drift to be based on mg/m3 reading and the correction alert to be based on % full scale

**TOC Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement EN12619**

|                        |      |       |                 |        |       |
|------------------------|------|-------|-----------------|--------|-------|
| Limit value            | 10   | mg/m3 | Calibration gas | 128.32 | mg/m3 |
| Measured concentration | 2.47 | mg/m3 | Full Scale      | 160    | mg/m3 |

| Performance characteristics            | Value |   |                 | specification        |
|--|-------|---|-----------------|----------------------|
| Response time                          | 180   | seconds                                 |                 | < 200 s              |
| Logger sampling interval               | 60    | seconds                                 |                 |                      |
| Measurement period                     | 33    | minutes                                 |                 |                      |
| Number of readings in measurement      | 33    | Assuming 1 minute collected over 1 hour |                 |                      |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev           | <0.2 % range         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev           | <0.4 % range         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-             | <0.3 % volume        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-             | <2% of volume / 24hr |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-             | <2% volume/24hr      |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + - 5 l/h       | <1% range            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + - 2kPa        | < 1.5 % range        |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + - 15K         | <0.3% volume 10 K    |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per | 15                   |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

|           | range of variation from conditions at calibration |     |                |
|-----------|---|-----|----------------|
|           | min   | max | value at calib |
| flow      | 5   | 15  | 10 l/h         |
| pressure  | 99.00   | 101 | 100 kPa        |
| temp      | 280   | 285 | 285 K          |
| CO2 range | 8   | 15  | 0 % vol        |

**Uncert Sheets**

|                                |     |      |                  |        |                    |           |     |     |         |
|--------------------------------|-----|------|------------------|--------|--------------------|-----------|-----|-----|---------|
| NO (mg/m3)                     | 300 | 0.02 | % by volume per  | 300    |                    | NO range  | 100 | 150 | 0 mg/m3 |
| NO2 (mg/m3)                    | 30  | 0    | % by volume per  | 30     |                    | NO2 range | 5   | 7.5 | 0 mg/m3 |
| Combined interference          |     | 0.56 | % range          |        | <2% range          | Voltage   | 105 | 115 | 110 V   |
| Dependence on voltage          |     | 0.1  | % by volume /10V | + - 5% | < 0.1%vol /10 volt |           |     |     |         |
| Losses in the line (leak)      |     | 2    | % of value       |        | < 2% of value      |           |     |     |         |
| Uncertainty of calibration gas |     | 0.5  | % of value       |        |                    |           |     |     |         |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | u0dr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.28                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |
| NO  |             |                               | 0.01                 |
| NO2   |             |                               | 0.00                 |
| Combined interference (from mcerts)               |             |                               | 0.52                 |
| dependence on voltage                             | uvolt       |                               | 0.03                 |
| losses in the line (leak)                         | uleak       |                               | 0.03                 |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.01                 |

|  |
|--|
| <b>Use largest of sum of all positive or all negative influences</b> |
| Criteria   |
| sum <2% value  |
| 0.049439625  |
| Value to use for intereference uncertainty                           |
| uint 0.06  |

| Measurement uncertainty  |   |                         |          |
|--|---|-------------------------|----------|
| Combined uncertainty   |   | 0.30                    | mg/m3    |
| Expanded uncertainty   |   | 0.59                    | mg/m3    |
| Expanded Uncertainty as % of value                               | 2 | 5.95                    | % of ELV |
| <b>Expanded uncertainty expressed with a level of confidence</b> |   | <b>24.07 % of value</b> |          |
| <b>Expanded uncertainty expressed with a level of confidence</b> |   | <b>0.59 mg/m3</b>       |          |

**HCL Uncert**

QGU-009-2013 Uncertainty calculation for HCL

v2

|                        |                                       |                  |               |
|------------------------|---------------------------------------|------------------|---------------|
| Limit value (ELV)      | 50 mg.m-3                             | Reference oxygen | 3 % by volume |
| Measured concentration | 0.27 mg.m-3 (at reference conditions) |                  |               |

Measurement Equation

$$c = \frac{m}{V} f_c$$

Uncert Sheets

| Measured Quantities   | Symbol           | Value  | Standard uncertainty | Units                | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|------------------|--------|----------------------|----------------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas  | V <sub>m</sub>   | 0.0642 | uV <sub>m</sub>      | 0.001 m <sup>3</sup> | 1.56                      |                   | <=2%               |
| Sampled gas Temperature   | T <sub>m</sub>   | 273    | uT <sub>m</sub>      | 2 k                  | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure  | ρ <sub>m</sub>   | 101.3  | uρ <sub>m</sub>      | 1 kPa                | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | H <sub>m</sub>   | 0      | uH <sub>m</sub>      | 1 % by volume        | 1.00                      |                   | <=1%               |
| Oxygen content  | O <sub>2,m</sub> | 8.4    | uO <sub>2,m</sub>    | 0.1 % by volume      | 1.19                      |                   | <=5%               |
| Concentration in impinger   | C                | 0.1    | uC                   | 0.003 mg/l           | 3.00                      |                   | <5%                |
| Impinger solution volume  | VS               | 350    | uVS                  | 0.001 l              | 0.00                      |                   | <1%                |
| Mass SO <sub>2</sub>  | m                | 35     | um                   | 1.05 mg              | 3.00                      | 0.02              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |        |                      |                      |                           |                   |                    |
| Leak  | L                | 2      |                      | %                    | 2.00                      |                   | <=2%               |

| Intermediate calculations                            |                  |                   |                      |
|--|------------------|-------------------|----------------------|
| Factor for std conds                                 | fs               | 1.00              |                      |
| uncertainty components                               | symbol           | sensitivity coeff | u (in units of fs)   |
|  | ρ <sub>m</sub>   | 0.010             | 0.010                |
|  | H <sub>m</sub>   | 0.010             | 0.010                |
|  | T <sub>m</sub>   | 0.004             | 0.007                |
|  | ufs              |                   | 0.016                |
| $f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$ |                  |                   |                      |
| Corrected volume                                     | V                | 0.06              | uV                   |
|  |                  |                   | 0.001 m <sup>3</sup> |
| $V = V_m f_s$  |                  |                   |                      |
| Factor for O <sub>2</sub> correction                 | fc               | 1.43              |                      |
| uncertainty components                               | symbol           | sensitivity coeff | u                    |
|  | O <sub>2,m</sub> | 0.11              | 0.011                |
| $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$          |                  |                   |                      |
| Factor for O <sub>2</sub> Correction                 | ufc              | 1.43              | 0.011                |

| Parameter                              | Value | Units               | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|---------------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.06 m <sup>3</sup> | 4.25           | 0.01 mg.m-3              | 2.22 %           |
| Mass                                   | m     | 35.00 mg            | 0.01           | 0.01 mg.m-3              | 3.00 %           |
| Factor for O <sub>2</sub> Correction   | fc    | 1.43                | 0.19           | 0.00 mg.m-3              | 0.79 %           |
| Leak                                   | L     | 0.00 mg.m-3         | 1.00           | 0.00 mg.m-3              | 1.15 %           |
| <b>Combined uncertainty</b>            |       |                     |                | <b>0.01 mg.m-3</b>       |                  |

|  |             |                     |  |
|--|-------------|---------------------|--|
| Expanded uncertainty as percentage of measured value | <b>7.98</b> | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | <b>0.02</b> | mg.m-3              |  |
| Expanded uncertainty as percentqge of limit value    | <b>0.04</b> | % ELV               |  |

Note: Enter values into green boxes

Uncert Sheets

Developed for the STA by R Robinson, NPL

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$$

QGU-009-2013 Uncertainty calculation for HF

v2

Measurement Equation

$$c = \frac{m}{V} f_c$$

|                        |      |                                  |                  |   |             |
|------------------------|------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 5    | mg.m-3                           | Reference oxygen | 3 | % by volume |
| Measured concentration | 0.11 | mg.m-3 (at reference conditions) |                  |   |             |

| Measured Quantities   | Symbol | Value  | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|--------|--------|----------------------|-----------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas  | Vm     | 0.0636 | uVm                  | 0.001 m3        | 1.57                      |                   | <=2%               |
| Sampled gas Temperature   | Tm     | 273    | uTm                  | 2 k             | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure  | pm     | 101.3  | upm                  | 1 kPa           | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | Hm     | 0      | uHm                  | 1 % by volume   | 1.00                      |                   | <=1%               |
| Oxygen content  | O2,m   | 8.4    | uO2,m                | 0.1 % by volume | 1.19                      |                   | <=5%               |
| Concentration in impinger   | C      | 0.04   | uC                   | 0.0012 mg/l     | 3.00                      |                   | <5%                |
| Impinger solution volume  | VS     | 350    | uVS                  | 0.001 l         | 0.00                      |                   | <1%                |
| Mass SO2  | m      | 14     | um                   | 0.42 mg         | 3.00                      | 0.07              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |        |        |                      |                 |                           |                   |                    |
| Leak  | L      | 2      |                      | %               | 2.00                      |                   | <=2%               |

| Intermediate calculations |        |                   |    |                    |
|---------------------------|--------|-------------------|----|--------------------|
| Factor for std conds      | fs     | 1.00              |    |                    |
| uncertainty components    | symbol | sensitivity coeff |    | u (in units of fs) |
|                           | pm     | 0.010             |    | 0.010              |
|                           | Hm     | 0.010             |    | 0.010              |
|                           | Tm     | 0.004             |    | 0.007              |
|                           | ufs    |                   |    | 0.016              |
| Corrected volume          | V      | 0.06              | uV | 0.001 m3           |
|                           |        |                   |    | $V = V_m f_s$      |
| Factor for O2 correction  | fc     | 1.43              |    |                    |
| uncertainty components    | symbol | sensitivity coeff |    | u                  |
|                           | O2,m   | 0.11              |    | 0.011              |
| Factor for O2 Correction  | ufc    | 1.43              |    | 0.011              |

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$$

$$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$$

| Parameter                              | Value | Units    | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|----------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.06 m3  | 1.73           | 0.00 mg.m-3              | 2.23 %           |
| Mass                                   | m     | 14.00 mg | 0.01           | 0.00 mg.m-3              | 3.00 %           |

**Uncert Sheets**

|                             |    |             |      |                    |        |
|-----------------------------|----|-------------|------|--------------------|--------|
| Factor for O2 Correction    | fc | 1.43        | 0.08 | 0.00 mg.m-3        | 0.79 % |
| Leak                        | L  | 0.00 mg.m-3 | 1.00 | 0.00 mg.m-3        | 1.15 % |
| <b>Combined uncertainty</b> |    |             |      | <b>0.00 mg.m-3</b> |        |

|  |                                   |                     |  |
|--|-----------------------------------|---------------------|--|
| Expanded uncertainty as percentage of measured value | <input type="text" value="7.99"/> | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | <input type="text" value="0.01"/> | mg.m-3              |  |
| Expanded uncertainty as percentage of limit value    | <input type="text" value="0.18"/> | % ELV               |  |

Note: Enter values into green boxes

Developed for the STA by R Robinson, NPL

$$SO_2 \text{ U}_{fs} = \frac{(100 - H_m) 273}{100} \frac{\rho_m}{T_m 101.3}$$

**Run 1**

**Uncertainty calculation for Gaseous Measurement SO2 EA M21**

|                        |                                      |                             |                                     |                                   |
|------------------------|--------------------------------------|-----------------------------|-------------------------------------|-----------------------------------|
| Limit value            | <input type="text" value="-"/>       | mg/m3 (correction gas conc) | <input type="text" value="2044.9"/> | mg.m-3                            |
| Measured concentration | <input type="text" value="1753.10"/> | mg/m3                       | Full Scale                          | <input type="text" value="2860"/> |
| Measured concentration | <input type="text" value="1753.10"/> | mg/m3 (Corrected)           |                                     |                                   |

| Correction for reference conditions |          |             |           |               |                |
|-------------------------------------|----------|-------------|-----------|---------------|----------------|
|                                     |          | O2, %       | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 3.00        | 0.00      | 101.30        | 273.00         |
|                                     | measured | 8.48        | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35        | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.44        | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.04        | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | <b>1.45</b> | uf        | <b>0.04</b>   |                |

| Performance characteristics           | Value |                       | specification    |
|---------------------------------------|-------|-----------------------|------------------|
| Response time                         | 180   | seconds               | 180.000          |
| Logger sampling interval              | 60    | seconds               |                  |
| Measurement period                    | 34    | minutes               |                  |
| Number of readings in measurement     | 34    |                       |                  |
| Repeatability at zero                 | 0.25  | % full scale          | <1 % range       |
| Repeatability at span level           | 0.15  | % full scale          | <2 % range       |
| Deviation from linearity(lack of fit) | 0.7   | % of value            | <2 % range       |
| Zero drift                            | 0     | mg/m3                 | <2% range / 24hr |
| Span drift                            | 0.5   | mg/m3                 | <2% range/24hr   |
| volume or pressure flow dependence    | 0.02  | % of full scale/3 kPa | <2 % / 3 kPa     |

|                   |
|-------------------|
| Effect of drift   |
| 0.43 mg/m3        |
| 0.01 % full scale |

|      | min   | max | value at calib |
|------|-------|-----|----------------|
| flow | 95.00 | 105 | 100 kPa        |

**Uncert Sheets**

|                                 |      |                       |                    |           |        |        |        |       |
|---------------------------------|------|-----------------------|--------------------|-----------|--------|--------|--------|-------|
| atmospheric pressure dependence | 0.8  | % of full scale/2 kPa | <3% / 2 kPa        | pressure  | 100.76 | 100.92 | 100.88 | kPa   |
| ambient temperature dependence  | 0.01 | % full scale/10K      | <3% range / 10 K   | temp      | 287    | 288.5  | 287.5  | K     |
| N2O (mg/m3)                     | 20   | 0.2                   | mg/m3              | N2O range | 0      | 40     | 0      | mg/m3 |
| CO2 (% vol)                     | 15   | 0.2                   | mg/m3              | CO2 range | 0      | 15     | 0      | %vol  |
| CH4 (mg/m3)                     | 40   | 0.7                   | mg/m3              | CH4 range | 0      | 57     | 0      | mg/m3 |
| H2O (% vol)                     | 20   | 0.2                   | mg/m3              | H2O range | 0      | 1      | 0      | %vol  |
| dependence on voltage           | 0.1  | % full scale/10V      | <2% range          | Voltage   | 93     | 121    | 110    | V     |
| losses in the line (leak)       | 2    | % of value            | < 0.1%vol /10 volt |           |        |        |        |       |
| Uncertainty of calibration gas  | 2    | % of value            | < 2% of value      |           |        |        |        |       |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.74            |
| Lack of fit                                       | ufit        |                               | 7.09            |
| Drift   | u0dr        |                               | 0.25            |
| volume or pressure flow dependence                | uspres      |                               | 0.55            |
| atmospheric pressure dependence                   | uapres      |                               | 0.70            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| N2O (mg/m3)                                       | uintenf     |                               | 0.23            |
| CO2 (% vol)                                       | uintenf     |                               | 0.12            |
| CH4 (mg/m3)                                       | uintenf     |                               | 0.58            |
| H2O (% vol)                                       | uintenf     |                               | 0.01            |
| Dependence on voltage                             | uvolt       |                               | 2.47            |
| losses in the line (leak)                         | uleak       |                               | 20.24           |
| Uncertainty of calibration gas                    | ucalib      |                               | 20.24           |
| Uncertainty in factor                             | uf          |                               | 72.90           |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.93 all +ves  | Criteria<br>sum <4% range<br>35.06191578 |
| 0 all -ves   |  |
| 0.93 largest   |  |
| <b>Value to use for interference uncertainty</b>                     |  |
| uint   | 0.93                                     |

| Measurement uncertainty                   |   |                      |       |
|---|---|----------------------|-------|
| Combined uncertainty                      |   | 29.63                | mg/m3 |
| Expanded uncertainty                      | k = 2                                       | 59.27                | mg/m3 |
| <b>Uncertainty corrected to std conds</b> |   |                      |       |
|   |   | 169.22               | mg/m3 |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>0.00 % ELV</b>    |       |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>169.22 mg.m-3</b> |       |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>9.65 % value</b>  |       |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

**Uncert Sheets**

Developed for the STA by R Robinson, NPL

**O<sub>2</sub> Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement Oxygen EN14789**

|                        |      |      |                 |      |      |
|------------------------|------|------|-----------------|------|------|
| Limit value            | n/a  | %vol | Calibration gas | 20.9 | %vol |
| Measured concentration | 8.48 | %vol | Full Scale      | 25   | %vol |

| Performance characteristics            | Value |   |                 | specification        |
|--|-------|---|-----------------|----------------------|
| Response time                          | 180   | seconds                                 |                 | < 200 s              |
| Logger sampling interval               | 60    | seconds                                 |                 |                      |
| Measurement period                     | 34    | minutes                                 |                 |                      |
| Number of readings in measurement      | 34    | Assuming 1 minute collected over 1 hour |                 |                      |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev           | <0.2 % range         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev           | <0.4 % range         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-             | <0.3 % volume        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-             | <2% of volume / 24hr |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-             | <2% volume/24hr      |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + 5 l/h         | <1% range            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + 2kPa          | < 1.5 % range        |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + 15K           | <0.3% volume 10 K    |
| CO <sub>2</sub> (% vol)                | 15    | 0.07                                    | % by volume per | 15                   |
| NO (mg/m <sup>3</sup> )                | 300   | 0.02                                    | % by volume per | 300                  |
| NO <sub>2</sub> (mg/m <sup>3</sup> )   | 30    | 0                                       | % by volume per | 30                   |
| Combined interference                  | 0.56  | % range                                 |                 | <2% range            |
| Dependence on voltage                  | 0.1   | % by volume /10V                        | + 5%            | < 0.1%vol /10 volt   |
| Losses in the line (leak)              | 2     | % of value                              |                 | < 2% of value        |
| Uncertainty of calibration gas         | 0.5   | % of value                              |                 |                      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

|                       | range of variation from conditions at calibration |     |                     |
|-----------------------|---|-----|---------------------|
|                       | min   | max | value at calib      |
| flow                  | 5   | 15  | 10 l/h              |
| pressure              | 99.00   | 101 | 100 kPa             |
| temp                  | 280   | 285 | 285 K               |
| CO <sub>2</sub> range | 8   | 15  | 0 % vol             |
| NO range              | 100   | 150 | 0 mg/m <sup>3</sup> |
| NO <sub>2</sub> range | 5   | 7.5 | 0 mg/m <sup>3</sup> |
| Voltage               | 105   | 115 | 110 V               |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | uodr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |



**Uncert Sheets**

|                                     |  |  |        |  |  |  |       |  |               |
|-------------------------------------|--|--|--------|--|--|--|-------|--|---------------|
| atmospheric pressure dependence     |  |  | uapres |  |  |  | 0.04  |  |               |
| ambient temperature dependence      |  |  | utemp  |  |  |  | -0.02 |  |               |
| CO2                                 |  |  |        |  |  |  | 0.05  | <b>Use largest of sum of all positive or all negative influences</b> |               |
| NO                                  |  |  |        |  |  |  | 0.01  |  | 0.06 all +ves |
| NO2                                 |  |  |        |  |  |  | 0.00  |  | 0 all -ves    |
| Combined interference (from mcerts) |  |  |        |  |  |  | 0.08  |  | 0.06 largest  |
| dependence on voltage               |  |  | uvolt  |  |  |  | 0.03  | <b>Value to use for intereference uncertainty</b>                    |               |
| losses in the line (leak)           |  |  | uleak  |  |  |  | 0.10  |  | uint 0.06     |
| Uncertainty of calibration gas      |  |  | ucalib |  |  |  | 0.02  |  |               |

|                                |   |  |                        |      |
|--------------------------------|---|--|------------------------|------|
| <b>Measurement uncertainty</b> |   |  | 8.48                   | %vol |
| Combined uncertainty           |   |  | 0.15                   | %vol |
| % of value                     |   |  | 1.78                   | %    |
| Coverage factor k =            | 2   |  |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>3.57 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>0.30 % vol</b>      |      |

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests  
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

corrected drift alert to be based on % full scale

**CO<sub>2</sub> Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement Carbon Dioxide**

|                        |       |      |                 |      |      |
|------------------------|-------|------|-----------------|------|------|
| Limit value            | n/a   | %vol | Calibration gas | 15.5 | %vol |
| Measured concentration | 12.14 | %vol | Full Scale      | 25   | %vol |

| Performance characteristics | Value       | specification |
|-----------------------------|-------------|---------------|
| Response time               | 180 seconds | < 200 s       |
| Logger sampling interval    | 60 seconds  |               |
| Measurement period          | 34 minutes  |               |

|                 |                   |
|-----------------|-------------------|
| Effect of drift | 0.00 % vol        |
|                 | 0.00 % full scale |

**Uncert Sheets**

|  |       |   |                 |                      |   |       |     |         |
|--|-------|---|-----------------|----------------------|---|-------|-----|---------|
| Number of readings in measurement      | 34    | Assuming 1 minute collected over 1 hour |                 |                      |   |       |     |         |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev           | <0.2 % range         |   |       |     |         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev           | <0.4 % range         |   |       |     |         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-             | <0.3 % volume        |   |       |     |         |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-             | <2% of volume / 24hr | range of variation from conditions at calibration |       |     |         |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-             | <2% volume/24hr      |   |       |     |         |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + 5 l/h         | <1% range            | flow  | 5     | 15  | 10 l/h  |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + 2kPa          | < 1.5 % range        | pressure  | 99.00 | 101 | 100 kPa |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + 15K           | <0.3% volume 10 K    | temp  | 280   | 285 | 285 K   |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per | 15                   | CO2 range   | 8     | 15  | 0 % vol |
| NO (mg/m3)                             | 300   | 0.02                                    | % by volume per | 300                  | NO range  | 100   | 150 | 0 mg/m3 |
| NO2 (mg/m3)                            | 30    | 0                                       | % by volume per | 30                   | NO2 range   | 5     | 7.5 | 0 mg/m3 |
| Combined interference                  | 0.56  | % range                                 |                 | <2% range            | Voltage   | 105   | 115 | 110 V   |
| Dependence on voltage                  | 0.1   | % by volume /10V                        | + 5%            | < 0.1%vol /10 volt   |   |       |     |         |
| Losses in the line (leak)              | 2     | % of value                              |                 | < 2% of value        |   |       |     |         |
| Uncertainty of calibration gas         | 0.5   | % of value                              |                 |                      |   |       |     |         |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | u0dr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.04                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |
| NO  |             |                               | 0.01                 |
| NO2   |             |                               | 0.00                 |
| Combined interference (from mcerts)               |             |                               | 0.08                 |
| dependence on voltage                             | uvolt       |                               | 0.03                 |
| losses in the line (leak)                         | uleak       |                               | 0.14                 |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.04                 |

**Use largest of sum of all positive or all negative influences**

|               |
|---------------|
| 0.06 all +ves |
| 0 all -ves    |
| 0.06 largest  |

**Value to use for intereference uncertainty**  
 uint 0.06

|                                |   |                        |      |
|--------------------------------|---|------------------------|------|
| <b>Measurement uncertainty</b> |   | 12.14                  | %vol |
| Combined uncertainty           |   | 0.18                   | %vol |
| % of value                     |   | 1.51                   | %    |
| Coverage factor k =            | 2   |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> | <b>3.02 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> | <b>0.37 % vol</b>      |      |

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

**Uncert Sheets**

**Note:** Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests  
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

**Moisture Uncert**

| Run 1   |                  |  |                      |                                 |   |   |
|---|------------------|--|----------------------|---------------------------------|---|---|
| Uncertainty calculation for Moisture  |                  |  |                      |                                 |   |   |
| Limit value (ELV)   | 0                | mg.m <sup>-3</sup>                           | Reference oxygen     | 3                               | % by volume                                 | Measurement Equation<br>$c = \frac{m}{V} f_c$ |
| Measured concentration  | 8.19             | mg.m <sup>-3</sup> (at reference conditions) |                      |                                 |   |   |
| Measured Quantities   | Symbol           | Value  | Standard uncertainty | Units                           | Uncertainty as percentage                   | Uncertainty at lv                             |
| Sampled Volume  | V <sub>m</sub>   | 0.06   | uV <sub>m</sub>      | 0.001 m <sup>3</sup>            |   | 1.67  |
| Sampled gas Temperature   | T <sub>m</sub>   | 273  | uT <sub>m</sub>      | 2 k                             |   | 0.73  |
| Sampled gas Pressure  | p <sub>m</sub>   | 101.3  | uρ <sub>m</sub>      | 1 kPa                           |   | 0.99  |
| Sampled gas Humidity  | H <sub>m</sub>   | 0  | uH <sub>m</sub>      | 1 % by volume                   |   | 1.00  |
| Oxygen content  | O <sub>2,m</sub> | 8.4  | uO <sub>2,m</sub>    | 0.1 % by volume                 |   | 1.19  |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |  |                      |                                 |   |   |
| Leak  | L                | 0.001  |                      | %                               |   | 0.00  |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM              | 0  |                      | mg                              | #REF!                                       |   |
| Intermediate calculations   |                  |  |                      |                                 |   |   |
| Factor for std conds  | f <sub>s</sub>   | 1.00   |                      |                                 |   |   |
| uncertainty components  | symbol           | sensitivity coeff                            |                      | u (in units of f <sub>s</sub> ) |   |   |
|   | p <sub>m</sub>   | 0.010  |                      | 0.010                           |   |   |
|   | H <sub>m</sub>   | 0.010  |                      | 0.010                           |   |   |
|   | T <sub>m</sub>   | 0.004  |                      | 0.007                           |   |   |
|   | uf <sub>s</sub>  |  |                      | 0.016                           |   | 1.58  |
| Corrected volume  | V                | 0.06   | uV                   | 0.001 m <sup>3</sup>            | $V = V_m f_s$                               | 2.30  |
| Factor for O2 correction  | f <sub>c</sub>   | 1.43   |                      |                                 |   |   |
| uncertainty components  | symbol           | sensitivity coeff                            |                      | u                               |   |   |
|   | O <sub>2,m</sub> | 0.11   |                      | 0.011                           | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |   |
| Factor for O2 Correction  | uf <sub>c</sub>  | 1.43   |                      | 0.011                           |   | 0.79  |

**Uncert Sheets**

| Parameter                               | Value | Units                   | Sensitivity cc | Uncertainty contribution      | Uncertainty as % |
|---|-------|-------------------------|----------------|-------------------------------|------------------|
| Corrected Volume (standard conditions)  | V     | 0.06 m <sup>3</sup>     | 136.47         | 0.19 mg.m <sup>-3</sup>       | 2.30 %           |
| Factor for O2 Correction                | fc    | 1.43                    | 5.73           | 0.06 mg.m <sup>-3</sup>       | 0.79 %           |
| Leak                                    | L     | 0.00 mg.m <sup>-3</sup> | 1.00           | 0.00 mg.m <sup>-3</sup>       | 0.00 %           |
| <b>Combined measurement uncertainty</b> |       |                         |                | <b>0.20 mg.m<sup>-3</sup></b> |                  |

Expanded uncertainty as percentage of measured value 4.87 % measured of value expressed with a level of confidence of 95%

(Using a coverage factor k=2)

Expanded uncertainty in units of measurement 0.398 mg.m<sup>-3</sup>

Expanded uncertainty as percentage of limit value 0.00 % ELV

## Certificate of Analysis

**Report No.:** 21-12428-1

**Issue No.:** 1

**Date of Issue** 28/10/2021

Customer Details: Air Scientific Ltd, Unit 32, De Granville Court, Dublin Road, Trim, Co. Meath, , Ireland

Customer Contact: Amanda Sheridan

Customer Order No.: KNLATL1061021

Customer Reference: Not Supplied

Quotation Reference: Q21-01409

Description: 3 gas samples, 12 liquid samples, 3 solid samples

Date Received: 12/10/2021

Date Started: 13/10/2021

Date Completed: 27/10/2021

Test Methods: Details available on request (refer to SOP code against relevant result/s)

Notes: None



**Approved By:** Joanne Dewhurst, Operational Manager

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service.

This certificate shall not be reproduced except in full without the prior written approval of the laboratory.

Observations and interpretations are outside of the scope of UKAS accreditation.

Results reported herein relate only to the items supplied to the laboratory for testing.

Results on an Interim Report are not dry-weight corrected.

Where the laboratory is not responsible for the sampling, results apply to the sample(s) as they were received.

The laboratory shall not be responsible for any information that is supplied by the customer that may affect the validity of results.



0605



[rpsgroup.com](http://rpsgroup.com)

RPS Environmental Management Limited trading as RPS Laboratories. Registered in England No. 01756175.

Unit 12, Waters Edge Business Park, Modwen Road, Salford, M5 3EZ. T +44 161 872 2443

A member of the RPS Group plc. Terms and conditions apply - copy on request

**Results Summary**

**Report No.:** 21-12428-1

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | KH01 223687 | KH01W      | KH02 223684 | KH02W      | B 223689   | BW         | KH01HCL 1+2 | KH01HCL 3  | HCL B      | KH02HCL 1+2 | KH02HCL 3  | F1HCL 1+2  | F1HCL 3    |
|--------------------|-------------|------------|-------------|------------|------------|------------|-------------|------------|------------|-------------|------------|------------|------------|
| RPS Sample No      | 67246       | 67247      | 67248       | 67249      | 67250      | 67251      | 67252       | 67253      | 67254      | 67255       | 67256      | 67257      | 67258      |
| Sample Matrix      | FILTER      | SOLUTION   | FILTER      | SOLUTION   | FILTER     | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION   |
| Sampling Date      | 06/10/2021  | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand                         | CAS No    | Codes | SOP | RL   | Units |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
|-------------------------------------|-----------|-------|-----|------|-------|--------|-------|--------|-------|--------|--|--|--|--------|--------|--------|--------|--------|--------|--------|
| volume of sample supplied           |           |       | U   | N/A  | n/a   | ml     |       |        |       |        |  |  |  | 142    | 135    | 127    | 144    | 140    | 142    | 127    |
| hydrogen chloride                   | 7647-01-0 | UM    | C27 | 0.05 | ug/mL |        |       |        |       |        |  |  |  | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzene FRONT                       | 71-43-2   | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| dichloromethane (DCM) FRONT         | 75-09-2   | UM    | O8  | 4    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| heptane FRONT                       | 142-82-5  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| m- & p-xylene FRONT                 |           | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| methyl isobutyl ketone (MIBK) FRONT | 108-10-1  | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| o-xylene FRONT                      | 95-47-6   | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| tetrachloroethylene FRONT           | 127-18-4  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| tetrahydrofuran (THF) FRONT         | 109-99-9  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| toluene FRONT                       | 108-88-3  | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| trichloroethylene FRONT             | 79-01-6   | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| particulates                        |           | UM    | D9  | 0.04 | mg    | < 0.04 |       | < 0.04 |       | < 0.04 |  |  |  |        |        |        |        |        |        |        |
| particulates                        |           | UM    | D9  | 0.5  | mg    |        | < 0.5 |        | < 0.5 |        |  |  |  |        |        |        |        |        |        |        |
| acetone FRONT                       | 67-64-1   | U     | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| 2-butanone (MEK) FRONT              | 78-93-3   | U     | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| cyclohexanone FRONT                 | 108-94-1  | U     | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| ethanol FRONT                       | 64-17-5   | U     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| ethyl acetate FRONT                 | 141-78-6  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| hexane FRONT                        | 110-54-3  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| 2-propanol (IPA) FRONT              | 67-63-0   | U     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| acetone BACK                        | 67-64-1   | U     | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| 2-butanone (MEK) BACK               | 78-93-3   | U     | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| cyclohexanone BACK                  | 108-94-1  | U     | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| ethanol BACK                        | 64-17-5   | U     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| ethyl acetate BACK                  | 141-78-6  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| hexane BACK                         | 110-54-3  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| 2-propanol (IPA) BACK               | 67-63-0   | U     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| benzene BACK                        | 71-43-2   | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| dichloromethane (DCM) BACK          | 75-09-2   | UM    | O8  | 4    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| heptane BACK                        | 142-82-5  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| m- & p-xylene BACK                  |           | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| methyl isobutyl ketone (MIBK) BACK  | 108-10-1  | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| o-xylene BACK                       | 95-47-6   | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| tetrachloroethylene BACK            | 127-18-4  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| tetrahydrofuran (THF) BACK          | 109-99-9  | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| toluene BACK                        | 108-88-3  | UM    | O8  | 1    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| trichloroethylene BACK              | 79-01-6   | UM    | O8  | 2    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| carbon tetrachloride FRONT          | 56-23-5   | N     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| carbon tetrachloride BACK           | 56-23-5   | N     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |
| chloroform FRONT                    | 67-66-3   | N     | O8  | 3    | ug    |        |       |        |       |        |  |  |  |        |        |        |        |        |        |        |

**Results Summary**
**Report No.: 21-12428-1**

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | KH01 223687 | KH01W      | KH02 223684 | KH02W      | B 223689   | BW         | KH01HCL 1+2 | KH01HCL 3  | HCL B      | KH02HCL 1+2 | KH02HCL 3  | F1HCL 1+2  | F1HCL 3    |
|--------------------|-------------|------------|-------------|------------|------------|------------|-------------|------------|------------|-------------|------------|------------|------------|
| RPS Sample No      | 67246       | 67247      | 67248       | 67249      | 67250      | 67251      | 67252       | 67253      | 67254      | 67255       | 67256      | 67257      | 67258      |
| Sample Matrix      | FILTER      | SOLUTION   | FILTER      | SOLUTION   | FILTER     | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION   |
| Sampling Date      | 06/10/2021  | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand       | CAS No   | Codes | SOP | RL | Units |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------|----------|-------|-----|----|-------|--|--|--|--|--|--|--|--|--|--|--|--|
| chloroform BACK   | 67-66-3  | N     | O8  | 3  | ug    |  |  |  |  |  |  |  |  |  |  |  |  |
| cyclohexane FRONT | 110-82-7 | N     | O8  | 3  | ug    |  |  |  |  |  |  |  |  |  |  |  |  |
| cyclohexane BACK  | 110-82-7 | N     | O8  | 3  | ug    |  |  |  |  |  |  |  |  |  |  |  |  |

**Results Summary**

**Report No.: 21-12428-1**

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | F2HCL 1+2  | F2HCL 3    | 1968       | 1976       | 1965       |
|--------------------|------------|------------|------------|------------|------------|
| RPS Sample No      | 67259      | 67260      | 67261      | 67262      | 67263      |
| Sample Matrix      | SOLUTION   | SOLUTION   | TUBE       | TUBE       | TUBE       |
| Sampling Date      | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand                         | CAS No    | Codes | SOP | RL   | Units | 138    | 141    |     |     |     |
|-------------------------------------|-----------|-------|-----|------|-------|--------|--------|-----|-----|-----|
| volume of sample supplied           |           | U     | N/A | n/a  | ml    | 138    | 141    |     |     |     |
| hydrogen chloride                   | 7647-01-0 | UM    | C27 | 0.05 | ug/mL | < 0.05 | < 0.05 |     |     |     |
| benzene FRONT                       | 71-43-2   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| dichloromethane (DCM) FRONT         | 75-09-2   | UM    | O8  | 4    | ug    |        |        | < 4 | < 4 | < 4 |
| heptane FRONT                       | 142-82-5  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| m- & p-xylene FRONT                 |           | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| methyl isobutyl ketone (MIBK) FRONT | 108-10-1  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| o-xylene FRONT                      | 95-47-6   | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| tetrachloroethylene FRONT           | 127-18-4  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| tetrahydrofuran (THF) FRONT         | 109-99-9  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| toluene FRONT                       | 108-88-3  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| trichloroethylene FRONT             | 79-01-6   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| particulates                        |           | UM    | D9  | 0.04 | mg    |        |        |     |     |     |
| particulates                        |           | UM    | D9  | 0.5  | mg    |        |        |     |     |     |
| acetone FRONT                       | 67-64-1   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-butanone (MEK) FRONT              | 78-93-3   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| cyclohexanone FRONT                 | 108-94-1  | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| ethanol FRONT                       | 64-17-5   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| ethyl acetate FRONT                 | 141-78-6  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| hexane FRONT                        | 110-54-3  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-propanol (IPA) FRONT              | 67-63-0   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| acetone BACK                        | 67-64-1   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-butanone (MEK) BACK               | 78-93-3   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| cyclohexanone BACK                  | 108-94-1  | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| ethanol BACK                        | 64-17-5   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| ethyl acetate BACK                  | 141-78-6  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| hexane BACK                         | 110-54-3  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-propanol (IPA) BACK               | 67-63-0   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| benzene BACK                        | 71-43-2   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| dichloromethane (DCM) BACK          | 75-09-2   | UM    | O8  | 4    | ug    |        |        | < 4 | < 4 | < 4 |
| heptane BACK                        | 142-82-5  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| m- & p-xylene BACK                  |           | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| methyl isobutyl ketone (MIBK) BACK  | 108-10-1  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| o-xylene BACK                       | 95-47-6   | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| tetrachloroethylene BACK            | 127-18-4  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| tetrahydrofuran (THF) BACK          | 109-99-9  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| toluene BACK                        | 108-88-3  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| trichloroethylene BACK              | 79-01-6   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| carbon tetrachloride FRONT          | 56-23-5   | N     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| carbon tetrachloride BACK           | 56-23-5   | N     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| chloroform FRONT                    | 67-66-3   | N     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |



**Results Summary**

**Report No.:** 21-12428-1

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | F2HCL 1+2  | F2HCL 3    | 1968       | 1976       | 1965       |
|--------------------|------------|------------|------------|------------|------------|
| RPS Sample No      | 67259      | 67260      | 67261      | 67262      | 67263      |
| Sample Matrix      | SOLUTION   | SOLUTION   | TUBE       | TUBE       | TUBE       |
| Sampling Date      | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand       | CAS No   | Codes | SOP | RL | Units | F2HCL 1+2 | F2HCL 3 | 1968 | 1976 | 1965 |
|-------------------|----------|-------|-----|----|-------|-----------|---------|------|------|------|
| chloroform BACK   | 67-66-3  | N     | O8  | 3  | ug    |           |         | < 3  | < 3  | < 3  |
| cyclohexane FRONT | 110-82-7 | N     | O8  | 3  | ug    |           |         | < 3  | < 3  | < 3  |
| cyclohexane BACK  | 110-82-7 | N     | O8  | 3  | ug    |           |         | < 3  | < 3  | < 3  |

## Deviating Samples

**Report No.:** 21-12428-1

**Customer Reference:** Not Supplied

**Customer Order No.:** KNLATL1061021

Our policy on Deviating Samples has been implemented in accordance with UKAS Policy on Deviating Samples (TPS63).

RPS is not responsible for the integrity of samples as received, unless RPS personnel performed the sampling. Samples submitted may be declared to be deviating.

Where applicable the analysis method remains UKAS accredited, however results reported for a deviating sample may be compromised.

Where no sampling date was supplied, samples have been declared to be deviating. If the date can be supplied, results may be reissued if assessed not deviating.

Where the sample container used was unsuitable or broken, the sample is flagged as deviating and re-sampling/re-submission may be required.

| RPS No. | Customer No. | Customer ID | Date Sampled | Containers Received | Deviating | Reason for Deviation |
|---------|--------------|-------------|--------------|---------------------|-----------|----------------------|
| 67246   | KH01 223687  |             | 06/10/2021   | Container           | No        |                      |
| 67247   | KH01W        |             | 06/10/2021   | Container           | No        |                      |
| 67248   | KH02 223684  |             | 06/10/2021   | Container           | No        |                      |
| 67249   | KH02W        |             | 06/10/2021   | Container           | No        |                      |
| 67250   | B 223689     |             | 06/10/2021   | Container           | No        |                      |
| 67251   | BW           |             | 06/10/2021   | Container           | No        |                      |
| 67252   | KH01HCL 1+2  |             | 06/10/2021   | Container           | No        |                      |
| 67253   | KH01HCL 3    |             | 06/10/2021   | Container           | No        |                      |
| 67254   | HCL B        |             | 06/10/2021   | Container           | No        |                      |
| 67255   | KH02HCL 1+2  |             | 06/10/2021   | Container           | No        |                      |
| 67256   | KH02HCL 3    |             | 06/10/2021   | Container           | No        |                      |
| 67257   | F1HCL 1+2    |             | 06/10/2021   | Container           | No        |                      |
| 67258   | F1HCL 3      |             | 06/10/2021   | Container           | No        |                      |
| 67259   | F2HCL 1+2    |             | 06/10/2021   | Container           | No        |                      |
| 67260   | F2HCL 3      |             | 06/10/2021   | Container           | No        |                      |
| 67261   | 1968         |             | 06/10/2021   | Container           | No        |                      |
| 67262   | 1976         |             | 06/10/2021   | Container           | No        |                      |
| 67263   | 1965         |             | 06/10/2021   | Container           | No        |                      |

**Report No.: 21-12428-1**

| Key Code         | Description   |
|------------------|---|
| N                | Not Accredited Test   |
| U                | UKAS Accredited Test - UKAS accreditation is only implied if the report carries the UKAS logo       |
| UF               | UKAS Flexible Scope Test  |
| M                | MCERTS Accredited Test - MCERTS accreditation is only implied if the report carries the MCERTS logo |
| O                | Marine Management Organisation (MMO) Validated  |
| SN               | Subcontracted to approved laboratory not accredited for the test                                    |
| SU               | Subcontracted to approved laboratory UKAS Accredited for the test                                   |
| SM               | Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test                            |
| SIN              | Subcontracted to internal RPS Group laboratory not accredited for the test                          |
| SIU              | Subcontracted to internal RPS Group laboratory UKAS Accredited for the test                         |
| SIM              | Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test                  |
| I/S (in results) | Insufficient Sample   |
| U/S (in results) | Unsuitable Sample   |
| S/C (in results) | See Comments  |
| ND (in results)  | Not Detected  |
| L (in results)   | Result is outside normal limits   |

Please note that all samples will be destroyed 4 WEEKS after the report has been issued.

Note: Sample retention may be subject to agreement with the customer for particular projects

| Certificate Notes | Description   |
|-------------------|---|
| Note 1            | This test report shall not be reproduced except in full, without written approval of the Laboratory.            |
| Note 2            | Unless otherwise stated, results are not corrected for analytical recoveries.                                   |
| Note 3            | Samples were taken by the customer and, unless otherwise stated, sampling locations were not supplied.          |
| Note 4            | Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.                      |
| Note 5            | Unless otherwise stated, method D9 conditioning temperatures are 180°C for pre-weigh and 160°C for re-weigh.    |
| Note 6            | The PDF version is the definitive copy and the Excel version is uncontrolled and provided for information only. |

Note: Where the following information is included in this certificate, it has usually been supplied by the customer: Customer Sample ID, Sample Location, Sampling Date and Sample Air Volumes. The laboratory shall not be responsible for any information that is supplied by the customer that may affect the validity of results.

Report No.: 21-12428-1

| Determinand                           | CAS No     | Media                           | SOP  | % Recovery | % Uncertainty |
|---------------------------------------|------------|---------------------------------|------|------------|---------------|
| acetaldehyde                          | 75-07-0    | tube                            | A40  | 98         | 16.2          |
| benzaldehyde                          | 100-52-7   | tube                            | A40  | 100        | 19.4          |
| butyraldehyde                         | 123-72-8   | tube                            | A40  | 92         | 11.5          |
| formaldehyde                          | 50-00-0    | tube                            | A40  | 97         | 12.8          |
| hexanal                               | 66-25-1    | tube                            | A40  | 89         | 11            |
| propionaldehyde                       | 123-38-6   | tube                            | A40  | 96         | 12.6          |
| valeraldehyde                         | 110-62-3   | tube                            | A40  | 93         | 12.3          |
| ammonia                               | 7664-41-7  | sulphuric acid solution         | A6   | n/a        | 8.9           |
| chlorine                              | 7782-50-5  | sodium hydroxide solution       | C27  | n/a        | 15.2          |
| hydrogen bromide                      | 10035-10-6 | sulphuric acid solution         | C27  | n/a        | 10.9          |
| hydrogen chloride                     | 7647-01-0  | deionised water                 | C27  | n/a        | 7.9           |
| hydrogen chloride                     | 7647-01-0  | sulphuric acid solution         | C27  | n/a        | 13.3          |
| hydrogen fluoride                     | 7664-3-3   | sodium hydroxide solution       | C27  | n/a        | 7.9           |
| sulphur dioxide                       | 7446-09-5  | hydrogen peroxide solution      | C27  | n/a        | 7.7           |
| nitrogen oxide                        | 10102-43-9 | potassium permanganate solution | C27  | n/a        | 11.7          |
| particulates                          | n/a        | filter                          | D9   | n/a        | 12.2          |
| particulates                          | n/a        | wash solution                   | D9   | n/a        | 14.8          |
| formaldehyde                          | 50-00-0    | deionised water                 | M103 | n/a        | 23.7          |
| 2,4- & 2,6-toluene diisocyanate (TDI) | n/a        | filter                          | M119 | n/a        | 8.6           |
| hexamethylene diisocyanate (HDI)      | 822-06-0   | filter                          | M119 | n/a        | 5.6           |
| methylene diphenyl diisocyanate (MDI) | 101-68-8   | filter                          | M119 | n/a        | 11.8          |
| hydrogen sulphide                     | 7783-06-4  | zinc acetate solution           | M120 | n/a        | 4.2           |
| antimony                              | 7440-36-0  | filter                          | M31  | n/a        | 10.3          |
| arsenic                               | 7440-38-2  | filter                          | M31  | n/a        | 17.1          |
| cadmium                               | 7440-43-9  | filter                          | M31  | n/a        | 12.1          |
| chromium                              | 7440-47-3  | filter                          | M31  | n/a        | 17.1          |
| cobalt                                | 7440-48-4  | filter                          | M31  | n/a        | 13.1          |
| copper                                | 7440-50-8  | filter                          | M31  | n/a        | 14            |
| lead                                  | 7439-92-1  | filter                          | M31  | n/a        | 9.8           |
| manganese                             | 7439-96-5  | filter                          | M31  | n/a        | 17.5          |
| nickel                                | 7440-02-0  | filter                          | M31  | n/a        | 14.4          |
| thallium                              | 7440-28-0  | filter                          | M31  | n/a        | 15.3          |
| tin                                   | 7440-31-5  | filter                          | M31  | n/a        | 18.5          |
| vanadium                              | 7440-62-2  | filter                          | M31  | n/a        | 12.1          |
| zinc                                  | 7440-66-6  | filter                          | M31  | n/a        | 15.2          |
| antimony                              | 7440-36-0  | nitric acid wash                | M31  | n/a        | 10.3          |
| arsenic                               | 7440-38-2  | nitric acid wash                | M31  | n/a        | 17.1          |
| cadmium                               | 7440-43-9  | nitric acid wash                | M31  | n/a        | 12.1          |
| chromium                              | 7440-47-3  | nitric acid wash                | M31  | n/a        | 17.1          |
| cobalt                                | 7440-48-4  | nitric acid wash                | M31  | n/a        | 13.1          |
| copper                                | 7440-50-8  | nitric acid wash                | M31  | n/a        | 14            |
| lead                                  | 7439-92-1  | nitric acid wash                | M31  | n/a        | 9.8           |
| manganese                             | 7439-96-5  | nitric acid wash                | M31  | n/a        | 17.5          |
| nickel                                | 7440-02-0  | nitric acid wash                | M31  | n/a        | 14.4          |
| selenium                              | 7782-49-2  | nitric acid wash                | M31  | n/a        | 15.1          |
| thallium                              | 7440-28-0  | nitric acid wash                | M31  | n/a        | 15.3          |
| tin                                   | 7440-31-5  | nitric acid wash                | M31  | n/a        | 18.5          |
| vanadium                              | 7440-62-2  | nitric acid wash                | M31  | n/a        | 12.1          |
| zinc                                  | 7440-66-6  | nitric acid wash                | M31  | n/a        | 15.2          |
| antimony                              | 7440-36-0  | nitric/peroxide solution        | M31  | n/a        | 5.9           |
| arsenic                               | 7440-38-2  | nitric/peroxide solution        | M31  | n/a        | 6.8           |
| cadmium                               | 7440-43-9  | nitric/peroxide solution        | M31  | n/a        | 6.3           |
| chromium                              | 7440-47-3  | nitric/peroxide solution        | M31  | n/a        | 7.2           |
| cobalt                                | 7440-48-4  | nitric/peroxide solution        | M31  | n/a        | 5.2           |
| copper                                | 7440-50-8  | nitric/peroxide solution        | M31  | n/a        | 6.8           |
| lead                                  | 7439-92-1  | nitric/peroxide solution        | M31  | n/a        | 8.6           |
| manganese                             | 7439-96-5  | nitric/peroxide solution        | M31  | n/a        | 9.6           |
| nickel                                | 7440-02-0  | nitric/peroxide solution        | M31  | n/a        | 5.5           |
| selenium                              | 7782-49-2  | nitric/peroxide solution        | M31  | n/a        | 8.7           |
| thallium                              | 7440-28-0  | nitric/peroxide solution        | M31  | n/a        | 7.7           |
| tin                                   | 7440-31-5  | nitric/peroxide solution        | M31  | n/a        | 5.8           |
| vanadium                              | 7440-62-2  | nitric/peroxide solution        | M31  | n/a        | 6.7           |
| zinc                                  | 7440-66-6  | nitric/peroxide solution        | M31  | n/a        | 11.9          |
| 1,2,4-trimethylbenzene                | 95-63-6    | tube                            | O8   | 88         | 8.1           |
| 1,3,5-trimethylbenzene                | 108-67-8   | tube                            | O8   | 92         | 7.7           |
| 2-ethyltoluene                        | 611-14-3   | tube                            | O8   | 91         | 8.4           |
| 3- & 4-ethyltoluene                   | n/a        | tube                            | O8   | 91         | 8.4           |
| benzene                               | 71-43-2    | tube                            | O8   | 90         | 13.9          |
| butyl acetate                         | 123-86-4   | tube                            | O8   | 90         | 10.3          |
| decane                                | 124-18-5   | tube                            | O8   | 97         | 6.7           |
| dichloromethane                       | 75-09-2    | tube                            | O8   | 88         | 24            |
| ethyl acetate                         | 141-78-6   | tube                            | O8   | n/a        | n/a           |
| ethyl benzene                         | 100-41-4   | tube                            | O8   | 92         | 9.8           |
| heptane                               | 142-82-5   | tube                            | O8   | 94         | 10.5          |
| hexane                                | 110-54-3   | tube                            | O8   | n/a        | n/a           |
| limonene                              | 138-86-3   | tube                            | O8   | 93         | 13            |
| m- & p-xylene                         | n/a        | tube                            | O8   | 90         | 9.3           |
| methyl isobutyl ketone (MIBK)         | 108-10-1   | tube                            | O8   | 86         | 10            |
| methyl tert-butyl ether (MTBE)        | 1634-04-4  | tube                            | O8   | 92         | 15            |
| o-xylene                              | 95-47-6    | tube                            | O8   | 86         | 9.9           |
| propylbenzene                         | 103-65-1   | tube                            | O8   | 92         | 7.5           |
| tetrachloroethylene                   | 127-18-4   | tube                            | O8   | 91         | 9.3           |
| tetrahydrofuran (THF)                 | 109-99-9   | tube                            | O8   | 87         | 14.7          |
| toluene                               | 108-88-3   | tube                            | O8   | 89         | 10.7          |
| trichloroethylene                     | 79-01-6    | tube                            | O8   | 91         | 10.6          |
| m- & p-cresol                         | n/a        | tube                            | P1   | n/a        | 11            |
| m- & p-xenol                          | n/a        | tube                            | P1   | n/a        | 11.9          |
| o-cresol                              | 95-48-7    | tube                            | P1   | n/a        | 10.8          |
| o-xenol                               | 526-75-0   | tube                            | P1   | n/a        | 12            |
| phenol                                | 108-95-2   | tube                            | P1   | n/a        | 10.4          |

## Test Certificate

Date 03/11/2021

|               |   |                        |                   |
|---------------|---|------------------------|-------------------|
| <b>Client</b> | Air Scientific (TM)<br>Unit 32 De Granville Court<br>Dublin Road<br>Trim<br>Co Meath<br>Ireland | <b>Order No.</b>       | KNLATL1061021     |
|               |   | <b>Certificate No.</b> | <b>WK21-00753</b> |
|               |   | <b>Issue No.</b>       | 1                 |

|                    |                    |                      |             |
|--------------------|--------------------|----------------------|-------------|
| <b>Contact</b>     | Amanda             | <b>Date Received</b> | 13/10/2021  |
| <b>Description</b> | 9 solutions for HF | <b>Technique</b>     | Subcontract |

| Sample No.               | 1164932    | KH01 HF 1+2 | Method         |
|--------------------------|------------|-------------|----------------|
| <b>Hydrogen Fluoride</b> | 0.05 mg/L  | 134 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164933    | KH01 HF 3   | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | 0.02 mg/L  | 124 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164934    | HFB         | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 122 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164935    | KH02 HF 1+2 | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | 0.02 mg/L  | 126 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164936    | KH02 HF 3   | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 127 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164937    | F1 HF 1+2   | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 135 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164938    | F1 HF 3     | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | 0.02 mg/L  | 110 ml      | Subcontract(N) |
| <b>Sample No.</b>        | 1164939    | F2 HF 1+2   | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 131 ml      | Subcontract(N) |

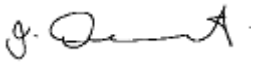
## Test Certificate

Date 03/11/2021

|                          |                     |         |                        |                |
|--------------------------|---------------------|---------|------------------------|----------------|
| <b>Client</b>            | Air Scientific (TM) |         | <b>Certificate No.</b> | WK21-00753     |
|                          |                     |         | <b>Issue No.</b>       | 1              |
| <b>Sample No.</b>        | 1164940             | F2 HF 3 |                        | <b>Method</b>  |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L          | 140 ml  |                        | Subcontract(N) |

Samples subcontracted to a UKAS/MCERTS laboratory.

Tested By Subcontract Date 02/11/2021

Approved By  Date 03/11/2021  
Joanne Dewhurst  
Operational

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited  
(N) Analysis is not UKAS Accredited

Concentration values reported as mg/m<sup>3</sup> and ppm where air volumes are supplied by the customer are not covered by the scope of UKAS accreditation.

Results stated as ml are referring to the sample volume.

RPS Laboratories terms and conditions apply - a copy is available on request.

Analysis carried out on samples 'as received'

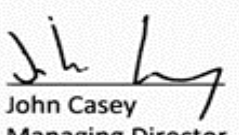
This document may not be reproduced other than in full, except with the written approval of the issuing laboratory.



Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F2  
Facility Location: Knockharley Facility  
Rev.No: 1



|   |   |
|---|---|
| <b>Report Title</b>                                   | Air Emissions Compliance Monitoring Emissions Report  |
| <b>Company address</b>                                | Air Scientific Ltd., 32 DeGranville Court, Dublin road,<br>Trim, Co. Meath  |
| <b>Stack Emissions Testing Report Commissioned by</b> | Knockharley Landfill  |
| <b>Facility Name</b>                                  | Knockharley Facility  |
| <b>Contact Person</b>                                 | Mr Sean O Callaghan   |
| <b>EPA Licence Number</b>                             | WL0146-02   |
| <b>Licence Holder</b>                                 | Knockharley Landfill, F2  |
| <b>Stack Reference Number</b>                         | F2  |
| <b>Dates of the Monitoring Campaign</b>               | 06/10/2021  |
| <b>Job Reference Number</b>                           | KNLATL1061021 / 20211664  |
| <b>Report Written By</b>                              | Amanda Sheridan   |
| <b>Report Approved by</b>                             | Dr. John Casey  |
| <b>Stack Testing Team</b>                             | Dr. John Casey, Amanda Sheridan   |
| <b>Report Date</b>                                    | 19/11/2021  |
| <b>Report Type</b>                                    | Test Report Compliance Monitoring   |
| <b>Version</b>  | 1   |
| <b>Signature of Approver</b>                          | <br>John Casey<br>Managing Director |



## Contents

|  |    |
|--|----|
| 1. Executive Summary .....   | 4  |
| I. Monitoring Objectives .....   | 4  |
| Overall Aim of the monitoring Campaign .....                               | 4  |
| Special Requirements .....   | 4  |
| Target Parameters .....  | 4  |
| Emission Limit Values .....  | 5  |
| Reference Conditions .....   | 5  |
| Overall Results .....  | 6  |
| Accreditation details .....  | 7  |
| Monitoring Dates & Times .....   | 8  |
| Monitoring, Equipment & Analytical Methods .....                           | 9  |
| Sampling Deviations .....  | 11 |
| Reference Documents .....  | 11 |
| Suitability of sampling location .....                                     | 12 |
| Process details .....  | 13 |
| Stack diagram .....  | 14 |
| 2. APPENDICES .....  | 15 |
| II. Appendix I - Monitoring Personnel & Equipment .....                    | 15 |
| Stack Emissions Monitoring Personnel .....                                 | 15 |
| III. Appendix II - Stack Details & flow characteristics .....              | 16 |
| Preliminary stack survey calculations .....                                | 16 |
| IV. Appendix III - Individual parameter sampling details and results ..... | 22 |
| Carbon Monoxide Quality Assurance .....                                    | 22 |
| Carbon Monoxide Results & Sampling details .....                           | 25 |
| Carbon Monoxide Trend .....  | 29 |
| Carbon Monoxide Measurement Uncertainty .....                              | 30 |
| Oxides of Nitrogen Quality Assurance .....                                 | 31 |
| Oxides of Nitrogen Results & Sampling details .....                        | 33 |
| Oxides of Nitrogen Trend .....   | 37 |
| Oxides of Nitrogen Measurement Uncertainty .....                           | 38 |
| Total Volatile Organic Carbon Quality Assurance .....                      | 39 |
| Total Volatile Organic Carbon Results and Sampling Details .....           | 41 |
| Total Volatile Organic Carbon Trend .....                                  | 45 |
| Total Volatile Organic Carbon Measurement Uncertainty .....                | 46 |
| Hydrogen Chloride Sampling Details & Results .....                         | 48 |
| Hydrogen Chloride Quality Assurance .....                                  | 49 |
| Hydrogen Chloride Results & Measurement Uncertainty .....                  | 51 |
| Hydrogen Fluoride Sampling Details & Results .....                         | 53 |
| Hydrogen Fluoride Quality Assurance .....                                  | 54 |
| Hydrogen Fluoride Results & Measurement Uncertainty .....                  | 56 |
| Sulphur Dioxide Quality Assurance .....                                    | 57 |
| Sulphur Dioxide Sampling Details & Results .....                           | 59 |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

Sulphur Dioxide Trend ..... 69

Sulphur Dioxide Results & Measurement Uncertainty ..... 71

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F2  
Facility Location: Knockharley Facility  
Rev.No: 1

|  |    |
|--|----|
| Oxygen Quality Assurance .....                   | 73 |
| Oxygen Trend .....                               | 76 |
| Carbon Dioxide Quality Assurance .....           | 77 |
| Carbon Dioxide Sampling Details & Results .....  | 77 |
| Carbon Dioxide Trend .....                       | 79 |
| Moisture Results & Measurement Uncertainty ..... | 81 |
| <br>   |    |
| Uncertainty Sheets .....                         | 84 |

*Opinions and interpretations expressed herein are outside the scope of Air Scientific Limited INAB accreditation.  
This test report shall not be reproduced, without the written approval of Air Scientific Limited. All sampling  
and reporting is completed in accordance with Environmental Protection Agency Air Guidance Note 2 requirements.*

## 1. Executive Summary

### I. Monitoring Objectives

#### Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

#### Special Requirements

There were no special requirements.

#### Target Parameters

|   |
|---|
| Carbon Monoxide (CO)                        |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> |
| Total Volatile Organic Carbon (TOC)         |
| Hydrogen Chloride (HCL)                     |
| Hydrogen Fluoride (HF)                      |
| Sulphur Dioxide (SO <sub>2</sub> )          |
| Stack Gas Temperature                       |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )   |
| Oxygen (O <sub>2</sub> )                    |
| Carbon Dioxide (CO <sub>2</sub> )           |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

### Emission Limit Values

| Emission Limit Values / Mass Emissions Limit Values | mg.m <sup>-3</sup> | kg.h <sup>-1</sup> |
|---|--------------------|--------------------|
| CO  | 50                 | -                  |
| NOx as NO <sub>2</sub>                              | 150                | -                  |
| TOC   | 10                 | -                  |
| HCL   | 50                 | -                  |
| HF  | 5                  | -                  |
| SO <sub>2</sub>                                     | -                  | -                  |
| Stack Gas Temperature                               | -                  | -                  |
| Volume (m <sup>3</sup> .h <sup>-1</sup> )           | -                  | -                  |

### Reference Conditions

| Reference Condition | Value  |
|---------------------|--------|
| Oxygen Reference %  | 3      |
| Temperature K       | 273.15 |
| Total Pressure kPa  | 101.3  |
| Moisture Correction | Yes    |

**Executive Summary**

**Overall Results**

| Parameter                         | Concentration                   | Result  | MU +/- | Blanks | Limit | Compliant | Mass Emission      | Result | Limit | Run 1 | Dates      | Time on  | Time off | O2 Ref. (%) | Accreditation | LOD  |
|-----------------------------------|---------------------------------|---------|--------|--------|-------|-----------|--------------------|--------|-------|-------|------------|----------|----------|-------------|---------------|------|
|                                   | Units                           |         |        |        |       |           | Units              |        |       |       |            |          |          |             |               |      |
| CO EN15058:2017                   | mg.m <sup>-3</sup>              | 4.47    | 3.34   | -      | 50    | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 14:35:00 | 15:13:00 | 3           | Yes           | <1.7 |
| NOx EN14792:2017                  | mg.m <sup>-3</sup>              | 25.9    | 2.81   | -      | 150   | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 14:35:00 | 15:13:00 | 3           | Yes           | <1.8 |
| TVOC EN12619:2013                 | mg.m <sup>-3</sup>              | 7.44    | 0.6    | -      | 10    | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 14:39:52 | 15:09:52 | 3           | Yes           | <0.8 |
| HCL EN1911:2010                   | mg.m <sup>-3</sup>              | <0.46   | 0.02   | <0.09  | 50    | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 00:00:00 | 00:00:00 | 3           | Yes           | 0.26 |
| HF EN15713:2006                   | mg.m <sup>-3</sup>              | <0.17   | 0.01   | <0.03  | 5     | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 00:00:00 | 00:00:00 | 3           | Yes           | 0.24 |
| SO <sub>2</sub> CEN/TS 17021:2017 | mg.m <sup>-3</sup>              | 4357.92 | 333    | -      | -     | N/A       | kg.h <sup>-1</sup> | -      | -     | -     | 06/10/2021 | 14:35:00 | 15:13:00 | 3           | No            | <6.1 |
| Oxygen (%) EN14789:2017           | % v/v                           | 10.66   | 0.17   | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 14:35:00 | 15:13:00 | 3           | Yes           | -    |
| CO <sub>2</sub> ISO12039:2001     | % v/v                           | 9.61    | 0.32   | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 14:35:00 | 15:13:00 | 3           | Yes           | -    |
| H <sub>2</sub> O EN14790:2017     | % v/v                           | 8       | 0.4    | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 00:00:00 | 00:00:00 | 3           | Yes           | -    |
| Stack Gas Temperature             | K                               | 1285.15 | -      | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 14:25:00 | 14:30:00 | 3           | Yes           | -    |
| Stack Gas Velocity EN16911:2013   | m.s <sup>-1</sup>               | -       | -      | -      | -     | N/A       | -                  | -      | -     | -     | 06/10/2021 | 14:25:00 | 14:30:00 | 3           | Yes           | -    |
| Volumetric Flow Rate              | m <sup>3</sup> .h <sup>-1</sup> | -       | -      | -      | -     | N/A       | -                  | -      | -     | -     | -          | -        | -        | 3           | Yes           | -    |
| Volumetric Flow Rate (Ref)        | m <sup>3</sup> .h <sup>-1</sup> | -       | -      | -      | -     | N/A       | -                  | -      | -     | -     | -          | -        | -        | 3           | Yes           | -    |

**Accreditation details**

|                                |          |
|--------------------------------|----------|
| Air Scientific Limited         | INAB319T |
| External Analytical Laboratory | UKAS0605 |
| Other                          | -        |



## Executive Summary

## Monitoring Dates &amp; Times

| Parameter                                   | Run   | Location ID | Sampling Dates | Sampling Time On | Sampling Time Off | Duration (mins.) |
|---|-------|-------------|----------------|------------------|-------------------|------------------|
| Carbon Monoxide (CO)                        | Run 1 | F2          | 06/10/2021     | 14:35:00         | 15:13:00          | 00:38:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxides of Nitrogen (NOx) as NO <sub>2</sub> | Run 1 | F2          | 06/10/2021     | 14:35:00         | 15:13:00          | 00:38:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Total Volatile Organic Carbon (VOC)         | Run 1 | F2          | 06/10/2021     | 14:39:52         | 15:09:52          | 00:30:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Chloride (HCL)                     | Run 1 | F2          | 06/10/2021     | 00:00:00         | 00:00:00          | 00:00:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Hydrogen Fluoride (HF)                      | Run 1 | F2          | 06/10/2021     | 00:00:00         | 00:00:00          | 00:00:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Sulphur Dioxide (SO <sub>2</sub> )          | Run 1 | F2          | 06/10/2021     | 14:35:00         | 15:13:00          | 00:38:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Oxygen (%)                                  | Run 1 | F2          | 06/10/2021     | 14:35:00         | 15:13:00          | 00:38:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |
| Water Vapour (%)                            |       | F2          | 06/10/2021     | 00:00:00         | 00:00:00          | 00:00:00         |
| Stack Gas Temperature                       |       | F2          | 06/10/2021     | 14:25:00         | 14:30:00          | 00:05:00         |
| Stack Gas Velocity                          |       | F2          | 06/10/2021     | 14:25:00         | 14:30:00          | 00:05:00         |
| Carbon Dioxide (%)                          | Run 1 | F2          | 06/10/2021     | 14:35:00         | 15:13:00          | 00:38:00         |
|   | Run 2 | -           | -              | -                | -                 | -                |
|   | Run 3 | -           | -              | -                | -                 | -                |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

### Executive Summary

### Monitoring, Equipment & Analytical Methods

| Parameter                           | Monitoring        |                     |                    |             | Analysis                   |               |
|-------------------------------------|-------------------|---------------------|--------------------|-------------|----------------------------|---------------|
|                                     | Standard          | Technical Procedure | Accredited Testing | Testing Lab | Analytical Technique       | INAB Analysis |
| Carbon Monoxide (CO)                | EN15058:2017      | SOP 2004            | Yes                | AirSci      | NCIR By Horiba PG-250      | -             |
| Oxides of Nitrogen (NOx)            | EN14792:2017      | SOP 2002            | Yes                | AirSci      | Chemiluminescence          | -             |
| Total Volatile Organic Carbon (TOC) | EN12619:2013      | SOP 2009            | Yes                | AirSci      | Flame Ionisation Detection | -             |
| Hydrogen Chloride (HCL)             | EN1911:2010       | SOP 2014            | Yes                | RPS         | Ion Chromatography         | -             |
| Hydrogen Fluoride (HF)              | EN15713:2006      | SOP 2024            | Yes                | RPS         | Ion Chromatography         | -             |
| Sulphur Dioxide (SO <sub>2</sub> )  | CEN/TS 17021:2017 | SOP 2046            | No                 | AirSci      | NDIR Absorption            | -             |
| Oxygen (%)                          | EN14789:2017      | SOP 2008            | Yes                | AirSci      | Paramagnetic               | -             |
| Carbon Dioxide                      | ISO12039:2001     | SOP 2045            | Yes                | AirSci      | Gravimetric                | -             |
| Water Vapour (%)                    | EN14790:2017      | SOP 2007            | Yes                | AirSci      | NDIR                       | -             |
| Stack Gas Temperature               | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Thermocouple               | -             |
| Stack Gas Velocity                  | EN16911:2013      | SOP 2005            | Yes                | AirSci      | Pitot tubes                | -             |



Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

### List of Equipment

| ID           | Item of Equipment                      | Manufacturer       | Serial No. |
|--------------|--|--------------------|------------|
| ASLTM12EQ511 | 3010 MiniFID                           | Signal Instruments | 17852      |
| ASLTM12EQ513 | Horiba PG2500 Portable Gas Analyzer    | Horiba             | ZVM969TT   |
| ASLTM12EQ526 | Knob weights (200,500,1000mg)          | KERN & Sohn GmbH   | G1117388   |
| ASLTM13EQ509 | 10 metre industrial heated sample line | Neptech            | 13B088     |
| ASLTM14EQ510 | 5 metre heated line                    | Neptech            | 14B052     |
| ASLTM15EQ505 | Mass flow meter                        | Siargo             | A1K05286   |
| ASLTM15EQ508 | My weigh ibalance i1200                | My Weigh           | 7.256.358  |
| ASLTM20EQ504 | K type thermocouple                    | TCR Tecora         | N/A        |
| ASLTM19EQ510 | Mass flow meter                        | Siargo             | N/A        |
| ASLTM19EQ509 | Kimo Manometer                         | Kimo               | N/A        |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

### Sampling Deviations

| Parameter   | Deviation  |
|-------------|--|
| Standard ID | -  |
| Standard ID | HCL Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS EN 1911:2010 section 5.2.1.2.2) |
| Standard ID | HF Impinger efficiency is lower than the requirements of 95% total of concentration in the first impinger (BS ISO 15713:2006 section 6.4).     |
| Standard ID | -  |

### Reference Documents

|                              |         |
|------------------------------|---------|
| Risk Assessment (RA)         | SOP1011 |
| Site Review (SR)             | SOP1015 |
| Site Specific Protocol (SSP) | SOP1015 |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**Executive Summary**

**Suitability of sampling location**

| General Information | Value     |
|---------------------|-----------|
| Permanent/Temporary | Temporary |
| Inside/ Outside     | Outside   |

| Platform Details   |       |         |
|--|-------|---------|
| Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements      | Value | Comment |
| Sufficient Working area to manipulate probe and measuring instruments          | Yes   | -       |
| Platform has 2 handrails (approx. 0.5m & 1.0 m high)                           | Yes   | -       |
| Platform has vertical base boards (approx. 0.25 m high)                        | Yes   | -       |
| Platform has chains / self closing gates at top of ladders                     | Yes   | -       |
| There are no obstructions present which hamper insertion of sampling equipment | No    | -       |
| Safe Access Available  | Yes   | -       |
| Easy Access Available  | Yes   | -       |

| Sampling Location / Platform Improvement Recommendations |
|--|
| None   |

| BSEN 15259 Homogeneity Test Requirements   |
|--|
| 1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack |

**Process details**

| Parameter                           |            |
|-------------------------------------|------------|
| Process status                      | Normal     |
| Capacity (per/hour) (if applicable) | As Normal  |
| Continuous or Batch Process         | Continuous |
| Feedstock                           | LFG        |
| Abatement System                    | No         |
| Abatement Systems Running Status    | N/A        |
| Fuel                                | Gas        |
| Plume Appearance                    | No         |
| Other information                   | None       |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

The process information below has been supplied by the client and as such ASL assume no responsibility or liability for any errors or omissions in the content of this Process Detail Form. The information provided in this form is provided on an 'as is' basis with no guarantees of completeness, accuracy or reliability.

| Licensee     |                     |                      |                     |
|--------------|---------------------|----------------------|---------------------|
| Reg. number  | WL0146-02           | Contractor           | Air Scientific Ltd. |
| Site Contact | Mr Sean O Callaghan | Contractor's contact | Amanda Sheridan     |
| Role         |                     | Role                 | -                   |
| Signature    |                     | Signature            | -                   |

| Emissions point       |     | -               |                            |     |                                   |   |
|-----------------------|-----|-----------------|----------------------------|-----|-----------------------------------|---|
| Type of process       |     | Load of process | Abatement system           |     | List of Solvents used per process |   |
| Rotogravure Printing  | -   | as normal       | Bag filter                 | -   | -                                 | - |
| Cement Plant          | -   |                 | Electrostatic precipitator | -   | -                                 | - |
| Electrical generation | -   |                 | Cyclone                    | -   | -                                 | - |
| Steam boiler          | -   |                 | Thermal oxidiser           | -   | -                                 | - |
| Other                 | Yes |                 | Active carbon bed          | -   | -                                 | - |
|                       |     |                 | NSCR                       | -   | -                                 | - |
|                       |     |                 | SCR                        | -   | -                                 | - |
|                       |     |                 | Dry scrubber               | -   | -                                 | - |
|                       |     |                 | Wet scrubber               | -   | -                                 | - |
|                       |     |                 | Lime injection             | -   | -                                 | - |
|                       |     |                 | Biofilter                  | -   | -                                 | - |
|                       |     |                 | None                       | Yes | -                                 | - |
|                       |     |                 | Other:                     | -   | -                                 | - |

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F2  
Facility Location: Knockharley Facility  
Rev.No: 1

**Executive Summary**

**Stack diagram**



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**2. APPENDICES**

**II. Appendix I - Monitoring Personnel & Equipment**

**Stack Emissions Monitoring Personnel**

|                    |                        |                                       |
|--------------------|------------------------|---------------------------------------|
| <b>Team Leader</b> | <b>Name</b>            | Dr. John Casey                        |
|                    | <b>Qualifications</b>  | PhD. (Eng.), MSc. (Agr.), B. Agr. Sc. |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Technician</b>  | <b>Name</b>            | Amanda Sheridan                       |
|                    | <b>Qualifications</b>  | B.A.                                  |
|                    | <b>System approval</b> | Air Scientific Limited Approved       |
|                    |                        | -                                     |
| <b>Team Leader</b> | <b>Name</b>            | -                                     |
|                    | <b>Qualifications</b>  | -                                     |
|                    | <b>System approval</b> | -                                     |
|                    |                        | -                                     |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**III. Appendix II - Stack Details & flow characteristics**

**Preliminary stack survey calculations**

| <b>General Stack Details</b>                |              |              |
|---|--------------|--------------|
| <b>Stack details</b>                        | <b>Units</b> | <b>Value</b> |
| Date of survey                              |              | 06/10/2021   |
| Time of survey                              |              | 14:25        |
| Type  |              | -            |
| Stack Diameter / Depth, D                   | m            | -            |
| Stack Width, W                              | m            | -            |
| Average Stack Gas Temp., Ta                 | C            | 1012         |
| Average Static Pressure, P static           | kPa          | 0.1          |
| Average Barometric Pressure, Pb             | kPa          | 101.1        |
| Type of Pitot                               |              | -            |
| Are Water Droplets Present?                 |              | -            |
| Average Pitot Tube Calibration Coeff, Cp    |              | -            |
| Negative flow                               |              | -            |
| Highly homogeneous flow stream/gas velocity |              | Yes          |

|                           |    |          |
|---------------------------|----|----------|
| Sample Port Size          | mm | -        |
| Initial Pitot Leak Check  | Pa | -        |
| Final Pitot Leak Check    | Pa | -        |
| Orientation of Duct       |    | Vertical |
| Pitot Tube Cp             |    | 0.998    |
| Number of Lines Available |    | -        |
| Number of Lines Used      |    | -        |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

| Sampling Line A |                      |    |         |                |            |                |
|-----------------|----------------------|----|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | -                    | -  | -       | -              | -          | -              |
| 2               | -                    | -  | -       | -              | -          | -              |
| 3               | -                    | -  | -       | -              | -          | -              |
| 4               | -                    | -  | -       | -              | -          | -              |
| 5               | -                    | -  | -       | -              | -          | -              |
| 6               | -                    | -  | -       | -              | -          | -              |
| 7               | -                    | -  | -       | -              | -          | -              |
| 8               | -                    | -  | -       | -              | -          | -              |
| 9               | -                    | -  | -       | -              | -          | -              |
| 10              | -                    | -  | -       | -              | -          | -              |
| Average         | -                    | -  | -       | -              | -          | -              |
| Min             | -                    | -  | -       | -              | -          | -              |
| Max             | -                    | -  | -       | -              | -          | -              |



Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

| Sampling Line B |                      |    |         |                |            |                |
|-----------------|----------------------|----|---------|----------------|------------|----------------|
| Point           | Distance to duct (m) | Pa | Temp °C | Velocity (m/s) | Oxygen (%) | Angle of Swirl |
| 1               | -                    | -  | -       | -              | -          | -              |
| 2               | -                    | -  | -       | -              | -          | -              |
| 3               | -                    | -  | -       | -              | -          | -              |
| 4               | -                    | -  | -       | -              | -          | -              |
| 5               | -                    | -  | -       | -              | -          | -              |
| 6               | -                    | -  | -       | -              | -          | -              |
| 7               | -                    | -  | -       | -              | -          | -              |
| 8               | -                    | -  | -       | -              | -          | -              |
| 9               | -                    | -  | -       | -              | -          | -              |
| 10              | -                    | -  | -       | -              | -          | -              |
| Average         | -                    | -  | -       | -              | -          | -              |
| Min             | -                    | -  | -       | -              | -          | -              |
| Max             | -                    | -  | -       | -              | -          | -              |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

| <b>Component</b>               | <b>Conc. ppm</b> | <b>Conc. Dry % v/v</b> | <b>Conc. Wet % v/v</b> | <b>Molar Mass</b> |
|--------------------------------|------------------|------------------------|------------------------|-------------------|
| Carbon Dioxide CO <sub>2</sub> | -                | 9.6                    | -                      | 44.01             |
| Oxygen O <sub>2</sub>          | -                | 10.6                   | -                      | 32                |
| Nitrogen N <sub>2</sub>        | -                | 79.8                   | -                      | 28.1              |
| Moisture (H <sub>2</sub> O)    | -                | -                      | 8                      | 18.02             |
| <b>Reference Conditions</b>    |                  |                        |                        |                   |
| <b>Reference Conditions</b>    | <b>Units</b>     | <b>Numbers</b>         |                        |                   |
| Temperature                    | °C               | 273.15                 |                        |                   |
| Total Pressure                 | kPa              | 101.3                  |                        |                   |
| Moisture                       | %                | -                      |                        |                   |
| Oxygen (Dry)                   | %                | 3                      |                        |                   |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

| Stack Gas Composition & Molecular Weights |              |                             |                 |                       |                                |                 |                       |                                |
|---|--------------|-----------------------------|-----------------|-----------------------|--------------------------------|-----------------|-----------------------|--------------------------------|
| Component                                 | Molar Mass M | Density Kg/m <sup>3</sup> p | Conc. Dry % v/v | Dry Volume Fraction r | Dry Conc. kg/m <sup>3</sup> pi | Conc. wet % v/v | Wet Volume Fraction r | Wet Conc. kg/m <sup>3</sup> pi |
| Carbon Dioxide CO <sub>2</sub>            | 44.01        | 1.96                        | 9.6             | 0.096                 | 0.19                           | 8.83            | 0.09                  | 0.17                           |
| Oxygen O <sub>2</sub>                     | 32           | 1.43                        | 10.6            | 0.106                 | 0.15                           | 9.75            | 0.1                   | 0.14                           |
| Nitrogen N <sub>2</sub>                   | 28.1         | 1.25                        | 79.8            | 0.798                 | 1                              | 73.42           | 0.73                  | 0.92                           |
| Moisture (H <sub>2</sub> O)               | 18.02        | 0.8                         | -               | -                     | -                              | 8               | 0.08                  | 0.06                           |
| where $p = M/22.41$                       |              |                             |                 |                       |                                |                 |                       |                                |
| $p_i = r \times p$                        |              |                             |                 |                       |                                |                 |                       |                                |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

| Calculation of Stack Gas Densities  |                    |        |
|---|--------------------|--------|
| Determinant   | Units              | Result |
| Dry Density (STP), P STD  | kg.m <sup>-3</sup> | 1.341  |
| Wet Density (STP), P STW  | kg.m <sup>-3</sup> | 1.301  |
| Dry Density (Actual), P Actual  | kg.m <sup>-3</sup> | 0.284  |
| Average wet Density (Actual), P Actual W  | kg.m <sup>-3</sup> | 0.276  |
| <b>Where</b>  |                    |        |
| P STD = sum of component concentrations, kg/m <sup>3</sup> (excluding water vapour)               |                    |        |
| $P_{STW} = (P_{STD} + p_{i \text{ of } H_2O}) / (1 + (p_{i \text{ of } H_2O} / 0.8036))$          |                    |        |
| $P_{actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times (P_a / T_a)$                            |                    |        |
| $P_{actual \ W} \text{ (at each sampling point)} = P_{STW} \times (T_s / P_s) \times (P_a / T_a)$ |                    |        |

Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

| Sampling Plane Validation Criteria     | Value | Units   | Requirement | Compliance | Method       |
|--|-------|---------|-------------|------------|--------------|
| Lowest Differential Pressure           | -     | Pa      | >5 Pa       | N/A        | EN16911:2013 |
| Lowest Gas Velocity                    | -     | m/s     | -           | N/A        | -            |
| Highest Gas Velocity                   | -     | m/s     | -           | N/A        | -            |
| Ratio of Above                         | -     | :1      | <3:1        | N/A        | EN16911:2013 |
| Mean Velocity                          | -     | m/s     | -           | N/A        | -            |
| Angle of flow with regard to duct axis | -     | degrees | < 15        | N/A        | EN16911:2013 |
| No local negative flow                 | -     | -       | -           | N/A        | -            |
| Homogeneous flow stream/gas velocity   | -     | -       | -           | N/A        | -            |

| Calculation of stack Gas Velocity, V  |       |
|---|-------|
| Velocity at Traverse Point, $V = K_{cp} * \text{Sqrt}((2 * DP) / \text{Density})$ | -     |
| <b>Where</b>  |       |
| $K_{pt}$ = Pitot tube calibration coefficient                                     | -     |
| Compressibility correction factor, assumed at a constant 0.998                    | 0.998 |

| Gas Volumetric Flowrate               | Units        | Result |
|---------------------------------------|--------------|--------|
| Gas Volumetric Flow Rate (Actual)     | $m^3.h^{-1}$ | -      |
| Gas Volumetric Flow Rate (STP, Wet)   | $m^3.h^{-1}$ | -      |
| Gas Volumetric Flowrate (STP, Dry)    | $m^3.h^{-1}$ | -      |
| Gas Volumetric Flowrate REF to Oxygen | $m^3.h^{-1}$ | -      |

|  |   |  |   |  |   |
|--|---|--|---|--|---|
| Standard uncertainty of velocity (m/s) | - | Expanded uncertainty of velocity (m/s) | - | Volume flow rate expanded uncertainty ( $m^3/hr$ ) | - |
|--|---|--|---|--|---|

Document No.: KNLATL1061021 / 20211664  
Visit No: 1  
Year: 2021  
Office: Trim

EPA Licence No.: WL0146-02  
Licence Holder: Knockharley Landfill, F2  
Facility Location: Knockharley Facility  
Rev.No: 1

***IV. Appendix 3 - Individual parameter sampling details and results***

## Carbon Monoxide Quality Assurance

| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F2                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 14:35        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 200          | -            | -            |
| Span Gas Value                 | ppm               | 157.5        | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.3          | -            | -            |
| Zero Drift                     | ppm               | -0.2         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 7.88         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.13        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 157.5        | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 158          | -            | -            |
| Span Drift                     | ppm               | -0.5         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 7.88         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.32        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 157.5        | -            | -            |
| Recorded Conc. down Line       | ppm               | 158          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |

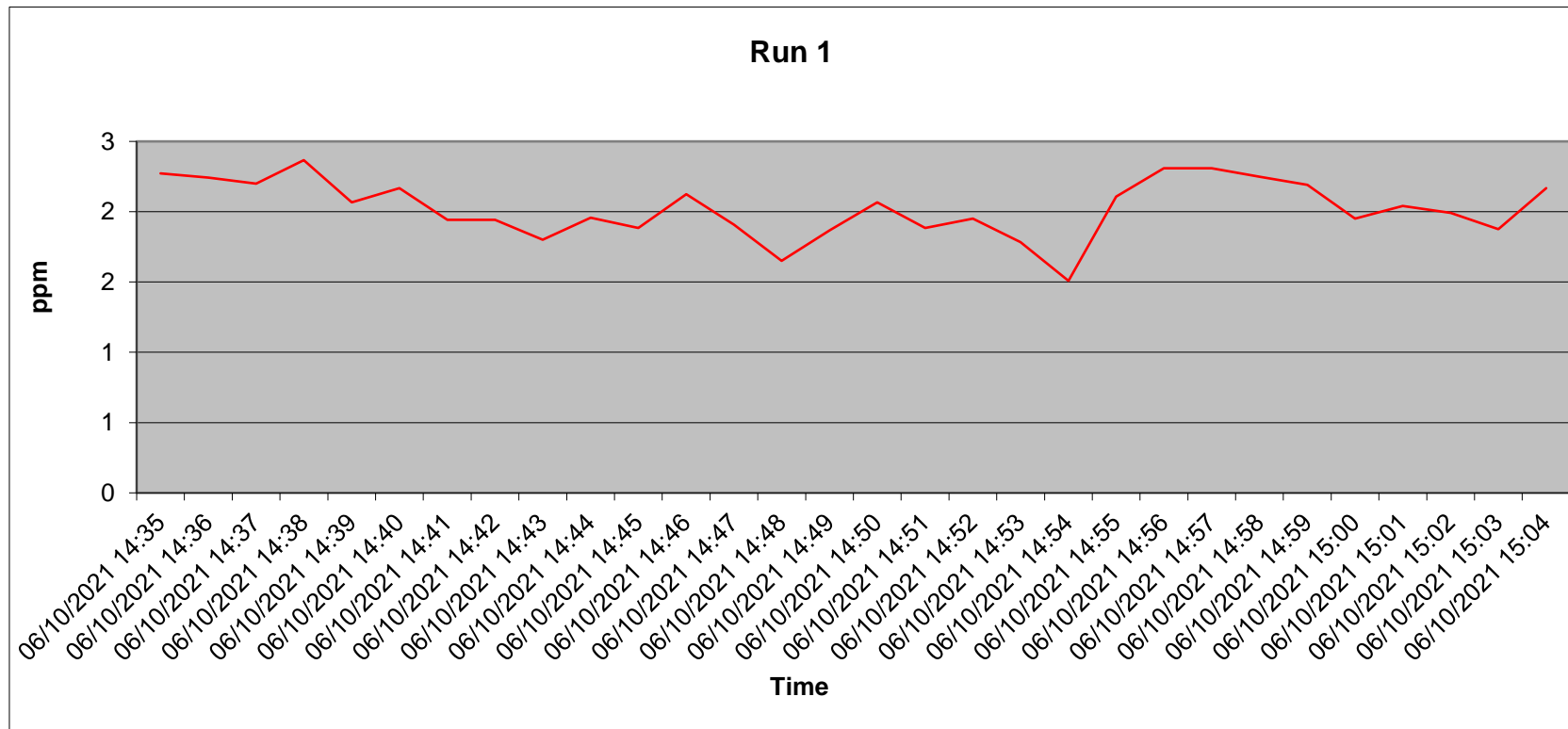
**Carbon Monoxide Results & Sampling Details**

| Parameter     | Units              | Run 1 | Run 2 | Run 3 | Mean |
|---------------|--------------------|-------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 2.56  | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 3.34  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -     | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | EN15058       |
| Technical Procedure              | SOP2004       |
| Probe material                   | SS            |
| Filtration Type/Size             | PTFE          |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM18ING514 |
| Span Gas Expiry Date             | 22-Dec        |
| Span Gas Start Pressure (bar)    | 50            |
| Gas Cylinder Concentration (ppm) | 157.5         |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | F2            |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 3             |



### Carbon Monoxide Trend



**Carbon Monoxide Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.36-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 200       | -     | -     |
| Measured Reading   | ppm                | 2.05      | -     | -     |
| <b>Measured Quantities</b>   |                    |           |       |       |
| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.9       | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.14      | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.12     | -     | -     |
| Cross-sensitivity  | %                  | 0.08      | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
| <b>Parameter</b>   |                    |           |       |       |
| Parameter  | Units              | Run 1     | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 0.95      | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 1.9       | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 3.34      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 6.68      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 3.34      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 130.53    | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Oxides of Nitrogen Quality Assurance

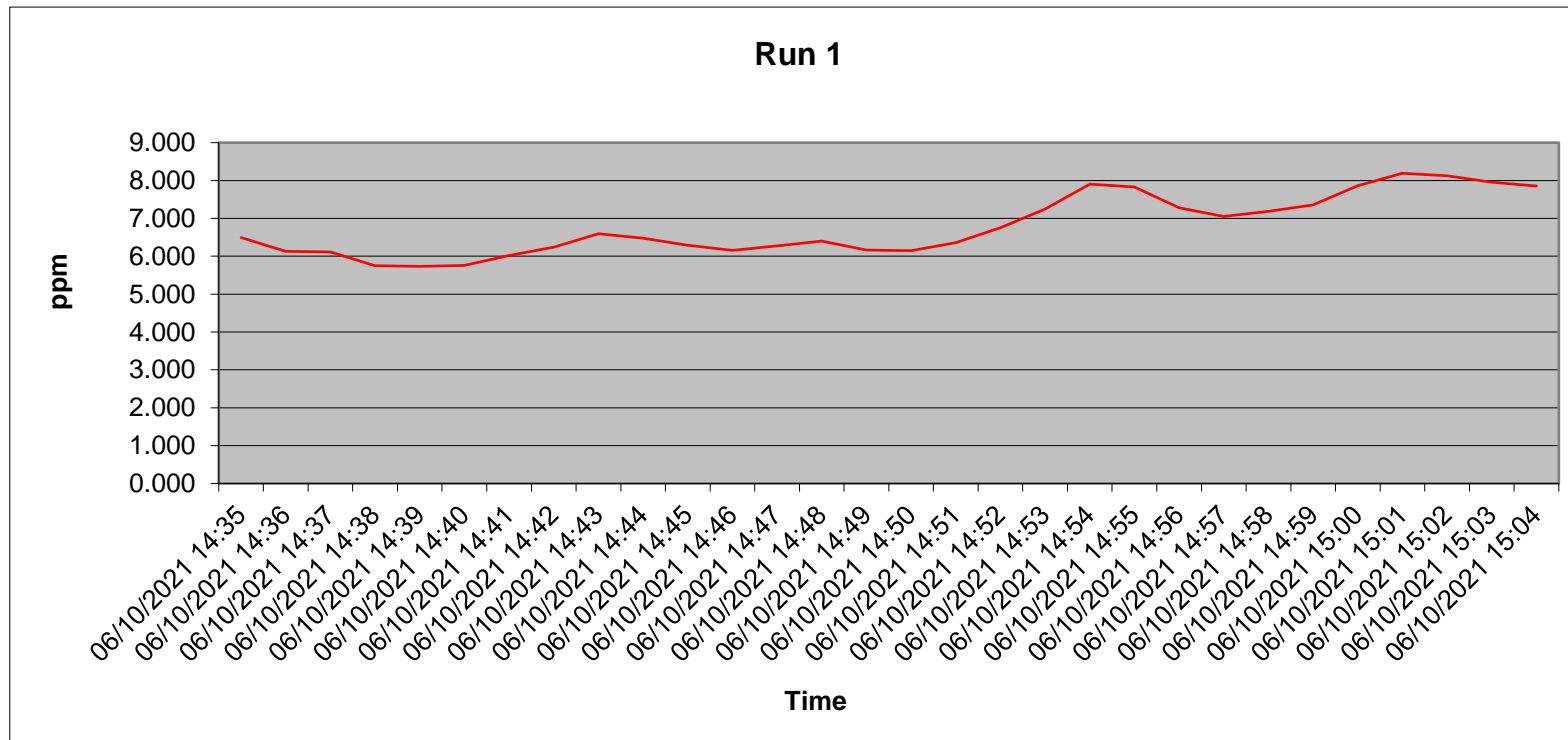
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F2                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 14:35        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 250          | -            | -            |
| Span Gas Value                 | ppm               | 159          | -            | -            |
| Acceptable Gas Range           | -                 | Yes          | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.2          | -            | -            |
| Zero Drift                     | ppm               | -0.1         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 7.95         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.06        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 159          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 159.4        | -            | -            |
| Span Drift                     | ppm               | -0.4         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 7.95         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.25        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 159          | -            | -            |
| Recorded Conc. down Line       | ppm               | 159.4        | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |

**Oxides of Nitrogen Results & Sampling Details**

| Parameter     | Units              | Run 1 | Run 2 | Run 3 | Mean |
|---------------|--------------------|-------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 14.82 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 2.81  | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -     | -     | -     | -    |

| General Sampling Information          |                 |
|---------------------------------------|-----------------|
| Parameter                             | Value           |
| Standard                              | EN14792         |
| Technical Procedure                   | SOP2002         |
| Probe material                        | SS              |
| Filtration Type/Size                  | PTFE            |
| Heated Head Filter Used               | Yes             |
| Heated Line Temperature               | 180             |
| Date & Result of last converter check | 95.5 08/01/2021 |
| Span Gas Reference Number             | ASLTM20ING512   |
| Span Gas Expiry Date                  | 21-Nov          |
| Span Gas Start Pressure (bar)         | 50              |
| Gas Cylinder Concentration (ppm)      | 159             |
| Span Gas Uncertainty (%)              | <2              |
| Zero Gas Type                         | N               |
| Number of Sampling Lines Used         | 1               |
| Number of Sampling Points Used        | 1               |
| Sample Point I.D's                    | F2              |
| Reference Conditions                  |                 |
| Temperature (K)                       | 273.15          |
| Pressure (kPa)                        | 101.3           |
| Gas (Wet or Dry)                      | Dry             |
| Oxygen                                | 3               |

### Oxides of Nitrogen Trend



Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Oxides of Nitrogen Measurement Uncertainty

| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
|--|--------------------|-----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.87-1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 250       | -     | -     |
| Measured Reading   | ppm                | 7.22      | -     | -     |
| <b>Measured Quantities</b>   |                    |           |       |       |
| Measured Quantities  | Units              | Run 1     | Run 2 | Run 3 |
| Nonlinearity   | %                  | 1.4       | -     | -     |
| Temperature Dependent Zero drift   | %                  | -0.04     | -     | -     |
| Temperature Dependent Span drift   | %                  | -0.25     | -     | -     |
| Cross-sensitivity  | %                  | 0.5       | -     | -     |
| Leak   | %                  | 0         | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2        | -     | -     |
| Mass Flow Controllers (Dilution) Uncertainty   | %                  | <1        | -     | -     |
| NOx Converter Efficiency   | %                  | 95.5      | -     | -     |
| <b>Parameter</b>   |                    |           |       |       |
| Parameter  | Units              | Run 1     | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 0.63      | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 1.25      | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 2.81      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | 1.87      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 2.81      | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 18.93     | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |           |       |       |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

**Total Volatile Organic Carbon Quality Assurance**

| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | F2                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 14:39        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 100          | -            | -            |
| Span Gas Value                 | ppm               | 80.2         | -            | -            |
| Acceptable Gas Range           | -                 | Yes          | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 194          | -            | -            |
| Average Temperature            | < °C              | 194          | -            | -            |
| Allowable Temperature          | -                 | Yes          | -            | -            |
| Temperature Acceptable         | -                 | 180          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 0.3          | -            | -            |
| Zero Drift                     | ppm               | -0.2         | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 4.01         | -            | -            |
| Zero Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y (<2%)      | -            | -            |
| Zero Drift                     | %                 | -0.25        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 80.2         | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 80.5         | -            | -            |
| Span Drift                     | ppm               | -0.3         | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 4.01         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y (<2%)      | -            | -            |
| Span Drift (%)                 | %                 | -0.37        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 80.2         | -            | -            |
| Recorded Conc. down Line       | ppm               | 80.5         | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y (<2%)      | -            | -            |

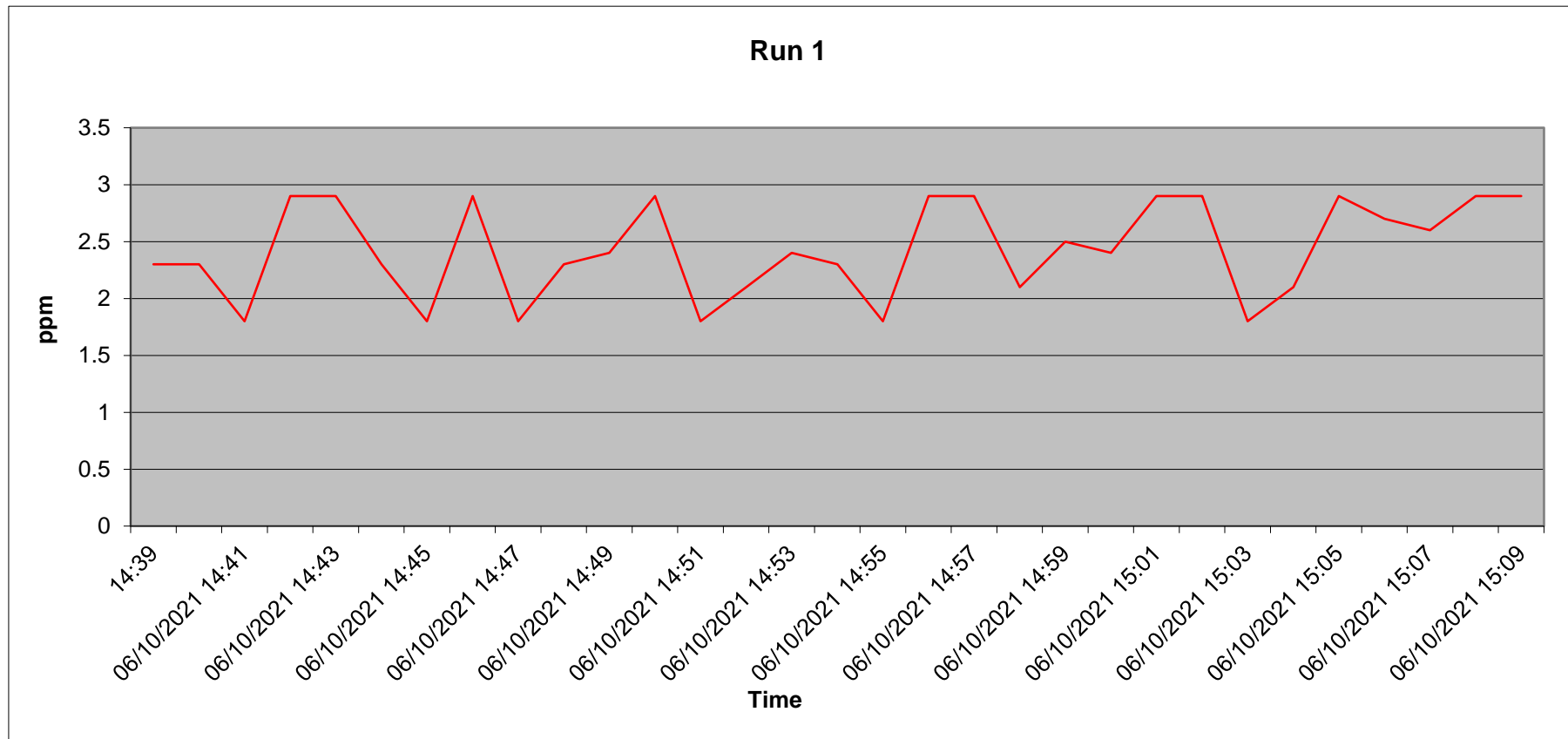
**Total Volatile Organic Carbon Results and Sampling Details**

| Parameter     | Units              | Run 1 | Run 2 | Run 3 | Mean |
|---------------|--------------------|-------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 4.25  | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 0.6   | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -     | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | EN12619       |
| Technical Procedure              | SOP2009       |
| Probe material                   | SS            |
| Filtration Type/Size             | PTFE          |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM20ING516 |
| Span Gas Expiry Date             | 01/06/2025    |
| Span Gas Start Pressure (bar)    | 60            |
| Gas Cylinder Concentration (ppm) | 80.2          |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | ZA            |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | F2            |
| Reference Conditions             | -             |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 3             |



### Total Volatile Organic Carbon Trend



**Total Volatile Organic Carbon Measurement Uncertainty**

| Measured Quantities  | Units              | Run 1    | Run 2 | Run 3 |
|--|--------------------|----------|-------|-------|
| Certified Range of Analyser  | ppm                | 0.6-1680 | -     | -     |
| Operational Range of Analyser  | ppm                | 100      | -     | -     |
| Measured Reading   | ppm                | 2.44     | -     | -     |
|  |                    |          |       |       |
| Measured Quantities  | Units              | Run 1    | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.068    | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.3      | -     | -     |
| Temperature Dependent Span drift   | %                  | 0.3      | -     | -     |
| Cross-sensitivity  | %                  | -        | -     | -     |
| Leak   | %                  | <2       | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2       | -     | -     |
|  |                    |          |       |       |
| Parameter  | Units              | Run 1    | Run 2 | Run 3 |
| Measurement uncertainty  | mg.m <sup>-3</sup> | 0.3      | -     | -     |
| Combined uncertainty   | mg.m <sup>-3</sup> | 0.6      | -     | -     |
|  |                    |          |       |       |
| <b>Expanded Uncertainty as % of Limit Value</b>  | %                  | 6.01     | -     | -     |
|  |                    |          |       |       |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 14.12    | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 0.6      | -     | -     |
|  |                    |          |       |       |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |          |       |       |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Hydrogen Chloride Sampling Details & Results

|                               |              |                 |
|-------------------------------|--------------|-----------------|
| <b>Stack ID</b>               | F2           | <b>Run 1</b>    |
| <b>Sample ID</b>              | F2 HCL 1+2   | <b>mls</b>      |
| <b>Impinger 1 ID</b>          | F2 HCL 1+2   | 220             |
| <b>Impinger 2 ID</b>          | -            | 0               |
| <b>Impinger 3 ID</b>          | F2 HCL 3     | 130             |
| <b>Time on</b>                | -            |                 |
| <b>Time off</b>               | -            |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 2.16         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ505 |                 |
| Calibration Rate Before Test: | 2.14         | l/min           |
| Calibration Rate After Test:  | 2.14         | l/min           |
| Average sample Volume:        | 2.14         | l/min           |
| Sample Test Time:             | 31           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.06634      | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.06634      | Nm <sup>3</sup> |

## Hydrogen Chloride Quality Assurance

| Stack ID                     | F2                 | Run 1    | Run 2 | Run 3 |
|------------------------------|--------------------|----------|-------|-------|
| Date                         | 06/10/2021         | -        | -     | -     |
| Start time                   |                    | 00:00:00 | -     | -     |
| Finish Time                  |                    | 00:00:00 | -     | -     |
| <b>Leak test results</b>     |                    |          |       |       |
|                              | Units              | Run 1    | Run 2 | Run 3 |
| Mean Sampling Rate           | l/min              | 2.16     | -     | -     |
| Pre-sampling leak rate       | l/min              | 0.01     | -     | -     |
| Post-sampling leak rate      | l/min              | 0.01     | -     | -     |
| Leak rate                    | l/min              | 0        | -     | -     |
| Acceptable leak rate (<2%)   | Y/N                | Yes      | -     | -     |
| <b>Filtration</b>            |                    |          |       |       |
| Filter Material              |                    | N/A      | -     | -     |
| Filter Size                  | mm                 | N/A      | -     | -     |
| Max. Filter Temp             | degrees            | N/A      | -     | -     |
| Absorbers Type               | Glass/PTFE/ Other  | PTFE     | -     | -     |
| Absorption Solution          |                    | Di H2O   | -     | -     |
| <b>Absorption Efficiency</b> |                    |          |       |       |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 17.5     | -     | -     |
| Impinger 3                   | µg                 | 6.5      | -     | -     |
| Absorption efficiency        | %                  | 63       | -     | -     |
| Acceptable Absorption Eff.   | >95% (Y/N)         | N        | -     | -     |
| <b>Blank sample</b>          |                    |          |       |       |
| Blank sample ID              |                    | HCL B    | -     | -     |
| Blank result                 | mg.m <sup>-3</sup> | <0.09    | -     | -     |
| Acceptable Blank             | <10% ELV (Y/N)     | Y        | -     | -     |
| <b>Testing laboratory</b>    |                    |          |       |       |
| Laboratory Name              |                    | UKAS0605 | -     | -     |
| Test certificate Number      |                    | 21-12428 | -     | -     |

**Hydrogen Chloride Results & Measurement Uncertainty**

| Stack ID                | F2    | Run 1              |
|-------------------------|-------|--------------------|
| Date                    | -     |                    |
| Start time              | 00:00 |                    |
| Finish Time             | 00:00 |                    |
| <b>Results</b>          |       |                    |
| Laboratory Result       | 17.5  | µg                 |
| Impinger final Volume   | 350   | ml                 |
| Factor                  | -     |                    |
| Concentration           | 0.02  | mg                 |
| Sample Volume           | 0.066 | Nm <sup>3</sup>    |
| Emissions Concentration | 0.26  | mg.m <sup>-3</sup> |
| Mass Emissions          | -     | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0.01  | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 8.01  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.02  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.04  | -     | -     | -    |

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Hydrogen Fluoride Sampling Details & Results

| Sampling Details              |              | Run 1           |
|-------------------------------|--------------|-----------------|
| Stack ID                      | F2           |                 |
| Time on                       | -            |                 |
| Time off                      | -            |                 |
| <b>Leak Check Results</b>     |              |                 |
| Prior to test:                | 0.01         | l/min           |
| Post Test:                    | 0.01         | l/min           |
| Sample Volume Flow Rate:      | 2.15         | l/min           |
| Standard Requirement:         | <2           | %               |
| Test Result:                  | 0            | %               |
| Test Status                   | Pass         |                 |
| <b>Calibration Details</b>    |              |                 |
| Pump Number:                  | -            |                 |
| Calibration Unit:             | ASLTM15EQ505 |                 |
| Calibration Rate Before Test: | 2.15         | l/min           |
| Calibration Rate After Test:  | 2.15         | l/min           |
| Average sample Volume:        | 2.15         | l/min           |
| Sample Test Time:             | 32           | min             |
| Pump Gas Temperature:         | 0            | °C              |
| Pump Sample Pressure:         | 101.3        | kPa             |
| Actual Sample Volume:         | 0.0688       | m <sup>3</sup>  |
| Normalised Gas Volume:        | 0.0688       | Nm <sup>3</sup> |

## Hydrogen Fluoride Quality Assurance

| Stack ID                     | F2                 | Run 1      | Run 2 | Run 3 |
|------------------------------|--------------------|------------|-------|-------|
| Date                         | 06/10/2021         | -          | -     | -     |
| Start time                   |                    | 00:00:00   | -     | -     |
| Finish Time                  |                    | 00:00:00   | -     | -     |
| <b>Leak test results</b>     |                    |            |       |       |
|                              | Units              | Run 1      | Run 2 | Run 3 |
| Mean Sampling Rate           | l/min              | 2.15       | -     | -     |
| Pre-sampling leak rate       | l/min              | 0.01       | -     | -     |
| Post-sampling leak rate      | l/min              | 0.01       | -     | -     |
| Leak rate                    | l/min              | 0          | -     | -     |
| Acceptable leak rate (<2%)   | Y/N                | Yes        | -     | -     |
| <b>Filtration</b>            |                    |            |       |       |
| Filter Material              |                    | N/A        | -     | -     |
| Filter Size                  | mm                 | N/A        | -     | -     |
| Max. Filter Temp             | degrees            | N/A        | -     | -     |
| Absorbers Type               | Glass/PTFE/ Other  | Glass      | -     | -     |
| Absorption Solution          |                    | 0.1m NaOH  | -     | -     |
| <b>Absorption Efficiency</b> |                    |            |       |       |
| Total Imp1 + Imp 2 + Imp 3   | µg                 | 6.6        | -     | -     |
| Impinger 3                   | µg                 | 2.2        | -     | -     |
| Absorption efficiency        | %                  | 67         | -     | -     |
| Acceptable Absorption Eff.   | >95% (Y/N)         | N          | -     | -     |
| <b>Blank sample</b>          |                    |            |       |       |
| Blank sample ID              |                    | HF B       | -     | -     |
| Blank result                 | mg.m <sup>-3</sup> | <0.        | -     | -     |
| Acceptable Blank             | <10% ELV (Y/N)     | Y          | -     | -     |
| <b>Testing laboratory</b>    |                    |            |       |       |
| Laboratory Name              |                    | UKAS0605   | -     | -     |
| Test certificate Number      |                    | WK21-00753 | -     | -     |

**Hydrogen Fluoride Results & Measurement Uncertainty**

| Stack ID                | F2       | Run 1              |
|-------------------------|----------|--------------------|
| Date                    | -        |                    |
| Start time              | 00:00:00 |                    |
| Finish Time             | 00:00:00 |                    |
| <b>Results</b>          |          |                    |
| Laboratory Result       | 6.6      | µg                 |
| Impinger final Volume   | 330      | ml                 |
| Factor                  | -        |                    |
| Concentration           | 0.01     | mg                 |
| Sample Volume           | 0.07     | Nm <sup>3</sup>    |
| Emissions Concentration | 0.1      | mg.m <sup>-3</sup> |
| Mass Emissions          | -        | kg.h <sup>-1</sup> |

| Parameter  | Units               | Run 1 | Run 2 | Run 3 | Mean |
|--|---------------------|-------|-------|-------|------|
| Combined Uncertainty                                 | mg.m <sup>-3</sup>  | 0     | -     | -     | -    |
| Expanded uncertainty as percentage of measured value | % of measured value | 7.97  | -     | -     | -    |
| Expanded uncertainty in units of measurement         | mg.m <sup>-3</sup>  | 0.01  | -     | -     | -    |
| Expanded uncertainty as percentage of limit value    | % Of ELV            | 0.15  | -     | -     | -    |



## Sulphur Dioxide Quality Assurance

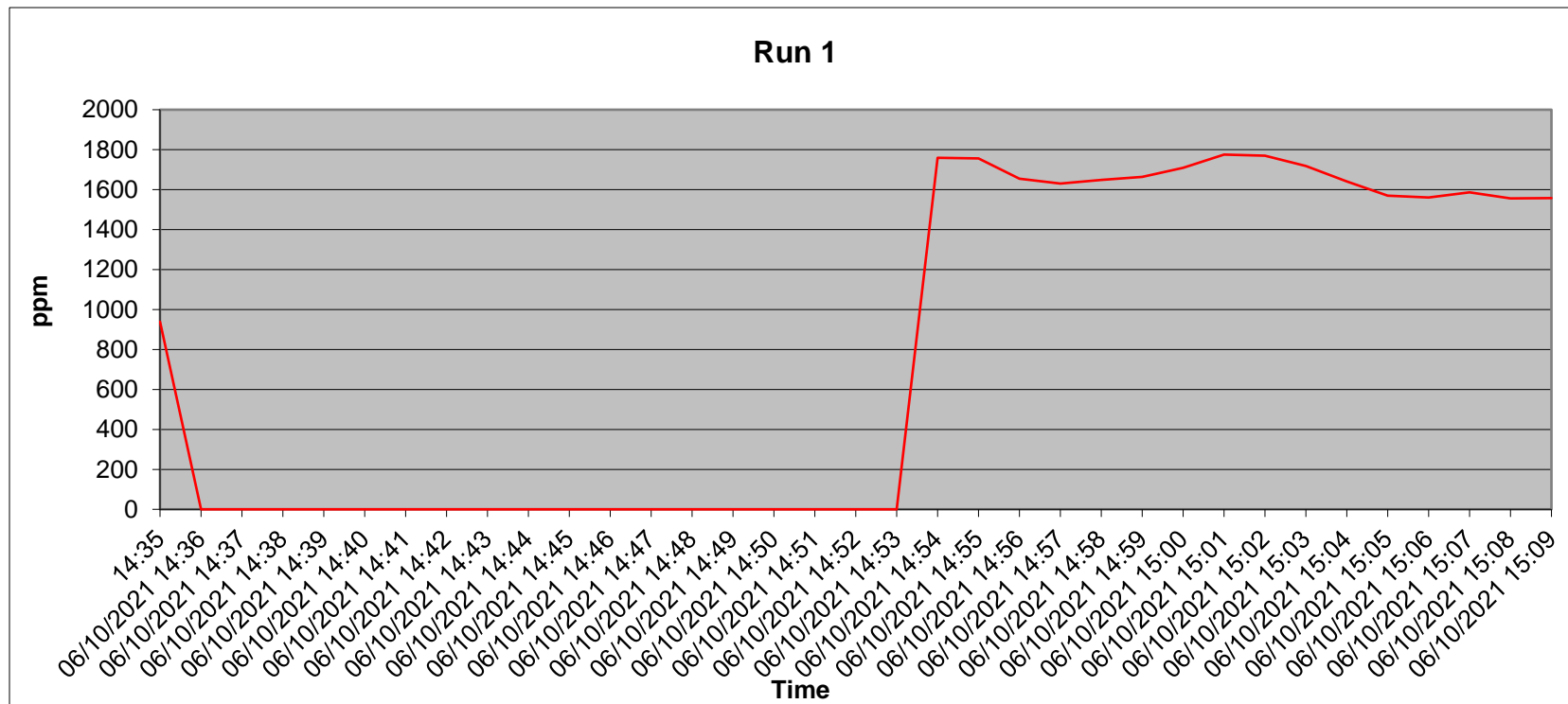
| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F2                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 14:35        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 1000         | -            | -            |
| Span Gas Value                 | ppm               | 715          | -            | -            |
| Acceptable Gas Range           | -                 | -            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | ppm               | 1            | -            | -            |
| Zero Down Sampling Line (Post) | ppm               | 4            | -            | -            |
| Zero Drift                     | ppm               | -3           | -            | -            |
| Allowable Zero Drift (5%)      | ppm               | 35.75        | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Zero Drift                     | %                 | -0.42        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | ppm               | 715          | -            | -            |
| Span Down Sampling Line (Post) | ppm               | 716          | -            | -            |
| Span Drift                     | ppm               | -1           | -            | -            |
| Allowable Span Drift (5%)      | ppm               | 35.75        | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| Span Drift                     | %                 | -0.14        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 715          | -            | -            |
| Recorded Conc. down Line       | ppm               | 716          | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |

**Sulphur Dioxide Results & Sampling Details**

| Parameter     | Units              | Run 1   | Run 2 | Run 3 | Mean |
|---------------|--------------------|---------|-------|-------|------|
| Concentration | mg.m <sup>-3</sup> | 2493.23 | -     | -     | -    |
| Uncertainty   | mg.m <sup>-3</sup> | 333     | -     | -     | -    |
| Mass Emission | kg.h <sup>-1</sup> | -       | -     | -     | -    |

| General Sampling Information          |               |
|---------------------------------------|---------------|
| Parameter                             | Value         |
| Standard                              | CEN/TS 17021  |
| Technical Procedure                   | SOP 2046      |
| Probe material                        | SS            |
| Filtration Type/Size                  | PTFE          |
| Heated Head Filter Used               | Yes           |
| Heated Line Temperature               | 180           |
| Date & Result of last converter check | -             |
| Span Gas Reference Number             | ASLTM19ING507 |
| Span Gas Expiry Date                  | Nov-21        |
| Span Gas Start Pressure (bar)         | 40            |
| Gas Cylinder Concentration (ppm)      | 715           |
| Span Gas Uncertainty (%)              | <2            |
| Zero Gas Type                         | N             |
| Number of Sampling Lines Used         | 1             |
| Number of Sampling Points Used        | 1             |
| Sample Point I.D's                    | F2            |
| Reference Conditions                  |               |
| Temperature (K)                       | 273.15        |
| Pressure (kPa)                        | 101.3         |
| Gas (Wet or Dry)                      | Dry           |
| Oxygen                                | 3             |

### Sulphur Dioxide Trend



Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

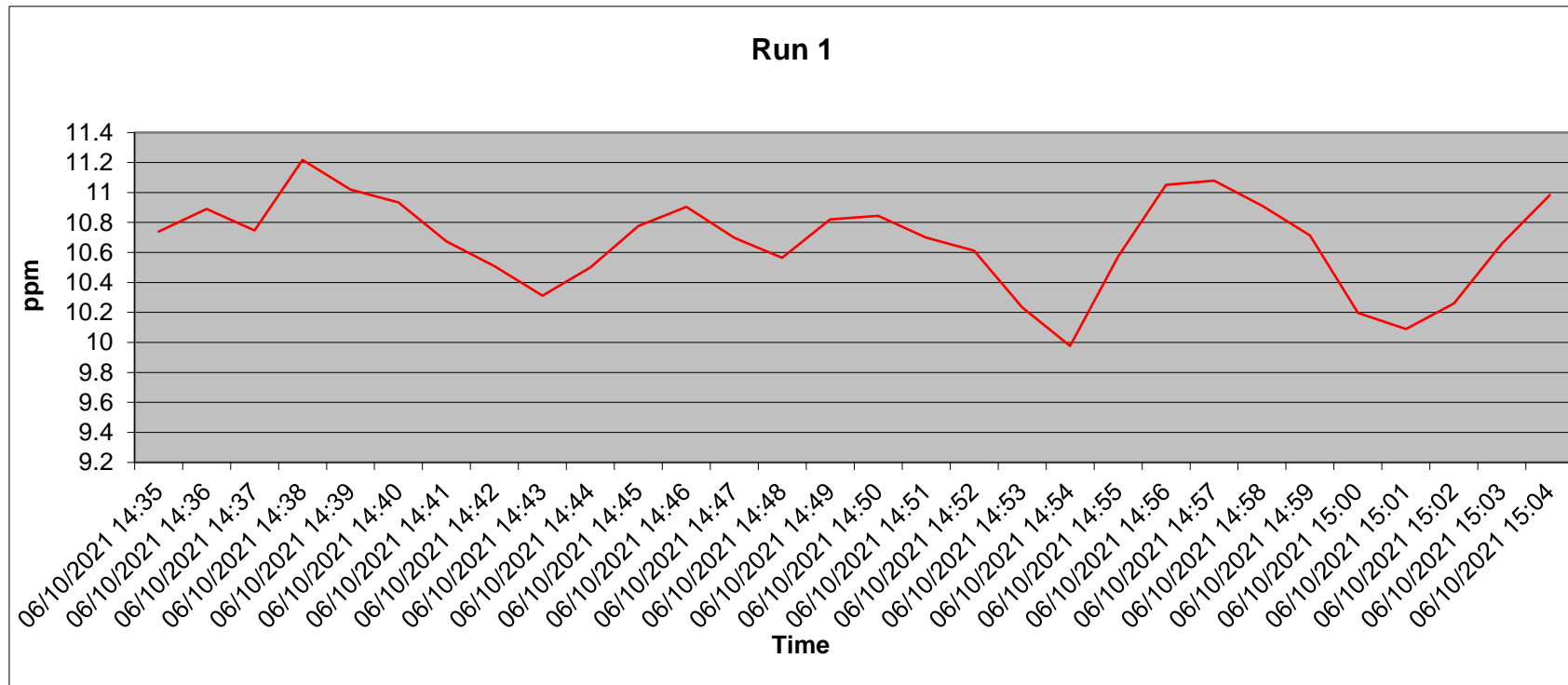
### Sulphur Dioxide Measurement Uncertainty

| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
|--|--------------------|--------------|-------|-------|
| Certified Range of Analyser  | ppm                | 2.14 to 1000 | -     | -     |
| Operational Range of Analyser  | ppm                | 1000         | -     | -     |
| Measured Reading   | ppm                | 871.76       | -     | -     |
| <b>Measured Quantities</b>   |                    |              |       |       |
| Measured Quantities  | Units              | Run 1        | Run 2 | Run 3 |
| Nonlinearity   | %                  | 0.8          | -     | -     |
| Temperature Dependent Zero drift   | %                  | 0.8          | -     | -     |
| Temperature Dependent Span drift   | %                  | 2            | -     | -     |
| Cross-sensitivity  | %                  | 1.5          | -     | -     |
| Leak   | %                  | 0            | -     | -     |
| Calibration Gas Uncertainty  | %                  | <2 %         | -     | -     |
| <b>Parameter</b>   |                    |              |       |       |
| Parameter  | Units              | Run 1        | Run 2 | Run 3 |
| Combined uncertainty   | mg.m <sup>-3</sup> | 42.04        | -     | -     |
| Expanded uncertainty   | mg.m <sup>-3</sup> | 84.08        | -     | -     |
| <b>Uncertainty corrected to std conds.</b>   | mg.m <sup>-3</sup> | 333          | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of ELV           | -            | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | mg.m <sup>-3</sup> | 333          | -     | -     |
| <b>Expanded uncertainty expressed with a level of confidence of 95%</b>                        | % of value         | 13.36        | -     | -     |
| <b>Requirement in standard is for uncertainty to be &lt; 10% at ELV at standard conditions</b> |                    |              |       |       |

**Oxygen Quality Assurance**

| <b>Sampling Details</b>        |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| <b>Stack ID</b>                | F2                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 14:35        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 25           | -            | -            |
| Span Gas Value                 | ppm               | 20.9         | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0            | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0.1          | -            | -            |
| Zero Drift                     | %                 | -0.1         | -            | -            |
| Allowable Zero Drift (5%)      | %                 | 1.05         | -            | -            |
| Zero Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 20.9         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 20.9         | -            | -            |
| Span Drift                     | %                 | 0            | -            | -            |
| Allowable Span Drift (5%)      | %                 | 1.05         | -            | -            |
| Span Drift Acceptable (Y/N)    | Y <2%/Y 2-5%/N>5% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | %                 | 20.9         | -            | -            |
| Recorded Conc. down Line       | %                 | 20.9         | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |
| Combined uncertainty           | % vol             | 0.17         | -            | -            |
| % of value                     | %                 | 1.59         | -            | -            |
| Expanded uncertainty           | % of value        | 3.18         | -            | -            |
| Expanded uncertainty           | % vol             | 0.34         | -            | -            |

### Oxygen trend



**Carbon Dioxide Quality Assurance**

| Sampling Details               |                   |              |              |              |
|--------------------------------|-------------------|--------------|--------------|--------------|
| Stack ID                       | F2                |              |              |              |
| <b>Parameter</b>               | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Sampling Times                 | -                 | 14:35        | -            | -            |
| Sampling Dates                 | -                 | 06/10/2021   | -            | -            |
| Instrument Range               | ppm               | 20           | -            | -            |
| Span Gas Value                 | ppm               | 15.5         | -            | -            |
| Acceptable Gas Range           | -                 | Y            | -            | -            |
| <b>Quality Assurance</b>       | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Conditioning Unit Temperature  | °C                | 2            | -            | -            |
| Average Temperature            | < °C              | 2            | -            | -            |
| Allowable Temperature          | -                 | 4            | -            | -            |
| Temperature Acceptable         | -                 | Y            | -            | -            |
| Pump flow rate                 | l/min             | 0.5          | -            | -            |
| <b>Zero Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Zero Down Sampling Line (Pre)  | %                 | 0.1          | -            | -            |
| Zero Down Sampling Line (Post) | %                 | 0            | -            | -            |
| Zero Drift                     | %                 | 0.1          | -            | -            |
| Allowable Zero Drift (4%)      | %                 | 0.62         | -            | -            |
| Zero Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Span Drift</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Down Sampling Line (Pre)  | %                 | 15.5         | -            | -            |
| Span Down Sampling Line (Post) | %                 | 15.4         | -            | -            |
| Span Drift                     | %                 | 0.1          | -            | -            |
| Allowable Span Drift (4%)      | %                 | 0.62         | -            | -            |
| Span Drift Acceptable          | Y <2%/Y 2-4%/N>4% | Y <2%        | -            | -            |
| <b>Leak Check</b>              | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Span Gas Conc.                 | ppm               | 15.5         | -            | -            |
| Recorded Conc. down Line       | ppm               | 15.4         | -            | -            |
| Leak check acceptable (< 2%)   | (Y/N)             | Y <2%        | -            | -            |
| <b>Test Conditions</b>         | <b>Units</b>      | <b>Run 1</b> | <b>Run 2</b> | <b>Run 3</b> |
| Run Ambient Temperature Range  | °C                | 12           | -            | -            |
| Combined uncertainty           | % vol             | 0.16         | -            | -            |
| % of value                     | %                 | 1.67         | -            | -            |
| Expanded uncertainty           | % of value        | 3.34         | -            | -            |
| Expanded uncertainty           | % vol             | 0.32         | -            | -            |

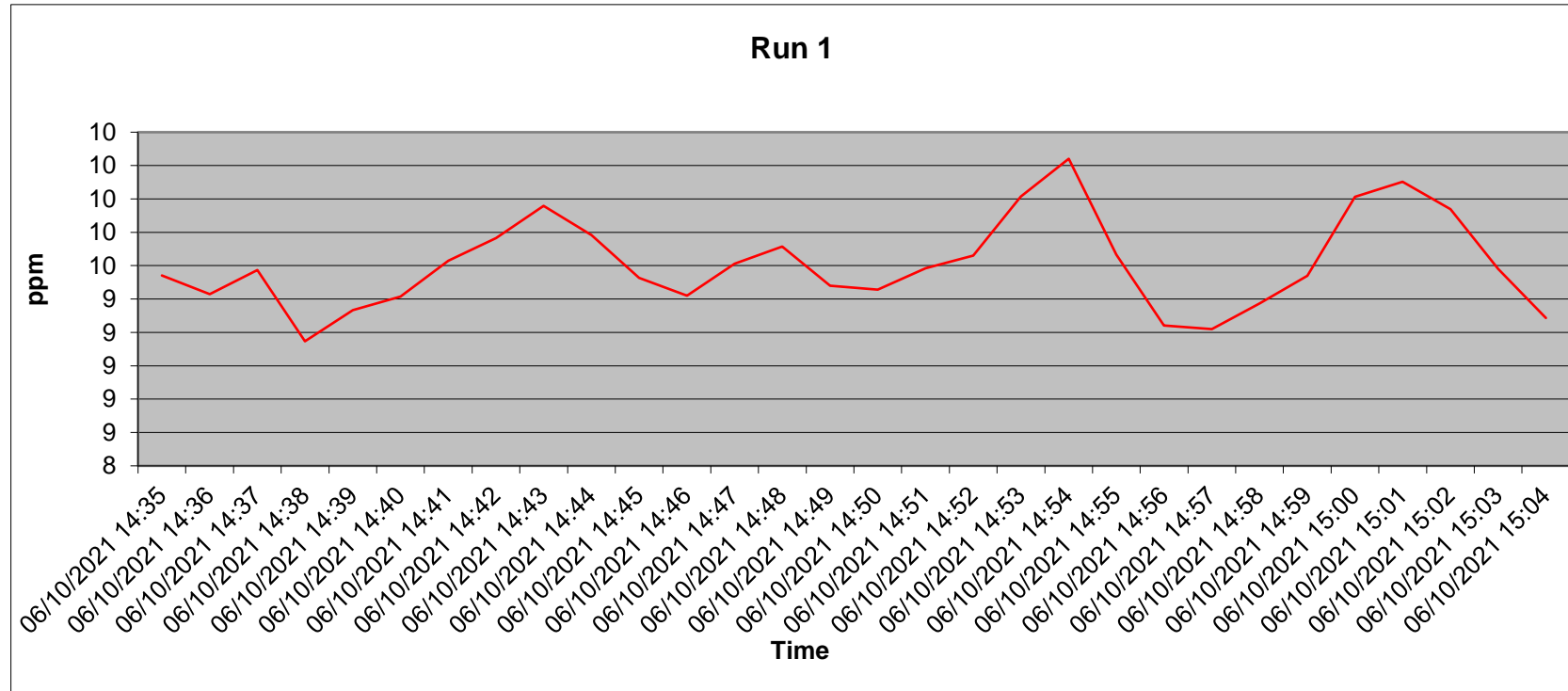


**Carbon Dioxide Results & Sampling Details**

| Parameter     | Units | Run 1 | Run 2 | Run 3 | Mean |
|---------------|-------|-------|-------|-------|------|
| Concentration | %     | 9.61  | -     | -     | -    |
| Uncertainty   | %     | 0.32  | -     | -     | -    |

| General Sampling Information     |               |
|----------------------------------|---------------|
| Parameter                        | Value         |
| Standard                         | ISO12039      |
| Technical Procedure              | SOP 2045      |
| Probe material                   | SS            |
| Filtration Type/Size             | Ceramic       |
| Heated Head Filter Used          | Yes           |
| Heated Line Temperature          | 180           |
| Span Gas Reference Number        | ASLTM19ING535 |
| Span Gas Expiry Date             | 24-Jun        |
| Span Gas Start Pressure (bar)    | 40            |
| Gas Cylinder Concentration (ppm) | 15.5          |
| Span Gas Uncertainty (%)         | <2            |
| Zero Gas Type                    | N             |
| Number of Sampling Lines Used    | 1             |
| Number of Sampling Points Used   | 1             |
| Sample Point I.D's               | F2            |
| Reference Conditions             |               |
| Temperature (K)                  | 273.15        |
| Pressure (kPa)                   | 101.3         |
| Gas (Wet or Dry)                 | Dry           |
| Oxygen                           | 3             |

### Carbon Dioxide Trend



Document No.: KNLATL1061021 / 20211664

Visit No: 1

Year: 2021

Office: Trim

EPA Licence No.: WL0146-02

Licence Holder: Knockharley Landfill, F2

Facility Location: Knockharley Facility

Rev.No: 1

Document No.: KNLATL1061021 / 20211664  
 Visit No: 1  
 Year: 2021  
 Office: Trim

EPA Licence No.: WL0146-02  
 Licence Holder: Knockharley Landfill, F2  
 Facility Location: Knockharley Facility  
 Rev.No: 1

### Moisture Results & Sampling Details

|  |                                  |                 |                            |       |       |
|--|----------------------------------|-----------------|----------------------------|-------|-------|
| <b>Title:</b>  | <b>Determination of Moisture</b> |                 |                            |       |       |
| <b>Method:</b>                                       | EN 14790                         |                 |                            |       |       |
| <b>Stack Name</b>                                    | F2                               | <b>Time off</b> | <b>Temperature at Pump</b> | 0     | Deg C |
| <b>Test Time</b>                                     | -                                |                 | <b>Pressure at Pump</b>    | 101.3 | kPa   |
| <b>Dry Gas Meter Reading Before</b>                  | -                                | m <sup>3</sup>  | <b>Humidity at Pumps</b>   | 0.1   | %     |
| <b>Dry Gas Meter Reading After</b>                   | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Volume of Air Sampled</b>                         | -                                | m <sup>3</sup>  |                            |       |       |
| <b>Normalised Air Volume Sampled</b>                 | 0.06                             | Nm <sup>3</sup> |                            |       |       |
| <b>Leak Rate</b>                                     | 0.001                            |                 |                            |       |       |
| <b>Balance Calibration</b>                           |                                  |                 |                            |       |       |
|  | <b>Weight</b>                    |                 |                            |       |       |
| 200.0  | 200                              | g               |                            |       |       |
| 1000.0   | 1000                             | g               |                            |       |       |
| <b>Inpinger Weights</b>                              |                                  |                 |                            |       |       |
|  | <b>Initial</b>                   | <b>Final</b>    | <b>Difference</b>          |       |       |
| 1  | 490                              | 492             | 2                          |       |       |
| 2  | 440                              | 441.4           | 1.4                        |       |       |
| 3  | 455.2                            | 455.9           | 0.7                        |       |       |
| 4  | 645                              | 645.1           | 0.1                        |       |       |
| <b>Volume of Air Sampled</b>                         | 0.06                             | Nm <sup>3</sup> | <b>4.2</b>                 |       |       |
| <b>Moisture Content (EN 14790)</b>                   | 8                                | %               |                            |       |       |
| <b>Uncertainty</b>                                   |                                  |                 |                            |       |       |
| Combined uncertainty                                 |                                  | 0.2             | %                          |       |       |
| Expanded uncertainty as percentage of measured value |                                  | 4.99            | % measured value           |       |       |
| Expanded uncertainty in units of measurement         |                                  | 0.4             | %                          |       |       |
| Expanded uncertainty as percentage of limit value    |                                  | -               | % ELV                      |       |       |

**Uncert Sheets**

**CO Uncert**

**Uncertainty calculation for Gaseous Measurement CO**

|                        |                              |                |
|------------------------|------------------------------|----------------|
| Limit value            | 50 mg/m3 (corre Cal gas conc | 196.875 mg.m-3 |
| Measured concentration | 2.56 mg/m3 Full Scale        | 200 mg/m3      |
| Measured concentration | 2.56 mg/m3 (Corrected)       |                |

| Correction for reference conditions |          |       |           |               |                |
|-------------------------------------|----------|-------|-----------|---------------|----------------|
|                                     |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 3.00  | 0.00      | 101.30        | 273.00         |
|                                     | measured | 10.66 | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35  | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.74  | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.06  | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | 1.75  | uf        | 0.06          |                |

| Performance characteristics           | Value  |                       | specification      |
|---------------------------------------|--------|-----------------------|--------------------|
| Response time                         | 180    | seconds               | 180.000            |
| Logger sampling interval              | 60     | seconds               |                    |
| Measurement period                    | 39     | minutes               |                    |
| Number of readings in measurement     | 39     |                       |                    |
| Repeatability at zero                 | 0.25   | % full scale          | <1 % range         |
| Repeatability at span level           | 0.15   | % full scale          | <2 % range         |
| Deviation from linearity(lack of fit) | 0.7    | % of value            | <2 % range         |
| Zero drift                            | -0.25  | mg/m3                 | <2% range / 24hr   |
| Span drift                            | -0.625 | mg/m3                 | <2% range/24hr     |
| volume or pressure flow dependence    | 0.02   | % of full scale/3 kPa | <2 % / 3 kPa       |
| atmospheric pressure dependence       | 0.8    | % of full scale/2 kPa | <3% / 2 kPa        |
| ambient temperature dependence        | 0.01   | % full scale/10K      | <3% range / 10 K   |
| N2O (mg/m3)                           | 20     | 0.2 mg/m3             |                    |
| CO2 (% vol)                           | 15     | 0.2 mg/m3             |                    |
| CH4 (mg/m3)                           | 40     | 0.7 mg/m3             |                    |
| H2O (% vol)                           | 20     | 0.2 mg/m3             |                    |
| dependence on voltage                 | 0.1    | % full scale/10V      | <2% range          |
| losses in the line (leak)             | 0.00   | % of value            | < 0.1%vol /10 volt |
| Uncertainty of calibration gas        | 2      | % of value            | < 2% of value      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | min    | max    | value at calib |
|-----------|--------|--------|----------------|
| flow      | 95.00  | 105    | 100 kPa        |
| pressure  | 100.76 | 100.92 | 100.88 kPa     |
| temp      | 287    | 288.5  | 287.5 K        |
| N2O range | 0      | 40     | 0 mg/m3        |
| CO2 range | 0      | 15     | 0 %vol         |
| CH4 range | 0      | 57     | 0 mg/m3        |
| H2O range | 0      | 1      | 0 %vol         |
| Voltage   | 93     | 121    | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.05            |
| Lack of fit                                       | ufit        |                               | 0.01            |
| Drift   | u0dr        |                               | 0.00            |
| volume or pressure flow dependence                | uspres      |                               | 0.04            |

**Uncert Sheets**

|                                 |  |  |         |  |  |  |      |  |               |
|---------------------------------|--|--|---------|--|--|--|------|--|---------------|
| atmospheric pressure dependence |  |  | uapres  |  |  |  | 0.05 |  |               |
| ambient temperature dependence  |  |  | utemp   |  |  |  | 0.00 |  |               |
| N2O (mg/m3)                     |  |  | uinterf |  |  |  | 0.23 | <b>Use largest of sum of all positive or all negative influences</b> |               |
| CO2 (% vol)                     |  |  | uinterf |  |  |  | 0.12 |  | 0.93 all +ves |
| CH4 (mg/m3)                     |  |  | uinterf |  |  |  | 0.58 |  | 0 all -ves    |
| H2O (% vol)                     |  |  | uinterf |  |  |  | 0.01 |  | 0.93 largest  |
| Dependence on voltage           |  |  | uvolt   |  |  |  | 0.17 | <b>Value to use for intereference uncertainty</b>                    |               |
| losses in the line (leak)       |  |  | uleak   |  |  |  | 0.00 |  | uint 0.93     |
| Uncertainty of calibration gas  |  |  | ucalib  |  |  |  | 0.03 |  |               |
| Uncertainty in factor           |  |  | uf      |  |  |  | 0.15 |  |               |

|   |                           |   |                |
|---|---------------------------|---|----------------|
| <b>Measurement uncertainty</b>                        |                           |   |                |
| Combined uncertainty                                  |                           |   | 0.95 mg/m3     |
| Expanded uncertainty                                  | k =                       | 2 | 1.90 mg/m3     |
| <b>Uncertainty corrected to std conds</b>             |                           |   |                |
|   |                           |   | 3.34 mg/m3     |
| Expanded uncertainty                                  | expressed with a level of |   | 6.68 % ELV     |
| Expanded uncertainty                                  | expressed with a level of |   | 3.34 mg.m-3    |
| <b>Expanded uncertainty expressed with a level of</b> |                           |   |                |
|   |                           |   | 130.53 % value |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

**NOx Uncert**

**Uncertainty calculation for Gaseous Measurement NOx EN14792**

|                        |       |                           |                      |
|------------------------|-------|---------------------------|----------------------|
| <b>RUN 1</b>           |       |                           |                      |
| Limit value            | 150   | mg/m3 (corre Cal gas conc | 326.427 mg.m-3 (NO2) |
| Measured concentration | 7     | ppm                       |                      |
| Measured concentration | 14.82 | mg/m3 (101.3 Full Scale   | 513.25 mg/m3 (NO2)   |
| Measured concentration | 14.82 | mg/m3 (Corrected)         |                      |
| <b>NO/NO2 ratio</b>    |       | 100.00                    |                      |
| <b>Gas</b>             |       | NO                        |                      |
| <b>Full Scale</b>      |       | 250                       | ppm                  |
| <b>Cal gas conc</b>    |       | 159                       | ppm                  |
| <b>Conversion</b>      |       | 2.053                     |                      |

|  |          |       |           |               |                |
|--|----------|-------|-----------|---------------|----------------|
| <b>Correction for reference conditions</b> |          |       |           |               |                |
|  |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|  | ref      | 3.00  | 0.00      | 101.30        | 273.00         |
|  | measured | 10.66 | 0.00      | 101.30        | 275.15         |
|  | Uncert   | 0.35  | 0.00      | 0.00          | 1.00           |
| <b>Factors</b>                             |          | 1.74  | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>               |          | 0.06  | 0.00      | 0.00          | 0.00           |
| <b>Correction Factor</b>                   |          | 1.75  | uf        | 0.06          |                |

Uncert Sheets

| Performance characteristics           | Value |                    | specification      |
|---------------------------------------|-------|--------------------|--------------------|
| Response time                         | 180   | seconds            | 180.000            |
| Logger sampling interval              | 60    | seconds            |                    |
| Measurement period                    | 39    | minutes            |                    |
| Number of readings in measurement     | 39    |                    |                    |
| Repeatability at zero                 | 0.03  | % full scale       | <1 % range         |
| Repeatability at span level           | 0.06  | % full scale       | <2 % range         |
| Deviation from linearity(lack of fit) | 0.2   | % of value         | <2 % range         |
| Zero drift                            | 0.8   | mg/m3              | <2% range / 24hr   |
| Span drift                            | 1.48  | mg/m3              | <2% range/24hr     |
| volume or pressure flow dependence    | 0     | %of full scale/kPa | <2 % / kPa         |
| atmospheric pressure dependence       | 0     | %of value /kPa     | <3% / kPa          |
| ambient temperature dependence        | 0.3   | % full scale/10K   | <3% range / 10 K   |
| NH3 (mg/m3)                           | 20    | 0.0                | mg/m3              |
| CO2 (% vol)                           | 15    | 0.2                | mg/m3              |
| H2O (% vol)                           | 30    | 0.0                | mg/m3              |
| dependence on voltage                 | 0.1   | % full scale/10V   | <2% range          |
| losses in the line (leak)             | 0     | % of value         | < 0.1%vol /10 volt |
| Converter efficiency                  | 95.5  | %                  | >95%               |
| Uncertainty of calibration gas        | 2     | % of value         | < 2% of value      |

| Effect of drift   |
|-------------------|
| 0.00 mg/m3        |
| 0.00 % full scale |

|           | min    | max   | value at calib |       |
|-----------|--------|-------|----------------|-------|
| flow      | 95.00  | 105   | 100            | kPa   |
| pressure  | 101.30 | 101.3 | 101.3          | kPa   |
| temp      | 289    | 289   | 289            | K     |
| NH3 range | 0      | 0     | 0              | mg/m3 |
| CO2 range | 0      | 15    | 0              | %vol  |
| H2O range | 0      | 0     | 0              | %vol  |
| Voltage   | 93     | 121   | 110            | V     |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.05            |
| Lack of fit                                       | ufit        |                               | 0.02            |
| Drift   | u0dr        |                               | 0.00            |
| volume or pressure flow dependence                | uspres      |                               | 0.00            |
| atmospheric pressure dependence                   | uapres      |                               | 0.00            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| NH3   | uinterf     |                               | 0.00            |
| CO2 (% vol)                                       | uinterf     |                               | 0.12            |
| H2O (% vol)                                       | uinterf     |                               | 0.00            |
| Dependence on voltage                             | uvolt       |                               | 0.44            |
| losses in the line (leak)                         | uleak       |                               | 0.00            |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.17            |
| converter efficiency                              | uceff       |                               | 0.39            |
| Uncertainty in factor                             | uf          |                               | 0.87            |

| Use largest of sum of all positive or all negative influences |  |  |
|---|--|--|
| 0.12 all +ves   | Criteria<br>sum <4% range<br>0.296412045 |  |
| 0 all -ves  |  |  |
| 0.12 largest  |  |  |
| Value to use for intereference uncertainty                    |  |  |
| uint  | 0.12                                     |  |

| Measurement uncertainty | Value | Unit  |
|-------------------------|-------|-------|
| Combined uncertainty    | 0.63  | mg/m3 |

**Uncert Sheets**

|   |                           |   |             |              |
|---|---------------------------|---|-------------|--------------|
| Expanded uncertainty  | k =                       | 2 | 1.25        | mg/m3        |
| <b>Uncertainty corrected to std conds</b>                           |                           |   |             |              |
|   |                           |   | <b>2.81</b> | <b>mg/m3</b> |
| Expanded uncertainty  | expressed with a level of |   | 1.87 % ELV  |              |
| Expanded uncertainty  | expressed with a level of |   | 2.81 mg.m-3 |              |
| <b>Expanded uncertainty expressed with a level of 18.93 % value</b> |                           |   |             |              |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

corrected drift to be based on mg/m3 reading and the correction alert to be based on % full scale

**TOC Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement EN12619**

|                        |            |                 |              |
|------------------------|------------|-----------------|--------------|
| Limit value            | 10 mg/m3   | Calibration gas | 128.32 mg/m3 |
| Measured concentration | 4.25 mg/m3 | Full Scale      | 160 mg/m3    |

| Performance characteristics            | Value |   |                    | specification        |
|--|-------|---|--------------------|----------------------|
| Response time                          | 180   | seconds                                 |                    | < 200 s              |
| Logger sampling interval               | 60    | seconds                                 |                    |                      |
| Measurement period                     | 31    | minutes                                 |                    |                      |
| Number of readings in measurement      | 31    | Assuming 1 minute collected over 1 hour |                    |                      |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev              | <0.2 % range         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev              | <0.4 % range         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-                | <0.3 % volume        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-                | <2% of volume / 24hr |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-                | <2% volume/24hr      |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + - 5 l/h          | <1% range            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + - 2kPa           | < 1.5 % range        |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + - 15K            | <0.3% volume 10 K    |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per 15 |                      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

|           | range of variation from conditions at calibration |     |                |
|-----------|---|-----|----------------|
|           | min   | max | value at calib |
| flow      | 5   | 15  | 10 l/h         |
| pressure  | 99.00   | 101 | 100 kPa        |
| temp      | 280   | 285 | 285 K          |
| CO2 range | 8   | 15  | 0 % vol        |



**Uncert Sheets**

|                                |     |      |                  |        |                    |           |     |     |         |
|--------------------------------|-----|------|------------------|--------|--------------------|-----------|-----|-----|---------|
| NO (mg/m3)                     | 300 | 0.02 | % by volume per  | 300    |                    | NO range  | 100 | 150 | 0 mg/m3 |
| NO2 (mg/m3)                    | 30  | 0    | % by volume per  | 30     |                    | NO2 range | 5   | 7.5 | 0 mg/m3 |
| Combined interference          |     | 0.56 | % range          |        | <2% range          | Voltage   | 105 | 115 | 110 V   |
| Dependence on voltage          |     | 0.1  | % by volume /10V | + - 5% | < 0.1%vol /10 volt |           |     |     |         |
| Losses in the line (leak)      |     | 2    | % of value       |        | < 2% of value      |           |     |     |         |
| Uncertainty of calibration gas |     | 0.5  | % of value       |        |                    |           |     |     |         |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | u0dr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.28                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |
| NO  |             |                               | 0.01                 |
| NO2   |             |                               | 0.00                 |
| Combined interference (from mcerts)               |             |                               | 0.52                 |
| dependence on voltage                             | uvolt       |                               | 0.03                 |
| losses in the line (leak)                         | uleak       |                               | 0.05                 |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.01                 |

|  |
|--|
| <b>Use largest of sum of all positive or all negative influences</b> |
| Criteria   |
| sum <2% value  |
| 0.0850831  |
| Value to use for intereference uncertainty                           |
| uint 0.06  |

| Measurement uncertainty            |   |                         |          |
|------------------------------------|---|-------------------------|----------|
| Combined uncertainty               |   | 0.30                    | mg/m3    |
| Expanded uncertainty               |   | 0.60                    | mg/m3    |
| Expanded Uncertainty as % of value | 2   | 6.01                    | % of ELV |
| <b>Expanded uncertainty</b>        | <b>expressed with a level of confidence</b> | <b>14.12 % of value</b> |          |
| <b>Expanded uncertainty</b>        | <b>expressed with a level of confidence</b> | <b>0.60 mg/m3</b>       |          |

**HCL Uncert**

QGU-009-2013 Uncertainty calculation for HCL

v2

|                        |                                       |                  |               |
|------------------------|---------------------------------------|------------------|---------------|
| Limit value (ELV)      | 50 mg.m-3                             | Reference oxygen | 3 % by volume |
| Measured concentration | 0.26 mg.m-3 (at reference conditions) |                  |               |

Measurement Equation

$$c = \frac{m}{V} f_c$$

Uncert Sheets

| Measured Quantities   | Symbol           | Value   | Standard uncertainty | Units                | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|------------------|---------|----------------------|----------------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas  | V <sub>m</sub>   | 0.06634 | uV <sub>m</sub>      | 0.001 m <sup>3</sup> | 1.51                      |                   | <=2%               |
| Sampled gas Temperature   | T <sub>m</sub>   | 273     | uT <sub>m</sub>      | 2 k                  | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure  | ρ <sub>m</sub>   | 101.3   | uρ <sub>m</sub>      | 1 kPa                | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | H <sub>m</sub>   | 0       | uH <sub>m</sub>      | 1 % by volume        | 1.00                      |                   | <=1%               |
| Oxygen content  | O <sub>2,m</sub> | 10.6    | uO <sub>2,m</sub>    | 0.1 % by volume      | 0.94                      |                   | <=5%               |
| Concentration in impinger   | C                | 0.1     | uC                   | 0.003 mg/l           | 3.00                      |                   | <5%                |
| Impinger solution volume  | VS               | 350     | uVS                  | 0.001 l              | 0.00                      |                   | <1%                |
| Mass SO <sub>2</sub>  | m                | 35      | um                   | 1.05 mg              | 3.00                      | 0.02              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |         |                      |                      |                           |                   |                    |
| Leak  | L                | 2       |                      | %                    | 2.00                      |                   | <=2%               |

| Intermediate calculations                            |                  |                   |                      |
|--|------------------|-------------------|----------------------|
| Factor for std conds                                 | fs               | 1.00              |                      |
| uncertainty components                               | symbol           | sensitivity coeff | u (in units of fs)   |
|  | ρ <sub>m</sub>   | 0.010             | 0.010                |
|  | H <sub>m</sub>   | 0.010             | 0.010                |
|  | T <sub>m</sub>   | 0.004             | 0.007                |
|  | ufs              |                   | 0.016                |
| $f_s = \frac{(100 - H_m) 273 \rho_m}{100 T_m 101.3}$ |                  |                   |                      |
| Corrected volume                                     | V                | 0.07              | uV                   |
|  |                  |                   | 0.001 m <sup>3</sup> |
| $V = V_m f_s$  |                  |                   |                      |
| Factor for O <sub>2</sub> correction                 | fc               | 1.73              |                      |
| uncertainty components                               | symbol           | sensitivity coeff | u                    |
|  | O <sub>2,m</sub> | 0.17              | 0.017                |
| $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$          |                  |                   |                      |
| Factor for O <sub>2</sub> Correction                 | ufc              | 1.73              | 0.017                |

| Parameter                              | Value | Units               | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|---------------------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.07 m <sup>3</sup> | 3.98           | 0.01 mg.m-3              | 2.19 %           |
| Mass                                   | m     | 35.00 mg            | 0.01           | 0.01 mg.m-3              | 3.00 %           |
| Factor for O <sub>2</sub> Correction   | fc    | 1.73                | 0.15           | 0.00 mg.m-3              | 0.96 %           |
| Leak                                   | L     | 0.00 mg.m-3         | 1.00           | 0.00 mg.m-3              | 1.15 %           |
| <b>Combined uncertainty</b>            |       |                     |                | <b>0.01 mg.m-3</b>       |                  |

|  |      |                     |  |
|--|------|---------------------|--|
| Expanded uncertainty as percentage of measured value | 8.01 | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |
| Expanded uncertainty in units of measurement         | 0.02 | mg.m-3              |  |
| Expanded uncertainty as percentqge of limit value    | 0.04 | % ELV               |  |

Note: Enter values into green boxes

Uncert Sheets

Developed for the STA by R Robinson, NPL

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$$

QGU-009-2013 Uncertainty calculation for HF

v2

|                        |      |                                  |                  |   |             |
|------------------------|------|----------------------------------|------------------|---|-------------|
| Limit value (ELV)      | 5    | mg.m-3                           | Reference oxygen | 3 | % by volume |
| Measured concentration | 0.10 | mg.m-3 (at reference conditions) |                  |   |             |

Measurement Equation

$$c = \frac{m}{V} f_c$$

| Measured Quantities   | Symbol | Value  | Standard uncertainty | Units           | Uncertainty as percentage | Uncertainty at lv | Requirement of std |
|---|--------|--------|----------------------|-----------------|---------------------------|-------------------|--------------------|
| Sampled Volume Gas  | Vm     | 0.0688 | uVm                  | 0.001 m3        | 1.45                      |                   | <=2%               |
| Sampled gas Temperature   | Tm     | 273    | uTm                  | 2 k             | 2.00                      |                   | <2.5 k             |
| Sampled gas Pressure  | pm     | 101.3  | upm                  | 1 kPa           | 0.99                      |                   | <=1%               |
| Sampled gas Humidity  | Hm     | 0      | uHm                  | 1 % by volume   | 1.00                      |                   | <=1%               |
| Oxygen content  | O2,m   | 10.6   | uO2,m                | 0.1 % by volume | 0.94                      |                   | <=5%               |
| Concentration in impinger   | C      | 0.04   | uC                   | 0.0012 mg/l     | 3.00                      |                   | <5%                |
| Impinger solution volume  | VS     | 330    | uVS                  | 0.001 l         | 0.00                      |                   | <1%                |
| Mass SO2  | m      | 13.2   | um                   | 0.40 mg         | 3.00                      | 0.06              | <5% of limit value |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |        |        |                      |                 |                           |                   |                    |
| Leak  | L      | 2      |                      | %               | 2.00                      |                   | <=2%               |

| Intermediate calculations |        |                   |    |                    |
|---------------------------|--------|-------------------|----|--------------------|
| Factor for std conds      | fs     | 1.00              |    |                    |
| uncertainty components    | symbol | sensitivity coeff |    | u (in units of fs) |
|                           | pm     | 0.010             |    | 0.010              |
|                           | Hm     | 0.010             |    | 0.010              |
|                           | Tm     | 0.004             |    | 0.007              |
|                           | ufs    |                   |    | 0.016              |
| Corrected volume          | V      | 0.07              | uV | 0.001 m3           |
|                           |        |                   |    | $V = V_m f_s$      |
| Factor for O2 correction  | fc     | 1.73              |    |                    |
| uncertainty components    | symbol | sensitivity coeff |    | u                  |
|                           | O2,m   | 0.17              |    | 0.017              |
| Factor for O2 Correction  | ufc    | 1.73              |    | 0.017              |

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{\rho_m}{101.3}$$

$$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$$

| Parameter                              | Value | Units    | Sensitivity cc | Uncertainty contribution | Uncertainty as % |
|--|-------|----------|----------------|--------------------------|------------------|
| Corrected Volume (standard conditions) | V     | 0.07 m3  | 1.39           | 0.00 mg.m-3              | 2.15 %           |
| Mass                                   | m     | 13.20 mg | 0.01           | 0.00 mg.m-3              | 3.00 %           |

**Uncert Sheets**

|                             |    |             |      |                    |        |
|-----------------------------|----|-------------|------|--------------------|--------|
| Factor for O2 Correction    | fc | 1.73        | 0.06 | 0.00 mg.m-3        | 0.96 % |
| Leak                        | L  | 0.00 mg.m-3 | 1.00 | 0.00 mg.m-3        | 1.15 % |
| <b>Combined uncertainty</b> |    |             |      | <b>0.00 mg.m-3</b> |        |

|  |                                   |                     |  |  |  |
|--|-----------------------------------|---------------------|--|--|--|
| Expanded uncertainty as percentage of measured value | <input type="text" value="7.97"/> | % measured of value | expressed with a level of confidence of 95%<br>(Using a coverage factor k=2) |  |  |
| Expanded uncertainty in units of measurement         | <input type="text" value="0.01"/> | mg.m-3              |  |  |  |
| Expanded uncertainty as percentage of limit value    | <input type="text" value="0.15"/> | % ELV               |  |  |  |

Note: Enter values into green boxes

Developed for the STA by R Robinson, NPL

$$SO_2 \text{ U}_{fs} = \frac{(100 - H_m) 273}{100} \frac{\rho_m}{T_m 101.3}$$

**Run 1**

**Uncertainty calculation for Gaseous Measurement SO2 EA M21**

|                        |                                      |                           |                                     |                                   |
|------------------------|--------------------------------------|---------------------------|-------------------------------------|-----------------------------------|
| Limit value            | <input type="text" value="-"/>       | mg/m3 (corre Cal gas conc | <input type="text" value="2044.9"/> | mg.m-3                            |
| Measured concentration | <input type="text" value="2493.23"/> | mg/m3                     | Full Scale                          | <input type="text" value="2860"/> |
| Measured concentration | <input type="text" value="2493.23"/> | mg/m3 (Corrected)         |                                     |                                   |

| Correction for reference conditions |          |       |           |               |                |
|-------------------------------------|----------|-------|-----------|---------------|----------------|
|                                     |          | O2, % | Moisture, | Pressure, KPa | Temperature, K |
|                                     | ref      | 3.00  | 0.00      | 101.30        | 273.00         |
|                                     | measured | 10.66 | 0.00      | 101.30        | 275.15         |
|                                     | Uncert   | 0.35  | 1.00      | 0.00          | 1.00           |
| <b>Factors</b>                      |          | 1.74  | 1.00      | 1.00          | 1.01           |
| <b>Uncertainty in factor</b>        |          | 0.06  | 0.01      | 0.00          | 0.00           |
| <b>Correction Factor</b>            |          | 1.75  | uf        | 0.06          |                |

| Performance characteristics           | Value                             |                       | specification    |
|---------------------------------------|-----------------------------------|-----------------------|------------------|
| Response time                         | <input type="text" value="180"/>  | seconds               | 180.000          |
| Logger sampling interval              | <input type="text" value="60"/>   | seconds               |                  |
| Measurement period                    | <input type="text" value="39"/>   | minutes               |                  |
| Number of readings in measurement     | <input type="text" value="39"/>   |                       |                  |
| Repeatability at zero                 | <input type="text" value="0.25"/> | % full scale          | <1 % range       |
| Repeatability at span level           | <input type="text" value="0.15"/> | % full scale          | <2 % range       |
| Deviation from linearity(lack of fit) | <input type="text" value="0.7"/>  | % of value            | <2 % range       |
| Zero drift                            | <input type="text" value="0"/>    | mg/m3                 | <2% range / 24hr |
| Span drift                            | <input type="text" value="0.5"/>  | mg/m3                 | <2% range/24hr   |
| volume or pressure flow dependence    | <input type="text" value="0.02"/> | % of full scale/3 kPa | <2 % / 3 kPa     |

|                                   |
|-----------------------------------|
| Effect of drift                   |
| <input type="text" value="0.61"/> |
| <input type="text" value="0.02"/> |

|      |                                    |                                  |                                  |     |
|------|------------------------------------|----------------------------------|----------------------------------|-----|
|      | ranges                             |                                  |                                  |     |
|      | min                                | max                              | value at calib                   |     |
| flow | <input type="text" value="95.00"/> | <input type="text" value="105"/> | <input type="text" value="100"/> | kPa |

**Uncert Sheets**

|                                 |      |                       |                    |           |        |        |        |       |
|---------------------------------|------|-----------------------|--------------------|-----------|--------|--------|--------|-------|
| atmospheric pressure dependence | 0.8  | % of full scale/2 kPa | <3% / 2 kPa        | pressure  | 100.76 | 100.92 | 100.88 | kPa   |
| ambient temperature dependence  | 0.01 | % full scale/10K      | <3% range / 10 K   | temp      | 287    | 288.5  | 287.5  | K     |
| N2O (mg/m3)                     | 20   | 0.2                   | mg/m3              | N2O range | 0      | 40     | 0      | mg/m3 |
| CO2 (% vol)                     | 15   | 0.2                   | mg/m3              | CO2 range | 0      | 15     | 0      | %vol  |
| CH4 (mg/m3)                     | 40   | 0.7                   | mg/m3              | CH4 range | 0      | 57     | 0      | mg/m3 |
| H2O (% vol)                     | 20   | 0.2                   | mg/m3              | H2O range | 0      | 1      | 0      | %vol  |
| dependence on voltage           | 0.1  | % full scale/10V      | <2% range          | Voltage   | 93     | 121    | 110    | V     |
| losses in the line (leak)       | 2    | % of value            | < 0.1%vol /10 volt |           |        |        |        |       |
| Uncertainty of calibration gas  | 2    | % of value            | < 2% of value      |           |        |        |        |       |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | mg/m3           |
|---|-------------|-------------------------------|-----------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.69            |
| Lack of fit                                       | ufit        |                               | 10.08           |
| Drift   | u0dr        |                               | 0.35            |
| volume or pressure flow dependence                | uspres      |                               | 0.55            |
| atmospheric pressure dependence                   | uapres      |                               | 0.70            |
| ambient temperature dependence                    | utemp       |                               | 0.00            |
| N2O (mg/m3)                                       | uinterf     |                               | 0.23            |
| CO2 (% vol)                                       | uinterf     |                               | 0.12            |
| CH4 (mg/m3)                                       | uinterf     |                               | 0.58            |
| H2O (% vol)                                       | uinterf     |                               | 0.01            |
| Dependence on voltage                             | uvolt       |                               | 2.47            |
| losses in the line (leak)                         | uleak       |                               | 28.79           |
| Uncertainty of calibration gas                    | ucalib      |                               | 28.79           |
| Uncertainty in factor                             | uf          |                               | 149.27          |

|  |  |
|--|--|
| <b>Use largest of sum of all positive or all negative influences</b> |  |
| 0.93 all +ves  | Criteria<br>sum <4% range<br>49.86458889 |
| 0 all -ves   |  |
| 0.93 largest   |  |
| <b>Value to use for interference uncertainty</b>                     | uint 0.93                                |

| Measurement uncertainty                   |   |               |                |
|---|---|---------------|----------------|
| Combined uncertainty                      |   | 42.04         | mg/m3          |
| Expanded uncertainty                      | k = 2                                       | 84.08         | mg/m3          |
| <b>Uncertainty corrected to std conds</b> |   | <b>333.00</b> | <b>mg/m3</b>   |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>0.00</b>   | <b>% ELV</b>   |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>333.00</b> | <b>mg.m-3</b>  |
| <b>Expanded uncertainty</b>               | <b>expressed with a level of confidence</b> | <b>13.36</b>  | <b>% value</b> |

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes  
Dark blue boxes indicate information that can be obtained from MCERTS tests

**Uncert Sheets**

Developed for the STA by R Robinson, NPL

**O<sub>2</sub> Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement Oxygen EN14789**

|                        |       |      |                 |      |      |
|------------------------|-------|------|-----------------|------|------|
| Limit value            | n/a   | %vol | Calibration gas | 20.9 | %vol |
| Measured concentration | 10.66 | %vol | Full Scale      | 25   | %vol |

| Performance characteristics            | Value |   |                 | specification        |
|--|-------|---|-----------------|----------------------|
| Response time                          | 180   | seconds                                 |                 | < 200 s              |
| Logger sampling interval               | 60    | seconds                                 |                 |                      |
| Measurement period                     | 39    | minutes                                 |                 |                      |
| Number of readings in measurement      | 39    | Assuming 1 minute collected over 1 hour |                 |                      |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev           | <0.2 % range         |
| Repeatability at span level            | 0.014 | % by volume                             | stdev           | <0.4 % range         |
| Deviation from linearity               | 0.13  | % vol                                   | +/-             | <0.3 % volume        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-             | <2% of volume / 24hr |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-             | <2% volume/24hr      |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + 5 l/h         | <1% range            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + 2kPa          | < 1.5 % range        |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + 15K           | <0.3% volume 10 K    |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per | 15                   |
| NO (mg/m3)                             | 300   | 0.02                                    | % by volume per | 300                  |
| NO2 (mg/m3)                            | 30    | 0                                       | % by volume per | 30                   |
| Combined interference                  | 0.56  | % range                                 |                 | <2% range            |
| Dependence on voltage                  | 0.1   | % by volume /10V                        | + 5%            | < 0.1%vol /10 volt   |
| Losses in the line (leak)              | 2     | % of value                              |                 | < 2% of value        |
| Uncertainty of calibration gas         | 0.5   | % of value                              |                 |                      |

|                   |
|-------------------|
| Effect of drift   |
| 0.00 % vol        |
| 0.00 % full scale |

|           | range of variation from conditions at calibration |     |                |
|-----------|---|-----|----------------|
|           | min   | max | value at calib |
| flow      | 5   | 15  | 10 l/h         |
| pressure  | 99.00   | 101 | 100 kPa        |
| temp      | 280   | 285 | 285 K          |
| CO2 range | 8   | 15  | 0 % vol        |
| NO range  | 100   | 150 | 0 mg/m3        |
| NO2 range | 5   | 7.5 | 0 mg/m3        |
| Voltage   | 105   | 115 | 110 V          |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | uodr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |

**Uncert Sheets**

|                                     |  |  |        |  |  |  |       |  |               |
|-------------------------------------|--|--|--------|--|--|--|-------|--|---------------|
| atmospheric pressure dependence     |  |  | uapres |  |  |  | 0.04  |  |               |
| ambient temperature dependence      |  |  | utemp  |  |  |  | -0.02 |  |               |
| CO2                                 |  |  |        |  |  |  | 0.05  | <b>Use largest of sum of all positive or all negative influences</b> |               |
| NO                                  |  |  |        |  |  |  | 0.01  |  | 0.06 all +ves |
| NO2                                 |  |  |        |  |  |  | 0.00  |  | 0 all -ves    |
| Combined interference (from mcerts) |  |  |        |  |  |  | 0.08  |  | 0.06 largest  |
| dependence on voltage               |  |  | uvolt  |  |  |  | 0.03  | <b>Value to use for intereference uncertainty</b>                    |               |
| losses in the line (leak)           |  |  | uleak  |  |  |  | 0.12  |  | uint 0.06     |
| Uncertainty of calibration gas      |  |  | ucalib |  |  |  | 0.03  |  |               |

|                                |   |  |                        |      |
|--------------------------------|---|--|------------------------|------|
| <b>Measurement uncertainty</b> |   |  | 10.66                  | %vol |
| Combined uncertainty           |   |  | 0.17                   | %vol |
| % of value                     |   |  | 1.59                   | %    |
| Coverage factor k =            | 2   |  |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>3.18 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> |  | <b>0.34 % vol</b>      |      |

Requirement for SRM is that Uncertaitny should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests  
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

corrected drift alert to be based on % full scale

**CO<sub>2</sub> Uncert**

**Run 1**

**Uncertainty calculation for Gaseous Measurement Carbon Dioxide**

|                        |      |      |                 |      |      |
|------------------------|------|------|-----------------|------|------|
| Limit value            | n/a  | %vol | Calibration gas | 15.5 | %vol |
| Measured concentration | 9.61 | %vol | Full Scale      | 25   | %vol |

| Performance characteristics | Value       | specification |
|-----------------------------|-------------|---------------|
| Response time               | 180 seconds | < 200 s       |
| Logger sampling interval    | 60 seconds  |               |
| Measurement period          | 39 minutes  |               |

|                 |                   |
|-----------------|-------------------|
| Effect of drift | 0.00 % vol        |
|                 | 0.00 % full scale |

**Uncert Sheets**

|  |       |   |                  |                      |   |                        |
|--|-------|---|------------------|----------------------|---|------------------------|
| Number of readings in measurement      | 39    | Assuming 1 minute collected over 1 hour |                  |                      |   |                        |
| Repeatability at zero                  | 0.015 | % by volume                             | stdev            | <0.2 % range         |   |                        |
| Repeatability at span level            | 0.014 | % by volume                             | stdev            | <0.4 % range         |   |                        |
| Deviation from linearity               | 0.13  | % vol                                   | +/-              | <0.3 % volume        |   |                        |
| Zero drift (during measurement period) | 0     | % vol at zero level                     | +/-              | <2% of volume / 24hr | range of variation from conditions at calibration |                        |
| Span drift (during measurement period) | 0     | % vol at span level                     | +/-              | <2% volume/24hr      |   | min max value at calib |
| volume or pressure flow dependence     | 0     | % of fs / 10l/h                         | + 5 l/h          | <1% range            | flow  | 5 15 10 l/h            |
| atmospheric pressure dependence        | 0.3   | % of fs/kPa                             | + 2kPa           | < 1.5 % range        | pressure  | 99.00 101 100 kPa      |
| ambient temperature dependence         | -0.07 | % by volume /10K                        | + 15K            | <0.3% volume 10 K    | temp  | 280 285 285 K          |
| CO2 (% vol)                            | 15    | 0.07                                    | % by volume per  | 15                   | CO2 range   | 8 15 0 % vol           |
| NO (mg/m3)                             | 300   | 0.02                                    | % by volume per  | 300                  | NO range  | 100 150 0 mg/m3        |
| NO2 (mg/m3)                            | 30    | 0                                       | % by volume per  | 30                   | NO2 range   | 5 7.5 0 mg/m3          |
| Combined interference                  |       | 0.56                                    | % range          | <2% range            | Voltage   | 105 115 110 V          |
| Dependence on voltage                  |       | 0.1                                     | % by volume /10V | + 5%                 |   |                        |
| Losses in the line (leak)              |       | 2                                       | % of value       |                      |   |                        |
| Uncertainty of calibration gas         |       | 0.5                                     | % of value       |                      |   |                        |

| Performance characteristic                        | Uncertainty | Value of uncertainty quantity | % vol                |
|---|-------------|-------------------------------|----------------------|
| Standard deviation of repeatability at zero       | ur0         | for mean                      | Only use rep at span |
| Standard deviation of repeatability at span level | urs         | for mean                      | 0.00                 |
| Lack of fit                                       | ufit        |                               | 0.08                 |
| Drift   | u0dr        |                               | 0.00                 |
| volume or pressure flow dependence                | uspres      |                               | 0.00                 |
| atmospheric pressure dependence                   | uapres      |                               | 0.04                 |
| ambient temperature dependence                    | utemp       |                               | -0.02                |
| CO2   |             |                               | 0.05                 |
| NO  |             |                               | 0.01                 |
| NO2   |             |                               | 0.00                 |
| Combined interference (from mcerts)               |             |                               | 0.08                 |
| dependence on voltage                             | uvolt       |                               | 0.03                 |
| losses in the line (leak)                         | uleak       |                               | 0.11                 |
| Uncertainty of calibration gas                    | ucalib      |                               | 0.03                 |

**Use largest of sum of all positive or all negative influences**

|               |
|---------------|
| 0.06 all +ves |
| 0 all -ves    |
| 0.06 largest  |

**Value to use for intereference uncertainty**

|      |      |
|------|------|
| uint | 0.06 |
|------|------|

|                                |   |                        |      |
|--------------------------------|---|------------------------|------|
| <b>Measurement uncertainty</b> |   | 9.61                   | %vol |
| Combined uncertainty           |   | 0.16                   | %vol |
| % of value                     |   | 1.67                   | %    |
| Coverage factor k =            | 2   |                        |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> | <b>3.34 % of value</b> |      |
| <b>Expanded uncertainty</b>    | <b>expressed with a level of confidence</b> | <b>0.32 % vol</b>      |      |

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis



**Uncert Sheets**

**Note:** Enter values into green boxes  
 Dark blue boxes indicate information that can be obtained from MCERTS tests  
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

**Moisture Uncert**

| Run 1   |                  |  |                      |                                 |   |   |
|---|------------------|--|----------------------|---------------------------------|---|---|
| Uncertainty calculation for Moisture  |                  |  |                      |                                 |   |   |
| Limit value (ELV)   | 0                | mg.m <sup>-3</sup>                           | Reference oxygen     | 3                               | % by volume                                 | Measurement Equation<br>$c = \frac{m}{V} f_c$ |
| Measured concentration  | 8.01             | mg.m <sup>-3</sup> (at reference conditions) |                      |                                 |   |   |
| Measured Quantities   | Symbol           | Value  | Standard uncertainty | Units                           | Uncertainty as percentage                   | Uncertainty at lv                             |
| Sampled Volume  | V <sub>m</sub>   | 0.06   | uV <sub>m</sub>      | 0.001 m <sup>3</sup>            |   | 1.67  |
| Sampled gas Temperature   | T <sub>m</sub>   | 273  | uT <sub>m</sub>      | 2 k                             |   | 0.73  |
| Sampled gas Pressure  | p <sub>m</sub>   | 101.3  | uρ <sub>m</sub>      | 1 kPa                           |   | 0.99  |
| Sampled gas Humidity  | H <sub>m</sub>   | 0  | uH <sub>m</sub>      | 1 % by volume                   |   | 1.00  |
| Oxygen content  | O <sub>2,m</sub> | 10.6   | uO <sub>2,m</sub>    | 0.1 % by volume                 |   | 0.94  |
| Note - Sampled gas humidity, temperature and pressure are values at the gas meter |                  |  |                      |                                 |   |   |
| Leak  | L                | 0.001  |                      | %                               |   | 0.00  |
| Uncollected Mass<br>(Instack filter - no rinse)                                   | UCM              | 0  |                      | mg                              | #REF!                                       |   |
| Intermediate calculations   |                  |  |                      |                                 |   |   |
| Factor for std conds  | f <sub>s</sub>   | 1.00   |                      |                                 |   |   |
| uncertainty components  | symbol           | sensitivity coeff                            |                      | u (in units of f <sub>s</sub> ) |   |   |
|   | p <sub>m</sub>   | 0.010  |                      | 0.010                           |   |   |
|   | H <sub>m</sub>   | 0.010  |                      | 0.010                           |   |   |
|   | T <sub>m</sub>   | 0.004  |                      | 0.007                           |   |   |
|   | u f <sub>s</sub> |  |                      | 0.016                           |   | 1.58  |
| Corrected volume  | V                | 0.06   | uV                   | 0.001 m <sup>3</sup>            | $V = V_m f_s$                               | 2.30  |
| Factor for O2 correction  | f <sub>c</sub>   | 1.73   |                      |                                 |   |   |
| uncertainty components  | symbol           | sensitivity coeff                            |                      | u                               |   |   |
|   | O <sub>2,m</sub> | 0.17   |                      | 0.017                           | $f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$ |   |
| Factor for O2 Correction  | u f <sub>c</sub> | 1.73   |                      | 0.017                           |   | 0.96  |

### Uncert Sheets

| Parameter                               | Value | Units                   | Sensitivity cc | Uncertainty contribution      | Uncertainty as % |
|---|-------|-------------------------|----------------|-------------------------------|------------------|
| Corrected Volume (standard conditions)  | V     | 0.06 m <sup>3</sup>     | 133.55         | 0.18 mg.m <sup>-3</sup>       | 2.30 %           |
| Factor for O2 Correction                | fc    | 1.73                    | 4.63           | 0.08 mg.m <sup>-3</sup>       | 0.96 %           |
| Leak                                    | L     | 0.00 mg.m <sup>-3</sup> | 1.00           | 0.00 mg.m <sup>-3</sup>       | 0.00 %           |
| <b>Combined measurement uncertainty</b> |       |                         |                | <b>0.20 mg.m<sup>-3</sup></b> |                  |

Expanded uncertainty as percentage of measured value 4.99 % measured of value expressed with a level of confidence of 95%

(Using a coverage factor k=2)

Expanded uncertainty in units of measurement 0.399 mg.m<sup>-3</sup>

Expanded uncertainty as percentage of limit value 0.00 % ELV

## Certificate of Analysis

**Report No.:** 21-12428-1

**Issue No.:** 1

**Date of Issue** 28/10/2021

Customer Details: Air Scientific Ltd, Unit 32, De Granville Court, Dublin Road, Trim, Co. Meath, , Ireland

Customer Contact: Amanda Sheridan

Customer Order No.: KNLATL1061021

Customer Reference: Not Supplied

Quotation Reference: Q21-01409

Description: 3 gas samples, 12 liquid samples, 3 solid samples

Date Received: 12/10/2021

Date Started: 13/10/2021

Date Completed: 27/10/2021

Test Methods: Details available on request (refer to SOP code against relevant result/s)

Notes: None



**Approved By:** Joanne Dewhurst, Operational Manager

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service.

This certificate shall not be reproduced except in full without the prior written approval of the laboratory.

Observations and interpretations are outside of the scope of UKAS accreditation.

Results reported herein relate only to the items supplied to the laboratory for testing.

Results on an Interim Report are not dry-weight corrected.

Where the laboratory is not responsible for the sampling, results apply to the sample(s) as they were received.

The laboratory shall not be responsible for any information that is supplied by the customer that may affect the validity of results.



0605



[rpsgroup.com](http://rpsgroup.com)

RPS Environmental Management Limited trading as RPS Laboratories. Registered in England No. 01756175.

Unit 12, Waters Edge Business Park, Modwen Road, Salford, M5 3EZ. T +44 161 872 2443

A member of the RPS Group plc. Terms and conditions apply - copy on request

**Results Summary**

**Report No.:** 21-12428-1

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | KH01 223687 | KH01W      | KH02 223684 | KH02W      | B 223689   | BW         | KH01HCL 1+2 | KH01HCL 3  | HCL B      | KH02HCL 1+2 | KH02HCL 3  | F1HCL 1+2  | F1HCL 3    |
|--------------------|-------------|------------|-------------|------------|------------|------------|-------------|------------|------------|-------------|------------|------------|------------|
| RPS Sample No      | 67246       | 67247      | 67248       | 67249      | 67250      | 67251      | 67252       | 67253      | 67254      | 67255       | 67256      | 67257      | 67258      |
| Sample Matrix      | FILTER      | SOLUTION   | FILTER      | SOLUTION   | FILTER     | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION   |
| Sampling Date      | 06/10/2021  | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand                         | CAS No    | Codes | SOP | RL   | Units |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
|-------------------------------------|-----------|-------|-----|------|-------|--------|-------|--------|-------|--------|-------|--|--|--------|--------|--------|--------|--------|--------|--------|
| volume of sample supplied           |           |       | U   | N/A  | n/a   | ml     |       |        |       |        |       |  |  | 142    | 135    | 127    | 144    | 140    | 142    | 127    |
| hydrogen chloride                   | 7647-01-0 | UM    | C27 | 0.05 | ug/mL |        |       |        |       |        |       |  |  | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| benzene FRONT                       | 71-43-2   | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| dichloromethane (DCM) FRONT         | 75-09-2   | UM    | O8  | 4    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| heptane FRONT                       | 142-82-5  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| m- & p-xylene FRONT                 |           | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| methyl isobutyl ketone (MIBK) FRONT | 108-10-1  | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| o-xylene FRONT                      | 95-47-6   | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| tetrachloroethylene FRONT           | 127-18-4  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| tetrahydrofuran (THF) FRONT         | 109-99-9  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| toluene FRONT                       | 108-88-3  | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| trichloroethylene FRONT             | 79-01-6   | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| particulates                        |           | UM    | D9  | 0.04 | mg    | < 0.04 |       | < 0.04 |       | < 0.04 |       |  |  |        |        |        |        |        |        |        |
| particulates                        |           | UM    | D9  | 0.5  | mg    |        | < 0.5 |        | < 0.5 |        | < 0.5 |  |  |        |        |        |        |        |        |        |
| acetone FRONT                       | 67-64-1   | U     | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| 2-butanone (MEK) FRONT              | 78-93-3   | U     | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| cyclohexanone FRONT                 | 108-94-1  | U     | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| ethanol FRONT                       | 64-17-5   | U     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| ethyl acetate FRONT                 | 141-78-6  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| hexane FRONT                        | 110-54-3  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| 2-propanol (IPA) FRONT              | 67-63-0   | U     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| acetone BACK                        | 67-64-1   | U     | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| 2-butanone (MEK) BACK               | 78-93-3   | U     | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| cyclohexanone BACK                  | 108-94-1  | U     | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| ethanol BACK                        | 64-17-5   | U     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| ethyl acetate BACK                  | 141-78-6  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| hexane BACK                         | 110-54-3  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| 2-propanol (IPA) BACK               | 67-63-0   | U     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| benzene BACK                        | 71-43-2   | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| dichloromethane (DCM) BACK          | 75-09-2   | UM    | O8  | 4    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| heptane BACK                        | 142-82-5  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| m- & p-xylene BACK                  |           | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| methyl isobutyl ketone (MIBK) BACK  | 108-10-1  | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| o-xylene BACK                       | 95-47-6   | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| tetrachloroethylene BACK            | 127-18-4  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| tetrahydrofuran (THF) BACK          | 109-99-9  | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| toluene BACK                        | 108-88-3  | UM    | O8  | 1    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| trichloroethylene BACK              | 79-01-6   | UM    | O8  | 2    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| carbon tetrachloride FRONT          | 56-23-5   | N     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| carbon tetrachloride BACK           | 56-23-5   | N     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |
| chloroform FRONT                    | 67-66-3   | N     | O8  | 3    | ug    |        |       |        |       |        |       |  |  |        |        |        |        |        |        |        |

**Results Summary**
**Report No.: 21-12428-1**

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | KH01 223687 | KH01W      | KH02 223684 | KH02W      | B 223689   | BW         | KH01HCL 1+2 | KH01HCL 3  | HCL B      | KH02HCL 1+2 | KH02HCL 3  | F1HCL 1+2  | F1HCL 3    |
|--------------------|-------------|------------|-------------|------------|------------|------------|-------------|------------|------------|-------------|------------|------------|------------|
| RPS Sample No      | 67246       | 67247      | 67248       | 67249      | 67250      | 67251      | 67252       | 67253      | 67254      | 67255       | 67256      | 67257      | 67258      |
| Sample Matrix      | FILTER      | SOLUTION   | FILTER      | SOLUTION   | FILTER     | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION    | SOLUTION   | SOLUTION   | SOLUTION   |
| Sampling Date      | 06/10/2021  | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021  | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand       | CAS No   | Codes | SOP | RL | Units |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------|----------|-------|-----|----|-------|--|--|--|--|--|--|--|--|--|--|--|--|--|
| chloroform BACK   | 67-66-3  | N     | O8  | 3  | ug    |  |  |  |  |  |  |  |  |  |  |  |  |  |
| cyclohexane FRONT | 110-82-7 | N     | O8  | 3  | ug    |  |  |  |  |  |  |  |  |  |  |  |  |  |
| cyclohexane BACK  | 110-82-7 | N     | O8  | 3  | ug    |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Results Summary**

**Report No.: 21-12428-1**

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | F2HCL 1+2  | F2HCL 3    | 1968       | 1976       | 1965       |
|--------------------|------------|------------|------------|------------|------------|
| RPS Sample No      | 67259      | 67260      | 67261      | 67262      | 67263      |
| Sample Matrix      | SOLUTION   | SOLUTION   | TUBE       | TUBE       | TUBE       |
| Sampling Date      | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand                         | CAS No    | Codes | SOP | RL   | Units | 138    | 141    |     |     |     |
|-------------------------------------|-----------|-------|-----|------|-------|--------|--------|-----|-----|-----|
| volume of sample supplied           |           | U     | N/A | n/a  | ml    | 138    | 141    |     |     |     |
| hydrogen chloride                   | 7647-01-0 | UM    | C27 | 0.05 | ug/mL | < 0.05 | < 0.05 |     |     |     |
| benzene FRONT                       | 71-43-2   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| dichloromethane (DCM) FRONT         | 75-09-2   | UM    | O8  | 4    | ug    |        |        | < 4 | < 4 | < 4 |
| heptane FRONT                       | 142-82-5  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| m- & p-xylene FRONT                 |           | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| methyl isobutyl ketone (MIBK) FRONT | 108-10-1  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| o-xylene FRONT                      | 95-47-6   | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| tetrachloroethylene FRONT           | 127-18-4  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| tetrahydrofuran (THF) FRONT         | 109-99-9  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| toluene FRONT                       | 108-88-3  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| trichloroethylene FRONT             | 79-01-6   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| particulates                        |           | UM    | D9  | 0.04 | mg    |        |        |     |     |     |
| particulates                        |           | UM    | D9  | 0.5  | mg    |        |        |     |     |     |
| acetone FRONT                       | 67-64-1   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-butanone (MEK) FRONT              | 78-93-3   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| cyclohexanone FRONT                 | 108-94-1  | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| ethanol FRONT                       | 64-17-5   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| ethyl acetate FRONT                 | 141-78-6  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| hexane FRONT                        | 110-54-3  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-propanol (IPA) FRONT              | 67-63-0   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| acetone BACK                        | 67-64-1   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-butanone (MEK) BACK               | 78-93-3   | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| cyclohexanone BACK                  | 108-94-1  | U     | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| ethanol BACK                        | 64-17-5   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| ethyl acetate BACK                  | 141-78-6  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| hexane BACK                         | 110-54-3  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| 2-propanol (IPA) BACK               | 67-63-0   | U     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| benzene BACK                        | 71-43-2   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| dichloromethane (DCM) BACK          | 75-09-2   | UM    | O8  | 4    | ug    |        |        | < 4 | < 4 | < 4 |
| heptane BACK                        | 142-82-5  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| m- & p-xylene BACK                  |           | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| methyl isobutyl ketone (MIBK) BACK  | 108-10-1  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| o-xylene BACK                       | 95-47-6   | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| tetrachloroethylene BACK            | 127-18-4  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| tetrahydrofuran (THF) BACK          | 109-99-9  | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| toluene BACK                        | 108-88-3  | UM    | O8  | 1    | ug    |        |        | < 1 | < 1 | < 1 |
| trichloroethylene BACK              | 79-01-6   | UM    | O8  | 2    | ug    |        |        | < 2 | < 2 | < 2 |
| carbon tetrachloride FRONT          | 56-23-5   | N     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| carbon tetrachloride BACK           | 56-23-5   | N     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |
| chloroform FRONT                    | 67-66-3   | N     | O8  | 3    | ug    |        |        | < 3 | < 3 | < 3 |

**Results Summary**

**Report No.:** 21-12428-1

Customer Reference: Not Supplied

Customer Order No: KNLATL1061021

| Customer Sample No | F2HCL 1+2  | F2HCL 3    | 1968       | 1976       | 1965       |
|--------------------|------------|------------|------------|------------|------------|
| RPS Sample No      | 67259      | 67260      | 67261      | 67262      | 67263      |
| Sample Matrix      | SOLUTION   | SOLUTION   | TUBE       | TUBE       | TUBE       |
| Sampling Date      | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 | 06/10/2021 |

| Determinand       | CAS No   | Codes | SOP | RL | Units | F2HCL 1+2 | F2HCL 3 | 1968 | 1976 | 1965 |
|-------------------|----------|-------|-----|----|-------|-----------|---------|------|------|------|
| chloroform BACK   | 67-66-3  | N     | O8  | 3  | ug    |           |         | < 3  | < 3  | < 3  |
| cyclohexane FRONT | 110-82-7 | N     | O8  | 3  | ug    |           |         | < 3  | < 3  | < 3  |
| cyclohexane BACK  | 110-82-7 | N     | O8  | 3  | ug    |           |         | < 3  | < 3  | < 3  |

## Deviating Samples

**Report No.:** 21-12428-1

**Customer Reference:** Not Supplied

**Customer Order No.:** KNLATL1061021

Our policy on Deviating Samples has been implemented in accordance with UKAS Policy on Deviating Samples (TPS63).

RPS is not responsible for the integrity of samples as received, unless RPS personnel performed the sampling. Samples submitted may be declared to be deviating.

Where applicable the analysis method remains UKAS accredited, however results reported for a deviating sample may be compromised.

Where no sampling date was supplied, samples have been declared to be deviating. If the date can be supplied, results may be reissued if assessed not deviating.

Where the sample container used was unsuitable or broken, the sample is flagged as deviating and re-sampling/re-submission may be required.

| RPS No. | Customer No. | Customer ID | Date Sampled | Containers Received | Deviating | Reason for Deviation |
|---------|--------------|-------------|--------------|---------------------|-----------|----------------------|
| 67246   | KH01 223687  |             | 06/10/2021   | Container           | No        |                      |
| 67247   | KH01W        |             | 06/10/2021   | Container           | No        |                      |
| 67248   | KH02 223684  |             | 06/10/2021   | Container           | No        |                      |
| 67249   | KH02W        |             | 06/10/2021   | Container           | No        |                      |
| 67250   | B 223689     |             | 06/10/2021   | Container           | No        |                      |
| 67251   | BW           |             | 06/10/2021   | Container           | No        |                      |
| 67252   | KH01HCL 1+2  |             | 06/10/2021   | Container           | No        |                      |
| 67253   | KH01HCL 3    |             | 06/10/2021   | Container           | No        |                      |
| 67254   | HCL B        |             | 06/10/2021   | Container           | No        |                      |
| 67255   | KH02HCL 1+2  |             | 06/10/2021   | Container           | No        |                      |
| 67256   | KH02HCL 3    |             | 06/10/2021   | Container           | No        |                      |
| 67257   | F1HCL 1+2    |             | 06/10/2021   | Container           | No        |                      |
| 67258   | F1HCL 3      |             | 06/10/2021   | Container           | No        |                      |
| 67259   | F2HCL 1+2    |             | 06/10/2021   | Container           | No        |                      |
| 67260   | F2HCL 3      |             | 06/10/2021   | Container           | No        |                      |
| 67261   | 1968         |             | 06/10/2021   | Container           | No        |                      |
| 67262   | 1976         |             | 06/10/2021   | Container           | No        |                      |
| 67263   | 1965         |             | 06/10/2021   | Container           | No        |                      |



**Report No.: 21-12428-1**

| Key Code         | Description   |
|------------------|---|
| N                | Not Accredited Test   |
| U                | UKAS Accredited Test - UKAS accreditation is only implied if the report carries the UKAS logo       |
| UF               | UKAS Flexible Scope Test  |
| M                | MCERTS Accredited Test - MCERTS accreditation is only implied if the report carries the MCERTS logo |
| O                | Marine Management Organisation (MMO) Validated  |
| SN               | Subcontracted to approved laboratory not accredited for the test                                    |
| SU               | Subcontracted to approved laboratory UKAS Accredited for the test                                   |
| SM               | Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test                            |
| SIN              | Subcontracted to internal RPS Group laboratory not accredited for the test                          |
| SIU              | Subcontracted to internal RPS Group laboratory UKAS Accredited for the test                         |
| SIM              | Subcontracted to internal RPS Group laboratory MCERTS/UKAS Accredited for the test                  |
| I/S (in results) | Insufficient Sample   |
| U/S (in results) | Unsuitable Sample   |
| S/C (in results) | See Comments  |
| ND (in results)  | Not Detected  |
| L (in results)   | Result is outside normal limits   |

Please note that all samples will be destroyed 4 WEEKS after the report has been issued.

Note: Sample retention may be subject to agreement with the customer for particular projects

| Certificate Notes | Description   |
|-------------------|---|
| Note 1            | This test report shall not be reproduced except in full, without written approval of the Laboratory.            |
| Note 2            | Unless otherwise stated, results are not corrected for analytical recoveries.                                   |
| Note 3            | Samples were taken by the customer and, unless otherwise stated, sampling locations were not supplied.          |
| Note 4            | Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.                      |
| Note 5            | Unless otherwise stated, method D9 conditioning temperatures are 180°C for pre-weigh and 160°C for re-weigh.    |
| Note 6            | The PDF version is the definitive copy and the Excel version is uncontrolled and provided for information only. |

Note: Where the following information is included in this certificate, it has usually been supplied by the customer: Customer Sample ID, Sample Location, Sampling Date and Sample Air Volumes. The laboratory shall not be responsible for any information that is supplied by the customer that may affect the validity of results.

Report No.: 21-12428-1

| Determinand                           | CAS No     | Media                           | SOP  | % Recovery | % Uncertainty |
|---------------------------------------|------------|---------------------------------|------|------------|---------------|
| acetaldehyde                          | 75-07-0    | tube                            | A40  | 98         | 16.2          |
| benzaldehyde                          | 100-52-7   | tube                            | A40  | 100        | 19.4          |
| butyraldehyde                         | 123-72-8   | tube                            | A40  | 92         | 11.5          |
| formaldehyde                          | 50-00-0    | tube                            | A40  | 97         | 12.8          |
| hexanal                               | 66-25-1    | tube                            | A40  | 89         | 11            |
| propionaldehyde                       | 123-38-6   | tube                            | A40  | 96         | 12.6          |
| valeraldehyde                         | 110-62-3   | tube                            | A40  | 93         | 12.3          |
| ammonia                               | 7664-41-7  | sulphuric acid solution         | A6   | n/a        | 8.9           |
| chlorine                              | 7782-50-5  | sodium hydroxide solution       | C27  | n/a        | 15.2          |
| hydrogen bromide                      | 10035-10-6 | sulphuric acid solution         | C27  | n/a        | 10.9          |
| hydrogen chloride                     | 7647-01-0  | deionised water                 | C27  | n/a        | 7.9           |
| hydrogen chloride                     | 7647-01-0  | sulphuric acid solution         | C27  | n/a        | 13.3          |
| hydrogen fluoride                     | 7664-3-3   | sodium hydroxide solution       | C27  | n/a        | 7.9           |
| sulphur dioxide                       | 7446-09-5  | hydrogen peroxide solution      | C27  | n/a        | 7.7           |
| nitrogen oxide                        | 10102-43-9 | potassium permanganate solution | C27  | n/a        | 11.7          |
| particulates                          | n/a        | filter                          | D9   | n/a        | 12.2          |
| particulates                          | n/a        | wash solution                   | D9   | n/a        | 14.8          |
| formaldehyde                          | 50-00-0    | deionised water                 | M103 | n/a        | 23.7          |
| 2,4- & 2,6-toluene diisocyanate (TDI) | n/a        | filter                          | M119 | n/a        | 8.6           |
| hexamethylene diisocyanate (HDI)      | 822-06-0   | filter                          | M119 | n/a        | 5.6           |
| methylene diphenyl diisocyanate (MDI) | 101-68-8   | filter                          | M119 | n/a        | 11.8          |
| hydrogen sulphide                     | 7783-06-4  | zinc acetate solution           | M120 | n/a        | 4.2           |
| antimony                              | 7440-36-0  | filter                          | M31  | n/a        | 10.3          |
| arsenic                               | 7440-38-2  | filter                          | M31  | n/a        | 17.1          |
| cadmium                               | 7440-43-9  | filter                          | M31  | n/a        | 12.1          |
| chromium                              | 7440-47-3  | filter                          | M31  | n/a        | 17.1          |
| cobalt                                | 7440-48-4  | filter                          | M31  | n/a        | 13.1          |
| copper                                | 7440-50-8  | filter                          | M31  | n/a        | 14            |
| lead                                  | 7439-92-1  | filter                          | M31  | n/a        | 9.8           |
| manganese                             | 7439-96-5  | filter                          | M31  | n/a        | 17.5          |
| nickel                                | 7440-02-0  | filter                          | M31  | n/a        | 14.4          |
| thallium                              | 7440-28-0  | filter                          | M31  | n/a        | 15.3          |
| tin                                   | 7440-31-5  | filter                          | M31  | n/a        | 18.5          |
| vanadium                              | 7440-62-2  | filter                          | M31  | n/a        | 12.1          |
| zinc                                  | 7440-66-6  | filter                          | M31  | n/a        | 15.2          |
| antimony                              | 7440-36-0  | nitric acid wash                | M31  | n/a        | 10.3          |
| arsenic                               | 7440-38-2  | nitric acid wash                | M31  | n/a        | 17.1          |
| cadmium                               | 7440-43-9  | nitric acid wash                | M31  | n/a        | 12.1          |
| chromium                              | 7440-47-3  | nitric acid wash                | M31  | n/a        | 17.1          |
| cobalt                                | 7440-48-4  | nitric acid wash                | M31  | n/a        | 13.1          |
| copper                                | 7440-50-8  | nitric acid wash                | M31  | n/a        | 14            |
| lead                                  | 7439-92-1  | nitric acid wash                | M31  | n/a        | 9.8           |
| manganese                             | 7439-96-5  | nitric acid wash                | M31  | n/a        | 17.5          |
| nickel                                | 7440-02-0  | nitric acid wash                | M31  | n/a        | 14.4          |
| selenium                              | 7782-49-2  | nitric acid wash                | M31  | n/a        | 15.1          |
| thallium                              | 7440-28-0  | nitric acid wash                | M31  | n/a        | 15.3          |
| tin                                   | 7440-31-5  | nitric acid wash                | M31  | n/a        | 18.5          |
| vanadium                              | 7440-62-2  | nitric acid wash                | M31  | n/a        | 12.1          |
| zinc                                  | 7440-66-6  | nitric acid wash                | M31  | n/a        | 15.2          |
| antimony                              | 7440-36-0  | nitric/peroxide solution        | M31  | n/a        | 5.9           |
| arsenic                               | 7440-38-2  | nitric/peroxide solution        | M31  | n/a        | 6.8           |
| cadmium                               | 7440-43-9  | nitric/peroxide solution        | M31  | n/a        | 6.3           |
| chromium                              | 7440-47-3  | nitric/peroxide solution        | M31  | n/a        | 7.2           |
| cobalt                                | 7440-48-4  | nitric/peroxide solution        | M31  | n/a        | 5.2           |
| copper                                | 7440-50-8  | nitric/peroxide solution        | M31  | n/a        | 6.8           |
| lead                                  | 7439-92-1  | nitric/peroxide solution        | M31  | n/a        | 8.6           |
| manganese                             | 7439-96-5  | nitric/peroxide solution        | M31  | n/a        | 9.6           |
| nickel                                | 7440-02-0  | nitric/peroxide solution        | M31  | n/a        | 5.5           |
| selenium                              | 7782-49-2  | nitric/peroxide solution        | M31  | n/a        | 8.7           |
| thallium                              | 7440-28-0  | nitric/peroxide solution        | M31  | n/a        | 7.7           |
| tin                                   | 7440-31-5  | nitric/peroxide solution        | M31  | n/a        | 5.8           |
| vanadium                              | 7440-62-2  | nitric/peroxide solution        | M31  | n/a        | 6.7           |
| zinc                                  | 7440-66-6  | nitric/peroxide solution        | M31  | n/a        | 11.9          |
| 1,2,4-trimethylbenzene                | 95-63-6    | tube                            | O8   | 88         | 8.1           |
| 1,3,5-trimethylbenzene                | 108-67-8   | tube                            | O8   | 92         | 7.7           |
| 2-ethyltoluene                        | 611-14-3   | tube                            | O8   | 91         | 8.4           |
| 3- & 4-ethyltoluene                   | n/a        | tube                            | O8   | 91         | 8.4           |
| benzene                               | 71-43-2    | tube                            | O8   | 90         | 13.9          |
| butyl acetate                         | 123-86-4   | tube                            | O8   | 90         | 10.3          |
| decane                                | 124-18-5   | tube                            | O8   | 97         | 6.7           |
| dichloromethane                       | 75-09-2    | tube                            | O8   | 88         | 24            |
| ethyl acetate                         | 141-78-6   | tube                            | O8   | n/a        | n/a           |
| ethyl benzene                         | 100-41-4   | tube                            | O8   | 92         | 9.8           |
| heptane                               | 142-82-5   | tube                            | O8   | 94         | 10.5          |
| hexane                                | 110-54-3   | tube                            | O8   | n/a        | n/a           |
| limonene                              | 138-86-3   | tube                            | O8   | 93         | 13            |
| m- & p-xylene                         | n/a        | tube                            | O8   | 90         | 9.3           |
| methyl isobutyl ketone (MIBK)         | 108-10-1   | tube                            | O8   | 86         | 10            |
| methyl tert-butyl ether (MTBE)        | 1634-04-4  | tube                            | O8   | 92         | 15            |
| o-xylene                              | 95-47-6    | tube                            | O8   | 86         | 9.9           |
| propylbenzene                         | 103-65-1   | tube                            | O8   | 92         | 7.5           |
| tetrachloroethylene                   | 127-18-4   | tube                            | O8   | 91         | 9.3           |
| tetrahydrofuran (THF)                 | 109-99-9   | tube                            | O8   | 87         | 14.7          |
| toluene                               | 108-88-3   | tube                            | O8   | 89         | 10.7          |
| trichloroethylene                     | 79-01-6    | tube                            | O8   | 91         | 10.6          |
| m- & p-cresol                         | n/a        | tube                            | P1   | n/a        | 11            |
| m- & p-xenol                          | n/a        | tube                            | P1   | n/a        | 11.9          |
| o-cresol                              | 95-48-7    | tube                            | P1   | n/a        | 10.8          |
| o-xenol                               | 526-75-0   | tube                            | P1   | n/a        | 12            |
| phenol                                | 108-95-2   | tube                            | P1   | n/a        | 10.4          |

### Test Certificate

Date 03/11/2021

|               |   |                        |                   |
|---------------|---|------------------------|-------------------|
| <b>Client</b> | Air Scientific (TM)<br>Unit 32 De Granville Court<br>Dublin Road<br>Trim<br>Co Meath<br>Ireland | <b>Order No.</b>       | KNLATL1061021     |
|               |   | <b>Certificate No.</b> | <b>WK21-00753</b> |
|               |   | <b>Issue No.</b>       | 1                 |

|                    |                    |                      |             |
|--------------------|--------------------|----------------------|-------------|
| <b>Contact</b>     | Amanda             | <b>Date Received</b> | 13/10/2021  |
| <b>Description</b> | 9 solutions for HF | <b>Technique</b>     | Subcontract |

| Sample No.               | 1164932    | KH01 HF 1+2 | Method         |
|--------------------------|------------|-------------|----------------|
| <b>Hydrogen Fluoride</b> | 0.05 mg/L  | 134 ml      | Subcontract(N) |
| Sample No.               | 1164933    | KH01 HF 3   | Method         |
| <b>Hydrogen Fluoride</b> | 0.02 mg/L  | 124 ml      | Subcontract(N) |
| Sample No.               | 1164934    | HFB         | Method         |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 122 ml      | Subcontract(N) |
| Sample No.               | 1164935    | KH02 HF 1+2 | Method         |
| <b>Hydrogen Fluoride</b> | 0.02 mg/L  | 126 ml      | Subcontract(N) |
| Sample No.               | 1164936    | KH02 HF 3   | Method         |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 127 ml      | Subcontract(N) |
| Sample No.               | 1164937    | F1 HF 1+2   | Method         |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 135 ml      | Subcontract(N) |
| Sample No.               | 1164938    | F1 HF 3     | Method         |
| <b>Hydrogen Fluoride</b> | 0.02 mg/L  | 110 ml      | Subcontract(N) |
| Sample No.               | 1164939    | F2 HF 1+2   | Method         |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L | 131 ml      | Subcontract(N) |

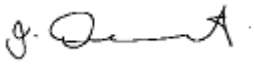
## Test Certificate

Date 03/11/2021

|                          |                     |         |                        |            |
|--------------------------|---------------------|---------|------------------------|------------|
| <b>Client</b>            | Air Scientific (TM) |         | <b>Certificate No.</b> | WK21-00753 |
|                          |                     |         | <b>Issue No.</b>       | 1          |
| <b>Sample No.</b>        | 1164940             | F2 HF 3 | <b>Method</b>          |            |
| <b>Hydrogen Fluoride</b> | <0.02 mg/L          | 140 ml  | Subcontract(N)         |            |

Samples subcontracted to a UKAS/MCERTS laboratory.

Tested By Subcontract Date 02/11/2021

Approved By  Date 03/11/2021  
Joanne Dewhurst  
Operational

For and on authority of RPS Laboratories Ltd.

Method Symbols (U) Analysis is UKAS Accredited  
(N) Analysis is not UKAS Accredited

Concentration values reported as mg/m<sup>3</sup> and ppm where air volumes are supplied by the customer are not covered by the scope of UKAS accreditation.

Results stated as ml are referring to the sample volume.

RPS Laboratories terms and conditions apply - a copy is available on request.

Analysis carried out on samples 'as received'

This document may not be reproduced other than in full, except with the written approval of the issuing laboratory.

**ATTACHMENT D**

2021

# Knockharley Operational Waste Plan

PREPARED FOR MEATH COUNTY COUNCIL IN FULFILMENT OF  
CONDITION 4(F) OF ABP -303211-18

DAVID A TOBIN

BEAUPARC UTILITIES

## Table of Contents

|   |                 |
|---|-----------------|
| <b>1.0 INTRODUCTION .....</b>                                     | <b><u>2</u></b> |
| <b>2.0 DEVELOPMENT DESCRIPTION .....</b>                          | <b><u>2</u></b> |
| <b>3.0 PERMITTED SITE LAYOUT .....</b>                            | <b><u>3</u></b> |
| <b>4.0 OPERATIONAL WASTE PLAN .....</b>                           | <b><u>3</u></b> |
| <b>4.1 OVERVIEW .....</b>   | <b><u>3</u></b> |
| <b>4.2 OPERATING PROCEDURES .....</b>                             | <b><u>3</u></b> |
| <b>4.3 SITE MANAGEMENT .....</b>                                  | <b><u>4</u></b> |
| <b>4.4 OPERATIONAL AND WASTE ACCEPTANCE HOURS.....</b>            | <b><u>4</u></b> |
| <b>4.5 ACCESS .....</b>   | <b><u>4</u></b> |
| <b>4.6 WASTE TYPES AND QUANTITIES .....</b>                       | <b><u>4</u></b> |
| <b>4.7 MARKET VARIABILITY .....</b>                               | <b><u>5</u></b> |
| <b>4.8 WASTE ACCEPTANCE .....</b>                                 | <b><u>5</u></b> |
| 4.8.1 PRE-TREATMENT OF WASTE .....                                | 5               |
| 4.8.2 WASTE COLLECTION PERMITS.....                               | 5               |
| 4.8.3 WASTE CHARACTERISATION.....                                 | 5               |
| 4.8.4 WASTE INSPECTION .....                                      | 5               |
| 4.8.5 WASTE RECORDS.....  | 6               |
| <b>5.0 WASTE TYPES AND TONNAGES TO BE ACCEPTED ANNUALLY .....</b> | <b><u>6</u></b> |
| <b>APPENDIX 1 ABP -303211-18 .....</b>                            | <b><u>8</u></b> |

## 1.0 Introduction

Knockharley landfill occupies a 135 hectare site in Knockharley County Meath. The facility has been operational since 2002. It is an EPA licenced site and currently has capacity to accept up to 200,000 tonnes of waste per annum. The facility has an existing EPA licence (W0146-02).

Planning permission was sought from An Bord Pleanála (ABP) under section 37E of the Planning and Development Act 2000, as amended. Following an oral hearing in December 2020, planning was granted by ABP for an extension of the landfill in May 2021. The planning reference number is ABP - 303211-18. For reference the Board Order ABP- 303211-18 is attached in Appendix 1.

This document is the waste plan for the facility as required, to be agreed with Meath County Council, as per condition 4(f) of PL 303211-18, which states:-

*within three months of the date of this Order, the applicant shall submit to the local authority, details of the overall volume and tonnage of waste which will be deposited in the landfill cells consistent with the information as contained in the application documentation.*

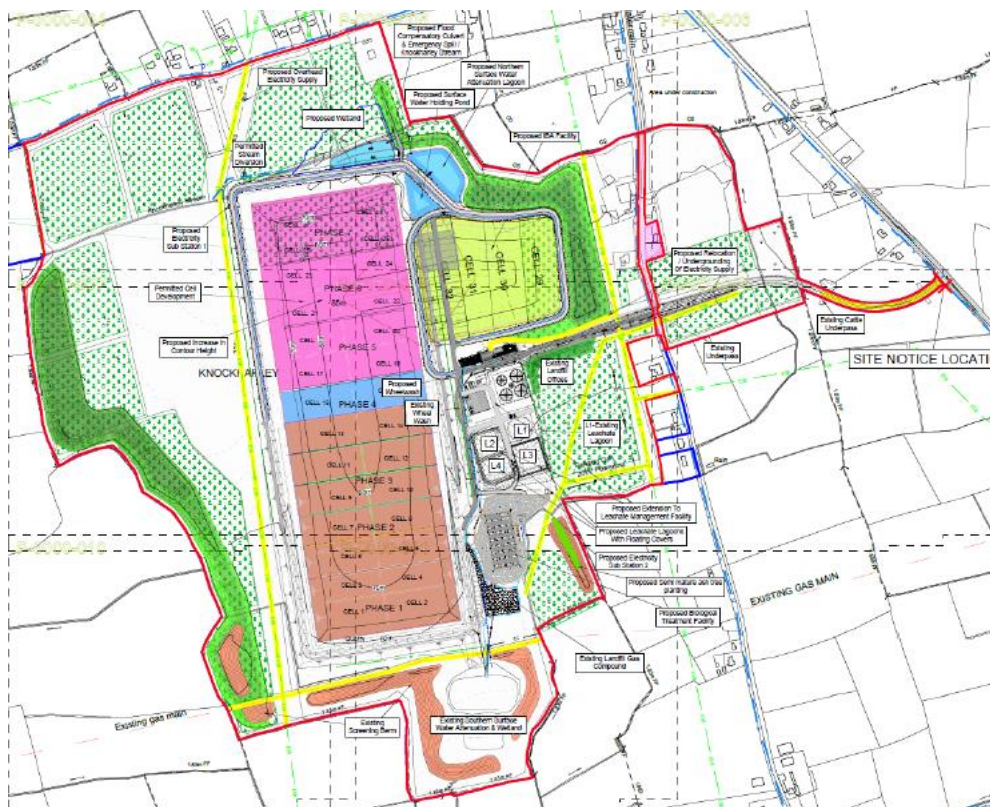
## 2.0 Development Description

The recent decision grants permission for a range of activities and structures including the following:-

1. An increase in the rate of waste acceptance up to 4440,000 tonnes per annum comprising of up to 435,000 tonnes of non-hazardous wastes including incinerator bottom ash (IBA) as well as household, commercial land industrial wastes including residual fines, non-hazardous contaminated soils, construction and demolition wastes and baled recyclables, and up to 5,000 tonnes of stable non-reactive hazardous waste.
2. The acceptance and placement within the existing permitted landfill footprint of incoming wastes for recovery or disposal as appropriate increasing the height of the landfill body from the current permitted post-settlement final contour height of 74 meters OD to a proposed post settlement final contour height of 85 metres OD. It is proposed to accept waste until the landfill cells are full.
3. The construction of a dedicated IBA facility. IBA will be accepted at up to 150,000 tonnes per annum. Permission is sought to store IBA until recovery outlets are identified. Permission is sought for trials to prepare IBA for recovery and removal at site. The IBA facility will consist of five number cells. The IBA facility will operate until the cells are full and subsequent aftercare works are complete.
4. The construction and operation of a processing building for the biological treatment of the organic fraction of municipal solid waste. Up to 25,000 tonnes per annum of MSW fines will be accepted at this facility, which will continue to operate post filling of the landfill cells on site.



## 3.0 Permitted Site Layout



## 4.0 Operational Waste Plan

### 4.1 Overview

The installation is an integrated waste management facility comprising:

- An engineered landfill for the disposal of residual non-hazardous and stable non-reactive hazardous waste;
- A biological treatment plant for MSW organic fines
- An IBA pre-treatment and temporary storage areas, and
- A Leachate treatment plant.

### 4.2 Operating Procedures

KLL has prepared a comprehensive set of Operating Procedures that cover all aspects of the day to day management of the installation and contingency measures. The procedures form part of the installation's Environmental Management System (EMS), which is certified to ISO 14001, and are subject to regular review based on operational experience, legislative changes and improvements in best practice.

### 4.3 Site Management

At a minimum the facility personnel include: -

- Facility Manager,
- Deputy Facility Manager,
- Weighbridge Operator,
- Foreman,
- Mobile plant operators,
- General Operatives,
- Administration.

### 4.4 Operational and Waste Acceptance Hours

Unless otherwise agreed with Meath County Council and the Agency the operational hours are 7.30 and 18.30 Monday to Saturday. Wastes are accepted between 8.00 and 18.00, Monday to Saturday.

### 4.5 Access

The only access to the facility is off the N2. The internal traffic control system requires all vehicles entering the facility to pass the weighbridges. The access gates are locked outside of operational hours. Signage is provided on the northern and southern approaches to the facility entrance identifying the site and the access point.

Directional and speed control signage is provided on the internal roads. Access to the weighbridges is controlled by automated barriers. All visitors must report to the administration building and provide their name, company/organisation, vehicle registration number and purpose of visit.

### 4.6 Waste Types and Quantities

When operating at full capacity, the facility will accept up to 440,000 tonnes per annum, a maximum of 5,000 tonnes per annum will be comprised of stable, non-reactive hazardous waste. A maximum of 25,000 tonnes will be allotted to the un-stabilised organic fines that will be processed in the new biological treatment plant.

In line with the Regional Waste Management Planning Offices (The Regions) recommendation, in their submission to the board, of the remaining 410,000 tonnes, 44,000 tonnes will be held in reserve as a contingency measure and a maximum of 188,000 tonnes will be allotted for the disposal of non-recoverable residual municipal solid waste, non-recoverable construction and demolition waste, non-recoverable bulky waste, solid non-reactive hazardous waste, and street cleanings.

The remaining 220,000 tonnes will be allocated to the storage of incinerator bottom ash and the recovery, through use in engineering works, of construction and demolition waste (soil and stones, crushed concrete); stabilised organic fines; inert construction and demolition waste and commercial and industrial waste fines, and incinerator bottom ash and the storage of incinerator bottom ash pending the conclusion of the trials on the suitability of the use of the ash in the manufacture of products.

## 4.7 Market Variability

Due to variability of market conditions, particularly with regard to construction and demolition waste, it is not possible to specify the precise amounts of each particular waste type that will be recovered. However only those wastes that meet the geotechnical criteria for use in engineering works in the landfill, as approved by the EPA, will be classified as recovery.

## 4.8 Waste Acceptance

KLL has prepared waste acceptance procedures to ensure that the waste pre-treatment, characterisation and acceptance requirements are achieved.

### 4.8.1 Pre-Treatment of Waste

With the exception of repatriated and unauthorised landfill waste, which it may not be possible to treat before delivery to the facility, only pre-treated waste is accepted for disposal. The stabilised organic fines must meet the AT4 limit of <7 mg O<sub>2</sub> /g DM.

### 4.8.2 Waste Collection Permits

Wastes are only accepted from holders of up to date Waste Collection Permits.

### 4.8.3 Waste Characterisation

Where necessary, waste producers are required to characterise the waste. The characterisation must meet all KLL's waste acceptance criteria.

### 4.8.4 Waste Inspection

All documentation accompanying waste deliveries records are checked. The wastes are, where practical, visually inspected at the weighbridge. If there are doubts about the nature of the non-stabilised, inert and SNRHW, the delivery vehicle will be directed to the Waste Inspection Area and off-loaded. If the waste is deemed suitable it will be moved to the appropriate handling area.

If the material is not suitable it will, where practical, be loaded onto the delivery vehicle and removed off-site. If this is not practical the waste is moved to the Waste Quarantine Area for storage pending removal by the waste producer/waste collector.

All wastes placed in the landfill cells will be inspected at the waste face to confirm that the wastes are suitable. Any unsuitable wastes will be removed to the Waste Quarantine Area, pending removal off-site by the waste producer/waste collector.

The IBA will be off-loaded inside the 'Weathering Area' and inspected. Any unsuitable materials will be removed to the Waste Quarantine Area.

All wastes delivered for treatment in the biological treatment plant will be inspected in the reception area inside the building. Where unsuitable waste is identified this will either be removed from the facility or disposed of in the landfill area.

#### 4.8.5 Waste Records

The following records on each waste load arriving at the site are maintained: -

- a) the date and time;
- b) the name of the carrier (including if appropriate. the waste carrier registration details);
- c) the vehicle registration number;
- d) the trailer, skip or other container unique identification number (where relevant);
- e) the name of the producer(s)/collector(s) of the waste as appropriate;
- f) the name of the waste facility (if appropriate) from which the load originated including the waste licence or waste permit register number;
- g) a description of the waste including the associated EWUHWL codes;
- h) the quantity of the waste - recorded in tonnes;
- i) details of the treatment(s) to which the waste has been subjected;
- j) the classification and coding of the waste, including whether MSW or otherwise;
- k) whether the waste is for disposal or recovery and if recovery - for what purpose;
- l) the name of the person checking the load; and,
- m) where loads or wastes are removed or rejected, details of the date of occurrence, the types of waste and the facility to which they were removed.

### 5.0 Waste Types and Tonnages to be Accepted Annually

The actual amount of each waste type may vary, but the total annual limit will not be exceeded. A possible example of the incoming materials may be presented as follows:-

| Waste Type  | Annual Intake (Tonnes) |                      |
|---|------------------------|----------------------|
| Residual MSW  | 65,000                 | Non-stabilised       |
| Fines Materials MSW   |                        |                      |
| Soil & Stone and other C&D materials                                    | 225,000                | Inert and Stabilised |
| Non-recoverable bulky waste individual industrial waste streams & SNRHW |                        |                      |
| Fines materials –C&D, C&I, MSW  |                        |                      |
| Street Sweepings & Cleansing Wastes                                     |                        |                      |
| IBA   | 150,000                | No organic fraction  |
| <b>Total</b>  | <b>440,000</b>         |                      |

Note that the 440,000 tonnes includes the 44,000 contingency requested by the Regions in their report, plus the 5,000 tonne contingency for the baled storage. Therefore, excluding contingency requirements, the maximum annual intake will be 391,000 tonnes, with the actual intake tonnage dictated by market conditions and needs within the Regional waste plan.

The sources of the residual non-stabilised waste will be household, commercial and industrial waste collections for which thermal treatment and/or export capacity may either not be available at certain times, e.g. thermal plant routine shut down or where suitable treatment is not available. It includes repatriated waste or waste from unauthorised and or legacy landfills.

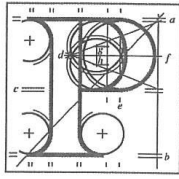
The stabilised waste i.e. waste that is relatively 'non-reactive' nature, in terms of leachate and landfill gas generation includes stabilised fines, bulky waste, street sweepings, SNRHW and inert wastes. The stabilised fines include those treated off-site and processed in the on-site in the biological treatment plant. The IBA will be generated at Waste to Energy (WtE) facilities operating in Ireland.

## 6.0 Use of Contingency Tonnage

The Eastern Midlands, Southern and Connaught Ulster Waste Management Planning Regions (The Regions), made a joint submission to An Bord Pleanála with regard to the planning application for Knockharley Landfill in February 2019. In their submission the Regions requested that contingency disposal capacity is maintained to respond to unforeseen volumes of waste. The regions recommended that provision of an annual contingency capacity of 44,000 TPA is maintained at Knockharley.

It is proposed that the contingency tonnage of 44,000 TPA will be held in reserve each year and only released to the market with the consent of Meath County Council following consultation with the Eastern-Midlands Regional Waste Management Planning Office (EMRWMPO). Such consent shall not be unreasonably withheld, refused or delayed. A review of need for contingency draw-down, between KLL and the EMRWMPO will be held quarterly and a protocol agreed between the parties for the draw-down of the contingency capacity.

Appendix 1 ABP -303211-18



An  
Bord  
Pleanála

**Board Order  
ABP-303211-18**

---

**Planning and Development Acts, 2000 to 2020**

**Planning Authority: Meath County Council**

**Application** for permission under section 37E of the Planning and Development Act 2000, as amended, in accordance with plans and particulars, including an Environmental Impact Assessment Report and Natura impact statement, lodged with An Bord Pleanála on the 12<sup>th</sup> day of December, 2018 by Knockharley Landfill Limited care of Fehily Timoney and Company of J5 Plaza, North Park Business Park, North Road, Dublin.

**Proposed Development:** Proposed development to the existing Knockharley Landfill (developed and operated pursuant to grants of permission by Meath County Council under Planning Register Reference Numbers 01/5006 (An Bord Pleanála reference number PL 17.125891), NA60336 (An Bord Pleanála reference number PL 17.220331) and An Bord Pleanála under reference number PL 17.PA0009. The proposed development comprises further development within the existing Knockharley Landfill of the following:

- (1) An increase in the rate of waste acceptance up to 440,000 tonnes per annum comprising up to 435,000 tonnes of non-hazardous wastes including incinerator bottom ash (IBA) as well as household, commercial and industrial wastes including residual fines, non-hazardous contaminated soils, construction and demolition (C&D) wastes and baled recyclables, and up to 5,000 tonnes of stable non-reactive hazardous waste.

*CMG*

- (2) The acceptance and placement within the existing permitted landfill footprint of incoming wastes for recovery or disposal as appropriate increasing the height of the landfill body from the current permitted post settlement final contour height of 74 metres OD to a proposed post settlement final contour height of 85 metres OD – the proposed height increase will apply from the active landfill phase at the date of grant of permission. It is proposed to accept waste until the landfill cells are full.
- (3) The construction and operation of a dedicated Incinerator Bottom Ash (IBA) facility. IBA will be accepted at up to 150,000 tonnes per annum. Permission is sought to store IBA until recovery outlets are identified. Permission is sought for trials to prepare IBA for recovery and removal off site. The IBA facility will consist of five number cells which will be constructed in accordance with the requirements of the Landfill Directive 99/31/EC for non-hazardous wastes. A final post settlement contour height of 85 metres OD is proposed. The proposed development includes new perimeter (haul) roads and screening berms. The IBA facility incorporates one number portal frame building 76 metres by 76 metres by 15.5 metres maximum height to facilitate (i) weathering, (ii) metals recovery trials and (iii) crushing, screening and washing of IBA material to facilitate recovery trials and processing. The IBA facility will operate until the cells are full and subsequent aftercare works are complete.
- (4) The construction and operation of a processing building (108 metres by 50 metres by 17 metres maximum height) for the biological treatment of the organic fraction of municipal solid waste (MSW) (i.e. MSW 'fines' material). The proposed biological waste treatment facility consists of incoming and outgoing materials stockpile areas, 12 number concrete composting tunnels (25 metres by 6 metres by 5 metres high), a covered bio-filtration unit with a 20-metre high stack, contingency storage of baled recyclables and baled MSW all located within the processing building and all ancillary and associated works including leachate storage in a below ground tank, bio-treatment system for sanitary wastewater, drainage and fencing. Access is at the internal site road with a marshalling yard area with egress from the





- (2) The acceptance and placement within the existing permitted landfill footprint of incoming wastes for recovery or disposal as appropriate increasing the height of the landfill body from the current permitted post settlement final contour height of 74 metres OD to a proposed post settlement final contour height of 85 metres OD – the proposed height increase will apply from the active landfill phase at the date of grant of permission. It is proposed to accept waste until the landfill cells are full.
- (3) The construction and operation of a dedicated Incinerator Bottom Ash (IBA) facility. IBA will be accepted at up to 150,000 tonnes per annum. Permission is sought to store IBA until recovery outlets are identified. Permission is sought for trials to prepare IBA for recovery and removal off site. The IBA facility will consist of five number cells which will be constructed in accordance with the requirements of the Landfill Directive 99/31/EC for non-hazardous wastes. A final post settlement contour height of 85 metres OD is proposed. The proposed development includes new perimeter (haul) roads and screening berms. The IBA facility incorporates one number portal frame building 76 metres by 76 metres by 15.5 metres maximum height to facilitate (i) weathering, (ii) metals recovery trials and (iii) crushing, screening and washing of IBA material to facilitate recovery trials and processing. The IBA facility will operate until the cells are full and subsequent aftercare works are complete.
- (4) The construction and operation of a processing building (108 metres by 50 metres by 17 metres maximum height) for the biological treatment of the organic fraction of municipal solid waste (MSW) (i.e. MSW 'fines' material). The proposed biological waste treatment facility consists of incoming and outgoing materials stockpile areas, 12 number concrete composting tunnels (25 metres by 6 metres by 5 metres high), a covered bio-filtration unit with a 20-metre high stack, contingency storage of baled recyclables and baled MSW all located within the processing building and all ancillary and associated works including leachate storage in a below ground tank, bio-treatment system for sanitary wastewater, drainage and fencing. Access is at the internal site road with a marshalling yard area with egress from the



existing site road to the landfill gas compound. It is proposed to accept up to 25,000 tonnes per annum of MSW fines material at the biological waste treatment facility and to continue to operate this facility post filling of the landfill cells onsite.

(5) The construction and operation of a leachate management facility at the site comprising as follows:

- Three number additional floating cover leachate storage lagoons (L2, L3 and L4) of circa 3,000 square metres each.
- Two number bunded above ground tanks for raw leachate from IBA cells (S1 and S2) approximately 25 metres diameter by 6.0 metres high.
- Three number bunded above ground tanks as follows: one number tank (S3) for treated leachate from landfill approximately 22 metres diameter by 6.0 metres high; one number tank for treated leachate from IBA approximately 25 metres diameter by 6.0 metres high (S4); and one number tank for leachate concentrate 16 metres diameter by 6.0 metres high (S5).
- Modular – typically containerised plant units (C1 through C6) on concrete slab of circa 1,000 square metres and one number elevated tank five metres diameter by 10 metres high (T1) with provision for two number additional low level (<5.0 metres high) bunded storage tanks for dosing and other compounds (T2 and T3).
- Extension of the existing loading area to accommodate two number 25 tonne articulated tankers.
- One new tanker loading area to accommodate two number 25 tonne articulated tankers.

Permission is sought for the continued operation of this plant post filling of the landfill cells to facilitate continued leachate management.

(6) The construction of screening berms up to 10 metres maximum height at the western and eastern boundaries and up to six metres maximum height at the northern boundary with a total berm footprint of approximately 11.3 hectares. Haul roads for construction of the berms will be in or immediately adjacent to the berm footprint.



- (7) The construction of surface water management infrastructure with discharge to the adjacent Knockharley Stream at the northern end of the permitted landfill footprint and proposed IBA cell to comprise: (i) holding pond; (ii) storm water attenuation lagoon; (iii) wetland; (iv) flood compensation culvert to provide equivalent 1:1000-year flood plain storage and (v) permitted stream diversion around permitted development.
- (8) The felling of approximately 12.5 hectares of commercial broadleaf/conifer mix plantations to facilitate the construction of the screening berms along the western boundary and to the north of the proposed IBA facility and the construction of Phase 7 (Cells 27 and 26) and the proposed northern surface water attenuation lagoon. Replanting and new planting totalling approximately 16.8 hectares is proposed at the following locations: (i) replanting over the proposed screening berms and (ii) new planting on the cap over cells 25, 26, 27 and 28 in the currently permitted landfill body.
- (9) The relocation of an existing 20kV overhead ESB powerline serving the facility administration buildings and the construction of two additional ESB substations (4.4 metres by 4.8 metres by 2.9 metres high) as follows: (i) new ESB substation and overhead ESB supply at the north-western corner of the permitted landfill footprint to serve pumps and other infrastructure and (ii) new ESB substation adjacent to proposed biological waste treatment building with ESB connection to adjacent 20kV power lines.
- (10) The extension of the existing car park for the administration area to provide 40 number additional car parking spaces.
- (11) The extension of existing permitted below ground infrastructure and the provision of additional below ground infrastructure including power, water, telemetry, leachate rising mains and drainage, together with all associated and ancillary works necessary to facilitate the proposed development at the subject site.

All on a 135.2-hectare site in the townlands of Knockharley, Flemingstown and Tuiterrath, Navan, County Meath.

*CME*