ANGUS COUNCIL'S SUMISSION ON GROUNDS OF REFUSAL

APPLICATION NUMBER – 20/00830/FULL

APPLICANT- DUNTRUNE LTD

PROPOSAL & ADDRESS – ERECTION OF CREMATORIUM BUILDING AND ASSOCIATED PARKING, ACCESS, TURNING SPACE, LANDSCAPING AND BOUNDARY ENCLOSURES ON LAND NORTH EAST OF DUNTRUNE HOUSE, DUNTRUNE

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Angus Council

Application Number:	20/00830/FULL
Description of Development:	Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures
Site Address:	Land North East Of Duntrune House Duntrune
Grid Ref:	344924 : 735118
Applicant Name:	Duntrune Ltd

Report of Handling

Site Description

The application site is a 1.99ha area of agricultural field located north of the C4 public road and around 300m east of Duntrune House. The site is bound by a wooded area (Duntrune Hill) at the west, a woodland strip and 2 houses at the east, the public road at the south and the balance of the agricultural field at the north with woodland beyond. The site is located around 1km north east of the Dundee City Council boundary.

Proposal

Planning permission is sought for the erection of crematorium building and associated parking, access, turning space, landscaping and boundary enclosures.

The crematorium would be located towards the west boundary of the site and would be a 544sqm, single storey, pitched roof building orientated on an east to west axis. The building would be around 8m high and would provide seating for 120 people The canopy-covered entrance elevation would face east towards the car parking and site entrance. The building would be finished with grey and timber clad walls, slate pitched roof, single-ply membrane flat roof sections and grey coloured aluminium frame glazing. Internally the building would provide a double-height central atrium for the entrance hall and main hall. Ancillary rooms such as offices and toilets would be provided and the crematorium plant would be located towards the rear of the building at its west side. A flue serving the crematorium would terminate around 9m from ground level towards the west end of the roof.

The site would take access from a new junction formed with the C4 public road at the south and would lead to car parking with 124 spaces and turning space formed to the east of the building. The site would be enclosed from the balance of the agricultural field at the north by a post and wire fence. A new drystone wall with entrance posts and gate would be formed at the south boundary of the site and new tree planting is proposed across the site, particularly concentrated towards the south east boundary corner.

The proposal would connect to the mains water supply and would use a private treatment system for foul water. Sustainable drainage would be used for surface water disposal.

Amendments

- Building and External Works Plan drawing no. 1226 / PD / 01 Revision C dated May 2020

amends and supersedes all previous Building and External Works Plan drawings and includes overflow car parking resulting in total of 124 car parking spaces (72 plus 52 overflow spaces).
- Site Plan drawing no. 1266 / PD / 02 Revision C dated May 2020 amends and supersedes all previous Site Plan drawings and includes overflow car parking resulting in total of 124 car parking spaces (72 plus 52 overflow spaces).
- Road Access drawing no. 1266 / SK / 06 Revision C dated May 2020 amends and supersedes all previous Road Access drawings and includes overflow car parking and annotates 'Existing Road to be widened as per Engineers drawings' on the public road.

Publicity

The application was subject to normal neighbour notification procedures.

The application was advertised in the Dundee Courier on 24 December 2020.

The nature of the proposal did not require a site notice to be posted.

Planning History

None.

Applicant's Case

The Drainage Statement reports on a site investigation involving trial pits undertaken with the purpose of infiltration tests. It is indicated that a private treatment system for foul water would be used and the population equivalent is determined using British Flows and Loads Document Version 4. This is calculated to a foul drainage system for the development to be designed for a population equivalent of 22 persons and the infiltration bed area must be at least 50.25sqm. For surface water, it is proposed where possible to utilise permeable pavement construction for the private road and car parking areas. The lower section of access road would be tarmac and drain to a roadside filter drain/soakaway. Roof water runoff would drain to a separate roofwater soakaway. A scheme of maintenance for drainage infrastructure is provided and the foul water and surface water drainage schemes are provided as appendices.

The Geotechnical Investigation Report confirms the findings of trial pits undertaken to ascertain ground bearing conditions for foundation design purposes only and no samples and/or geotechnical or environmental testing was undertaken. It is recommended that foundations are situated at a minimum depth of 0.7m below the original ground level on either the firm clay or medium dense gravels. This should ensure foundations are situated below the softer clays and sand and gravels that were typically encountered in the upper substrata horizons immediately below the topsoil layer. These substrata are considered suitable for an allowable bearing pressure of 100kN/m2.

Correspondence from the Scotland's Rural College and a soil plan of the site which indicates the land within the site is not prime quality agricultural land.

The Planning Design and Access Statement provides an overview of the site, design solution and traffic and access analysis. It indicates a crematorium is not suited to a location within a development boundary because it needs to be at least 200 yards from a dwelling and 50 yards from a highway and should preferably benefit from existing landscaping. It indicates that this site has been selected for its location in South Angus to serve the surrounding population and is considered to be a community facility that will help satisfy the demand in the area to the benefit of the local communities.

In respect of access and transport, the statement suggests that journeys to the crematorium would be made by private car or occasional private bus hire and indicates that public transport is not used. It suggests that there are two existing bus services that run directly past the site which run one in each direction on each working day and operate on a hail and ride basis. It refers to additional bus services outwith a 400m distance from the site and suggests that a bus stop or pull in area could be incorporated as part of the site access or alternatively a call up service could be offered for those who want to be collected from the nearest bus stop.

The statement provides information relating to population and death prediction figures and funeral poverty. It indicates that cremation costs in the local area are the most expensive in Scotland and refers to a Funeral Poverty in Dundee report prepared in July 2019 which suggested Dundee City Council could actively consider the addition of another cremation facility. The statement refers to crematorium-specific locational requirements and emissions. The proposal is discussed in the context of development plan policy and a sequential assessment of alternative sites is provided. The sequential assessment covers a number of sites in south Angus identified in the Angus Employment Land Audit 2019, the Angus Housing Land Audit 2020 and other brownfield opportunities. It indicates that there are no sites within any of the South Angus Housing Market Area settlement boundaries of sufficient size to meet the requirements of the proposal. The statement concludes that, amongst other things, the development would provide a significant benefit to the local community, requires a countryside location and there is no loss of prime agricultural ground.

A Swept Path Analysis plan for a coach, a refuse vehicle and a hearse circulating within the site is provided in support of the application.

The Traffic Survey Report consists of junction turning counts & queue surveys at the B961 (Drumgeith Road) / Kellas Road priority junction; and automatic traffic counts adjacent to the proposed site access (unnamed road, east of Duntrune House) and at Kellas Road - approximately 30m south of junction with unnamed road. The report indicates that the data was compiled on Tuesday 8 October 2019.

A Transportation Assessment to assess the suitability of the site transport infrastructure proposals, the local road network and local transport infrastructure for the development. It outlines the development proposal, considers sustainable travel opportunities, provides a network analysis and provides a conclusion and recommendations.

It indicates that the crematorium would have a seating capacity of 120, with an average of 3 (and a maximum of 5) cremations per day. It estimates that cremations will be attended by an average of 70 people arriving in 24 cars, with an infrequent extreme maximum of 200 people arriving in 67 cars (based on an average occupancy of 3 people per car).

The assessment proposes mitigation on the surrounding road network including the widening of the public road to 5.5m along the site frontage; the installation of passing places on the C4 and U315; crematorium signage to direct traffic from the B978 Kellas Road to the south; and the provision of 90 car parking spaces within the site.

It suggests that bus services are available including two services which pass the site frontage and can be accessed on a hail and ride basis. Additional bus services are provided to the surrounding area which gives the opportunity for staff and funeral attendees to access the site via existing public transport. It indicates that a bus stop or pull in area could be incorporated as part of the access to be formed or alternatively a call up service for those who wanted to be collected from the nearest existing bus stop. It indicates that there are currently no footpath or cycle links to the site and given the nature of the development there is no proposal to provide a footpath link.

The Air Quality Assessment provides an assessment of the likely impact of air quality on residential receptors around the proposed site of the crematorium development. The assessment indicates that the overall air quality impact associated with the development - even conservatively assuming various worst-case conditions - can be assumed to be negligible and no further modelling evaluation of impact significance is merited.

The Odour Assessment provides an assessment of the likely impact of odour on residential receptors around the site. The proposed cremator technology incorporates several pollutant abatement technologies covering particulate and vapour-phase species, which can be expected to have a significant impact on the controlled odour releases from the process. Fugitive emissions are considered to be negligible. A simple semi-quantitative screening air quality assessment was used, utilising standard "FIDOL" scoring system in accordance with Institute of Air Quality Management (IAQM) guidance. The assessment concluded that the aggregated odour impact - for worst-case constant operation of the facility (6 cycles per day) - is small and the receptor sensitivity is high, resulting in an overall slight adverse impact magnitude. It concludes that this is not sufficiently significant to warrant recommendation of additional mitigation and control measures.

The Ecology and Protected Species Report reports on data and field surveys of the site and indicates that the site is considered poor from an ecology viewpoint. It is considered that no protected species or habitats are present on site. It concludes that the proposed construction work would have no adverse impact on any protected species or habitats and that no further survey work is required.

A Consultation Response Report is provided which responds to issues raised through consultee and third party representations submitted. The report concludes that the applicants view is that the matters raised by the various third party objectors do not have material weight and the proper and a rounded analysis of the development plan and relevant material considerations continue to support the approval of planning permission.

Consultations

Community Council - Objects to the proposal due to conflicts with the Angus Local Development Plan; lack of suitable access to public transport; and due to the unsuitability of roads surrounding the site which are narrow, with acute bends and poor junction visibility. It suggests 4 road accidents took place during October 2021 and raises concern that the additional traffic associated with the development will only increase the risk of further accidents.

Angus Council - Roads – Provided comments in respect of the road network and access, accidents, parking, pedestrian access, cycling access and public transport and has responded to representations submitted in respect of those matters.

In respect of the road network and access, it is indicated that roads in the vicinity of the site are typical of rural roads in Angus, being twisty and relatively narrow in some places. The proposal to widen the carriageway along the site frontage and provide passing places on sections of the C4 and U315 between the site and the B978 is noted.

Roads has indicated that sightlines at the junction of the U315 and the B978 Kellas Road are currently substandard and are impeded by topography to the south west. Visibility at the junction of the C4/U315 and C4/B978 is also substandard, with the latter having a stop sign at its junction with the B978. Roads has indicated that the visibility at U315/B978 and C4/U315 junctions would need to be improved were planning permission to be granted. On the B978 that would require physical works to alter the vertical alignment of the road and the work at both junctions may affect land outside of the control of the applicant. Roads has indicated that the intensification of use of sub-standard junctions by concentrated levels of new traffic is undesirable and has the potential to be detrimental to road safety.

In respect of parking, the roads service has requested an increase in the level of parking proposed to 120 car parking spaces (1 space per crematorium seat).

In respect of accidents, roads notes that concerns have been raised and evidence provided through representations relating to a recent spate of collisions in the Duntrune and Murroes area during late 2021. Roads has confirmed that the data recorded by Police Scotland relates to injury collisions only and records are no longer kept of collisions resulting in damage only. Recorded collision data over a three year period shows three collisions resulting in injury have been reported in that period, which is low. Damage only collisions are not normally considered by the traffic authority when analysing collision data but that does not mean to imply that concerns raised by local residents are not valid.

Roads notes that there are no formal pedestrian or cycling links in the immediate vicinity of the site. In respect of public transport, it comments that given the location of the site and the fact that the existing public transport services are very low in frequency, the site is not readily accessible by sustainable means of transport. There are two existing bus services that run directly past the proposed site, but they are school bus services and operate before and after school, on school days during term time only. Two additional bus services are cited as running approximately 450m west of the proposed site which is above the recommended desirable walking catchment distance of 400m. Roads notes that the frequency of these bus services is very low and no footways are provided between the site and that bus route. The nature of the public road is such that it would not be desirable to encourage pedestrians to walk on a section of carriageway which is twisty, with changes in level, darkened by tree canopy, unlit, and with a verge with limited opportunities for harbourage by pedestrians to allow vehicles to pass. As such, it is not a route which roads would wish to see pedestrians walk from a bus route to the crematorium facility.

Scottish Water - Offered no objection.

Aberdeenshire Council Archaeology Service – Offered no objection and indicated that no archaeological mitigation is required.

Environmental Health - Offered no objection in terms of air quality, odour and noise subject to the attachment of a planning condition regulating noise levels from fixed plant associated with the development.

Dundee City Council – Indicated that the application does not raise any issues of strategic significance for Dundee City Council and offered no objection.

Scottish Environment Protection Agency – Considered the air quality information submitted and offered no objection.

Representations

A total of 866 representations have been received with 775 raising objection, 89 offering support, and 2 providing neutral comment.

The main points of concern were as follows:

- Proposal is contrary to Scottish Planning Policy and development plan policies;
- Lack of accessibility by a range of transport modes (poor public transport links; lack of footpath and cycle connections);
- The proposal would better serve Dundee than Angus;
- Lack of need, demand and viability for a crematorium in this location;
- Impacts on residential amenity;
- Impacts on air quality/ pollution;
- Impacts on landscape and urbanisation of the countryside;
- Inappropriate building design;
- Impacts on trees, wildlife, protected species and biodiversity;
- Loss of greenfield land/ farmland and impact on farming uses in surrounding area;
- Issues associated with the surrounding road network, substandard visibility at road junctions, narrow and twisty rural roads, frequent accidents, impacts on safety of existing traffic, pedestrians, cyclists and horse riders;
- Insufficient parking provision;
- Impacts on Murroes Primary School and its pupils;
- Would change council/ school catchment boundaries;
- Flooding and drainage issues;
- Issues caused by power supply failure;
- Impact on aviation;
- Deficiencies/ inaccuracies in supporting information;
- Impacts on house prices.

Points in support were as follows:

- Economic benefits including employment during construction and operation of the development and increase in use of nearby hospitality businesses;
- Would reduce journey times/ short travel times from major population;
- There is a demand/waiting lists at existing crematoria and a new facility is needed;
- The site is well located for both Angus and Dundee;
- Provides greater choice for funerals;
- Would reduce costs/help tackle funeral poverty;
- Pleasant setting for a crematorium;
- There would be little environmental/ visual impact;
- The development would result in improvements to the local road network;
- Potential for other community activities within the building;
- Validity of representations submitted in objection and weight that should be attached.

Two letters have been submitted that indicate they are neither in support or objection of the application, but they raise issues similar to those summarised in the matters of objection listed above.

Development Plan Policies

<u>Angus Local Development Plan 2016</u>

Policy DS1 : Development Boundaries and Priorities
Policy DS2 : Accessible Development
Policy DS3 : Design Quality and Placemaking
Policy DS4 : Amenity
Policy TC8 : Community Facilities and Services
Policy TC15 : Employment Development

Policy TC17 : Network of Centres
Policy TC19 : Retail and Town Centre Uses
Policy PV5 : Protected Species
Policy PV6 : Development in the Landscape
Policy PV7 : Woodland, Trees and Hedges
Policy PV15 : Drainage Infrastructure
Policy PV17 : Waste Management Facilities
Policy PV20 : Soils and Geodiversity

TAYplan Strategic Development Plan

Policy 1 Locational Priorities
Policy 2 Shaping Better Places
Policy 5 Town Centres First
Policy 9 Managing TAYplan's assets

The full text of the relevant development plan policies can be viewed at Appendix 1 to this report.

Assessment

Sections 25 and 37(2) of the Town and Country Planning (Scotland) Act 1997 require that planning decisions be made in accordance with the development plan unless material considerations indicate otherwise.

Paragraph 33 of Scottish Planning Policy (SPP) states that where a development plan is more than five years old, the presumption in favour of development that contributes to sustainable development will be a significant material consideration. In this case TAYplan is less than 5-years old but the ALDP has recently become more than 5-years old as it was adopted in September 2016. The assessment that follows considers the content of SPP in relation to the relevant topics.

There are no policies in either TAYplan or the ALDP which deal specifically with applications for crematorium developments. Crematorium developments can attract reasonably significant numbers of people attending funeral services and memorial gardens; they can generate employment and can provide an important and necessary service for the community. Policies relating to the general location of development, accessibility of the site, rural employment, and community facilities are therefore relevant as well as policies relating to design, the natural and built environment, amenity and infrastructure issues.

The suitability of the proposed location

In considering the suitability of the proposed crematorium location, Scottish Planning Policy (SPP) seeks to promote rural development that supports prosperous and sustainable communities. It indicates that *in pressurised areas easily accessible from Scotland's cities and main towns, where ongoing development pressures are likely to continue, it is important to protect against an unsustainable growth in car-based commuting and the suburbanisation of the countryside*. In terms of promoting sustainable transport and active travel, SPP indicates that *planning permission should not be granted for significant travel-generating uses at locations which would increase reliance on the car and where direct links to local facilities via walking and cycling networks are not available or cannot be made available; access to local facilities via public transport networks would involve walking more than 400m; or the transport assessment does not identify satisfactory ways of meeting sustainable transport requirements.* SPP also indicates that a sequential approach should be adopted for uses which generate significant footfall including community facilities. It requires that locations are considered in order of preference: town centres; edge of centre; other commercial centres identified in the development plan; and out of centre locations that are, or can be, made easily accessible by a choice of transport. The SPP indicates that *it is important that community, education and healthcare facilities are located where they are easily accessible to the communities that they are intended to serve*.

Tayplan Policy 1 *location priorities* states, amongst other things, that *development proposals shall focus the majority of development in the region's principal settlements*. The application site is not within a principal settlement as defined by TAYplan.

TAYplan Policy 1 further indicates that proposals for development in the countryside should be assessed against the need to avoid suburbanisation of the countryside and unsustainable patterns of travel and development. Policy 2 *shaping better quality places* seeks to deliver better quality development and places which respond to climate change with developments which are active and healthy by design. This is achieved by ensuring that transport and land use are integrated to reduce the need to travel and improve accessibility by foot, cycle and public transport.

Policy DS1 in the Angus Local Development Plan (ALDP) indicates that outwith development boundaries proposals will be supported where they are of a scale and nature appropriate to their location and where they are in accordance with relevant policies of the ALDP. The policy promotes the redevelopment of brownfield land in preference to greenfield sites

The ALDP supports development which is accessible by a choice of transport modes including walking, cycling and public transport. Policy DS2 *accessible development* indicates that *development proposals will require to demonstrate, according to scale, type and location, that they are or can be made accessible to existing or proposed public transport networks and provide and/or enhance safe and pleasant paths for walking and cycling which are suitable for use by all, and link existing and proposed path networks*. Policy DS3 *design quality and placemaking* indicates that development proposals should create buildings and places which are well connected and where development connects pedestrians, cyclists and vehicles with the surrounding area and public transport. Policy TC8 *community facilities and services* indicates that new facilities should be accessible and of an appropriate scale and nature for the location. Policy TC15 directs new employment development to employment land allocations and existing employment areas within development boundaries. It also offers support for rural diversification where there is an economic and/or operational need for the location and other relevant issues can be addressed.

The application proposes a new 120 seat crematorium and memorial garden in the countryside to the north of the C4 Monifieth-Kingennie-Duntrune public road around 900m to the east of Burnside of Duntrune.

The Planning Statement includes information which seeks to demonstrate that the site is the most sequentially preferable for the proposed development. It lists and discounts sites in Monifieth and Carnoustie and suggests alternative sites within settlement boundaries which are greenfield are not a reasonable alternative to the application site.

Information submitted in support of the application indicates that the majority of traffic visiting the site would do so via private car. The transportation assessment estimates an average of 3 and a maximum of 5 cremations per day, which it suggests would be attended by an average of 70 people per cremation arriving in 24 cars, with an infrequent extreme maximum of 200 people per cremation arriving in 67 cars (based on an average occupancy of 3 people per car). That assessment indicates that there are no footpath links or dedicated cycling links to the site. Public transport options comprise two bus services which pass the site and there are two additional bus services passing 450m to the west of the site. The applicant has suggested that a bus stop could be provided outside of the site entrance and/or a call up service could be provided for users who wish to be collected from the nearest existing bus stop.

Public transport options are limited to two school bus services which pass the site entrance and operate before and after school during term time on a hail and ride basis; with two further infrequent services passing 450m to the west of the site and requiring a user to walk to the site along a section of the C4 public road which is winding, with changes in level, darkened by tree canopy, unlit, and with a verge with limited opportunities for harbourage by pedestrians to allow vehicles to pass.

The roads service has commented on the proposal in the context of the accessibility of the development by a choice of transport modes and notes that there is no formalised pedestrian or cycling links between the site and the surrounding area. They comment that given the location of the site and the fact that the existing public transport services are very low in frequency, the site is not readily accessible by sustainable means of transport and suggest that the C4 to the west of the site is not a route which they would wish to see pedestrians walk from a bus route to the crematorium facility.

The level of public transport provision is extremely limited, and it is unrealistic to imagine that persons attending a funeral would reasonably be expected to rely upon a school bus service that operates on school days, before and after school, and during term time only. The bus services that utilises a route which passes 450m west of the site cannot be considered adequate to provide reasonable accessibility for a crematorium at this location given the limited frequency of service and the physical characteristics of the route between the site and the bus services as described above. The mitigation measures proposed would not address the infrequency of the bus services and the proposed call up service cannot be regarded as convenient for users and again would not address issues relating to limited frequency of service. This site is not well connected to public transport and footpath and cycle connections between the site and the wider area are poor. Overall accessibility by means other than private car for a facility of this nature do not meet policy objectives for a use that would attract significant numbers of visitors.

This site is not located within a principal settlement where policy seeks to direct the majority of new development. While it is accepted that the type of use proposed is unlikely to be come forward in a town centre or edge of centre location, the information relating to alternative sites does not consider sites within Dundee or out of centre sites which are (or can be made) easily accessible by a choice of transport such as those on established transport corridors served by regular public transport services. The information does not reasonably demonstrate that there are no sequentially preferable options available, and the site selected is not accessible by a reasonable choice of transport.

The site proposed for development would not be accessible by a choice of transport modes and would increase reliance on the private car in a location where access to walking, cycling and public transport is poor. A crematorium in this location would promote an unsustainable pattern of travel and development contrary to the approach set out in SPP, TAYplan and the ALDP.

Other development plan considerations

The closest sensitive receptors to the site are three houses (Lunaria, No.1 Cottage, Westhall and The Ship, Westhall) located around 180m from the proposed crematorium building to the east and north east. All other surrounding housing is over 250m from the application site. The proposal would impact on the amenity of those that live in the surrounding area through an increase in activity in and around the site, including an increase in traffic associated with the development on surrounding roads. However, the development would have its own dedicated access onto the public road and there would be reasonable separation between activities within the site and those that reside closest to the development. Impact on neighbouring property would be further reduced if additional planting was provided between the houses and the development.

Technical assessments have been submitted in relation to noise, air quality and odour control and they indicate the impacts from the development would not be unacceptable. The assessments have been reviewed by the council's environmental health service and it has offered no objection to the proposal subject to the attachment of a planning condition regulating noise levels from fixed plant and machinery. SEPA has considered additional information submitted and has offered no objection, noting that the development would require a permit under the Pollution Prevention and Control Regulations. There are no significant amenity issues in respect of air quality, noise, light pollution, odour or loss of privacy to residential property that could not be mitigated by planning conditions.

Development plan policy seeks to ensure that development delivers a high design standard and seeks to protect and enhance the quality of the landscape in Angus. The site selected for development is sloping in nature with rising landform to the north and it is surrounded by established woodland. The building would be sited in the lower part of the field and would be cut into the sloping site, back clothed by landform and woodland which would help it integrate into the landscape. The scale of the proposed building and use of recessive external finishes would also reduce the prominence of the building in views from areas to the south. The new landscaping proposed would also assist with this over time. It is considered that the siting and design of the proposed development would not give rise to any significant design or landscape issues and planning conditions could be attached to secure appropriate external finishes on the building and appropriate new landscaping.

The proposal would result in the loss of around 2HA of agricultural land. Available information and information submitted by the applicant indicates that this field does not contain prime quality agricultural land. It is not clear how the remaining area of agricultural land to the north of the site would be accessed following completion of the development, but that matter could be regulated by planning condition. The proposal has generally been designed to minimise the loss of agricultural land and there is no evidence to demonstrate that the loss of a comparatively small area of non-prime land would affect the viability of a farm unit.

The site is not subject of any natural heritage designation. The ecology and protected species report indicates that the site is poor from an ecology viewpoint and considers that no protected species or habitats are present on site. The report indicates the proposed construction work would have no adverse impact on any protected species or habitats and indicates that no further survey work is required. The woodland to the north and west of the site is subject to a Tree Preservation Order, but that woodland would not be directly affected by the development. The development would include new planting which may enhance the biodiversity contained within the site in the longer term.

The site is not subject to any built or cultural heritage designation and is sufficiently remote and discrete from listed buildings in the surrounding area that it would not impact on their setting. The archaeology service indicated that no archaeological mitigation is required and offer no objection to the proposal. The proposal would not result in any significant direct or indirect impacts on natural, built, or cultural heritage interests.

Information submitted with the application includes a road network analysis and traffic surveys. The trip distribution information suggests that 61.4% of traffic would access the crematorium from the east using the C4 and U315, and 38.5% would access from the west using the C4 and C6.

The assessment indicates that traffic resulting from the development would result in a 27% increase in traffic during the AM peak and 20.3% during the PM peak on the C4 along the site frontage.

The applicant's transportation assessment (TA) asserts that as a result of the low traffic impact on the surrounding road network and the proposed access provision and improvements to existing visibility splays, there is no foreseeable reason for refusal in terms of traffic impact or transport provision. The TA proposes mitigation on the road network including a widening of the C4 public road along the site frontage to 5.5m, the installation of passing places on the C4 and U315 to the east of the site, the provision of signage to direct traffic from the east to use the U315 junction, and improvements to visibility splays at the junction of the U315/B978.

The roads service has reviewed the transportation information submitted by the applicant and has also considered information submitted by or on behalf of third parties (including information provided by a transportation consultant) relating to traffic which is expected to be generated by the development, impacts on the road network and information relating to accidents.

The roads service accepts that aggregated traffic flows associated with the development are anticipated to be below those expected to cause capacity and queuing issues. It also agrees with comments contained within the applicant's TA that suggest it would be desirable to have visibility splays of 4.5m x 160m in both directions at the junction of the U315/B978. Roads also accept the findings of the transportation consultant acting for a third party which identifies that the south-westerly sightline at U315/B978 junction is currently obstructed by the natural topography of the B978 and is currently substandard. Roads indicate that it may be possible for the applicant to improve the topography of the B978 as part of the development mitigation to provide a visibility splay of 4.5m x 160m but has indicated that the physical works to do this would be significant, requiring the vertical alignment of the B978 to be lowered on the north-eastbound approach to the junction. Similarly, the roads service has indicated that sightlines at the junction of the C4/U315 are substandard and require to be improved to 2.4m x 160m. Available information suggests the provision of visibility splay improvements at both junctions could affect land outside of the applicants control and no evidence has been submitted to suggest that the applicant is in a position to make those improvements. While, issues around land ownership or control would not prevent use of a negative, suspensive planning condition to secure provision of improved visibility splays, such works, especially in relation to the U315/B978 junction would be significant.

The roads service has indicated that the intensification of use of sub-standard junctions by concentrated levels of new traffic is undesirable and has the potential to be detrimental to road safety. They indicate that if the development is to go ahead planning conditions would be required to secure improvements and mitigation to the road network, including negative suspensive conditions to secure improvements to the substandard visibility splays at the U315/B978 and C4/U315 junctions.

There is conflicting information regarding the adequacy of the local road network to accommodate development traffic. However, the advice of the council's roads service is that the development could be accommodated subject to identified mitigation. Having regard to their expertise and knowledge of the local area, that advice is accepted.

The site is not shown on SEPA flood maps as being at risk from any source of flooding. The proposal would connect to the public water supply and would utilise a private treatment system for foul drainage which is acceptable outside of areas served by the public drainage network. A soakaway would manage surface water from the development. Supporting technical assessments indicate the site is capable of accommodating the required drainage infrastructure and Scottish Water has offered no objection to the proposal.

The proposal is compatible with some aspects of the development plan and SPP, but it does not comply with policies designed to ensure that development is directed to locations which are accessible by a choice of transport modes and avoids increasing reliance on the private car in situations where access to walking, cycling and public transport is poor. A crematorium in this location would promote an unsustainable pattern of travel and development contrary to the approach set out in SPP, TAYplan and the ALDP. On this basis the proposal is considered contrary to TAYplan and ALDP.

Material considerations

In terms of material considerations, it is relevant to have regard to additional matters raised in the applicants supporting information, issues raised in support and objection to the proposal by third parties, and Scottish Planning Policy (SPP) in so far as that has not been addressed above.

The applicant has submitted information that suggests there is a requirement for additional crematorium facilities in the area and references a report prepared by University of Dundee in July 2019 titled *Tackling Funeral Poverty in Dundee through Social Enterprise*. That report provides a number of recommendations to help address funeral poverty in Dundee including a recommendation that Dundee City Council could actively consider the addition of another crematorium facility. The report suggests that 800-1000 cremations per year are required to make a crematorium viable and given there are approximately 1,800 deaths per year in Dundee, if the surrounding areas were included, there could be potential for additional crematorium capacity. Third parties have suggested that the development would alleviate pressure on existing facilities.

It is relevant to note that a new crematorium has been granted planning permission at Brewsterwells, 6 miles south of St Andrews and that will provide some additional capacity to serve the wider area. Objectors suggest that there is no need for a new crematorium facility, having regard to existing provision at Dundee and Friockheim and the consented development at Brewsterwells. A Drive Time Analysis Report has been submitted by a crematorium development consultant on behalf of a third party, which suggests the need for an additional crematorium is not cogent and that a new facility is unlikely to be viable. The applicant has refuted that suggestion and suggests the figures projected in the consultant's report would be highly satisfactory for the operator in terms of development viability.

There is some suggestion that the proposed crematorium would encourage competition and result in reduced prices in the area, but that cannot be controlled through the planning system.

Third parties have suggested that the development would reduce the need to travel to existing facilities and some comparison is drawn between the locational characteristics of this site and the existing crematorium facility at Parkgrove, located east of Friockheim. However, planning policy has evolved since the establishment of Parkgrove and seeks to reduce reliance on the private car and to direct new development to locations which are accessible by a choice of transport modes including walking, cycling and public transport. A more relevant comparison to this proposal is the crematorium facility which was proposed on Linlathen Estate in 2007 (Dundee City Council ref: 07/00160/OUT), just to the south of Drumsturdy Road and around 1.8km south east of the application site. That proposal, which included a crematorium, cemetery and associated public house/restaurant, was refused planning permission by Scottish Ministers, for amongst other reasons, because it did not enjoy good accessibility, particularly for pedestrians, cyclists and public transport users. That proposal was in a location close to the current application site and with similar characteristics in terms of limited accessibility by sustainable modes of transport. It is clear that Scottish Ministers considered good accessibility, particularly for pedestrians, cyclists and public transport users to be an important requirement for a facility of this nature. Planning policy has retained, and if anything increased the importance of accessibility by sustainable modes of transport in the intervening period.

Information submitted in support of the application indicates that the development is anticipated to create 4 full time jobs and those making representation in support of the proposal suggest that it would have associated benefits for the hospitality sector. There would also be employment opportunities associated with the construction of the facility. It is accepted that there would likely be additional employment opportunities created through the construction and operation of the business. Potential benefit to the hospitality sector has not been quantified and the provision of an additional crematorium is unlikely, in itself, to increase hospitality trade; it may simply result in displacement of spend. Information has not been provided to quantify net economic impact associated with the proposal.

The community council and third parties raise concerns relating to traffic safety for local residents, public access, public transport provision and the suitability of access roads in the area surrounding the site. These matters are discussed earlier in this report and the lack of accessibility of the site to sustainable modes of transport is an issue which cannot readily be addressed at this location and which renders the proposal contrary to development plan policy and SPP.

The proposal would provide some additional choice and it may provide some economic benefit. However, there is no information to demonstrate that there is an overriding need for the provision of a new crematorium on a site in the countryside that has poor accessibility, and there is no evidence to demonstrate it would provide significant net economic benefit that would justify setting aside SPP or development plan policy requirements regarding location of development and accessibility.

Comment has been submitted raising concern regarding the adverse impact of the proposed development on the amenity and environment of the area. Comment has been submitted suggesting that the development would give rise to little environmental impact and that the site is a good location for a crematorium. Issues regarding these matters are discussed in the policy assessment above having regard to the expert advice provided by consultation bodies and other relevant information. The development would change the environment of the area and it would result in some adverse impact on the amenity of those that live in the vicinity. However, impact could be mitigated through the use of planning conditions and impacts are not such that they would merit refusal of the application. The absence of unacceptable amenity or environmental impact does not justify setting aside SPP or development plan policy requirements regarding location of development and accessibility.

The development would result in the loss of around 2HA of agricultural land, but that land is not identified as being of prime quality and there is no evidence to suggest that there would be any adverse impact on the viability of any farm unit. Additional traffic on the local road network may have some minor impact on the movement of agricultural vehicles, but potential for significant impact would be infrequent and could be mitigated through the provision of passing places.

Significant information has been submitted by the applicant and by objectors regarding road safety matters. Objectors provide evidence of road accidents in the vicinity of the site and raise concerns about the suitability of the surrounding road network to accommodate the development. Supporters refer to improvements which would be made to the road network should the development go ahead, commenting that would be a wider benefit to the public. The roads service indicate that recorded collision data over a three year period shows three collisions resulting in injury have been reported in that period, which is low. While they note the evidence and concerns relating to damage only collisions, they offer no objection to the proposal subject to identified road improvements. As the roads service is satisfied that the development could take place without unacceptable impacts on the surrounding road network, albeit subject to identified mitigation, this matter does not justify refusal of planning permission. The improvements to the road network which would result from the development may be of minor benefit to road safety on the surrounding road network, but they would not justify approval of development in a location that otherwise has poor accessibility.

Some concern has been raised regarding impacts on Murroes School and the wellbeing of its pupils. However, the site is some distance from the school. While school pupils might pass the facility or be aware of persons attending a service if public transport links were shared, this arrangement would not be unusual or uncommon. There is no basis to consider that approval of this application would result in alteration of administrative boundaries in the area.

The site is not within an area identified by SEPA as being at risk of flooding and there is no evidence to suggest that adequate drainage provision could not be provided in a manner that would avoid significant flood risk to the surrounding area.

There is no development plan policy requirement for a backup power supply to deal with situations where there are power cuts. Issues regarding power supply to the site would be matters for the developer and the relevant utility supplier.

There is no basis to consider that the development would adversely affect aviation interests and there is no requirement to undertake consultation in relation to this matter for a development of this nature.

Third parties suggest that the site could be beneficial in providing opportunity for other community use. That does not form part of this proposal but, in any case, a community building should be located such that it is accessible to all sections of the community by a range of transport modes. This location does not meet that requirement.

Reduction in property value as a result of development is not a material planning consideration.

The information submitted in relation to the application is adequate to allow a decision to be made.

A significant number of representations have been submitted both in objection to and in support of the application. All relevant planning issues raised in those letters have been considered irrespective whether they are submitted using a standard format.

As indicated above SPP states that where a development plan is more than five years old, the presumption in favour of development that contributes to sustainable development will be a significant material consideration. In this case TAYplan is less than 5-years old but the ALDP has recently become more than 5-years old as it was adopted in September 2016.

This is a proposal for a use that would attract a significant number of visitors. The applicant has suggested that persons attending cremations are likely to travel by car. However, there are those in the community that do not have access to a private car and that rely upon other means of transport. There are also those in the community that want to exercise the ability to use sustainable means of transport. In addition, planning policy at all levels promotes an approach that directs new travel generating uses to locations that are accessible by sustainable modes of transport.

TAYplan and SPP indicate that uses that generate significant numbers of visitors should be directed to locations which are accessible by a choice of transport modes and that avoid increasing reliance on the private car in situations where access to walking, cycling and public transport is poor. This proposal is not in a location that would meet those requirements regarding accessibility. It is in a location where direct links by walking and cycling networks are not available, and where public transport accessibility is poor. This development would increase reliance on the private car.

The proposal is compatible with some aspects of TAYplan and SPP and account has been had for the principles identified at paragraph 29 of the SPP along with its wider policy objectives. However, the proposal is not consistent with those policies in both documents which seek to ensure new development that would generate significant numbers of visitors is located in areas that are accessible by a choice of sustainable transport modes and that reduce reliance upon the private car. The proposal does not constitute a sustainable form of development given the reliance upon the private car and the lack of accessibility by sustainable modes of transport.

NPF4 has been published in draft form and contains national planning policy that will form part of the development plan. However, it has been published for consultation purposes and therefore the policies it contains merit little weight at this time. Notwithstanding that, it is relevant to note that the document retains a general policy objective to ensure that new development is located in locations that are accessible by sustainable modes of transport and that reduce reliance on travel by private car.

In conclusion, a development that would generate a significant number of visitors but that would increase reliance on access by private car is contrary to policies of SPP, TAYplan and the ALDP which are designed to ensure that new development is accessible by a range of transport modes including walking, cycling and public transport. The development is proposed at a location that does not have good accessibility, particularly for pedestrians, cyclists and public transport users and there is a significant level of objection to the application raising this concern. While the proposal may be compatible with some aspects of relevant policy, it is contrary to SPP, TAYplan and the ALDP for reasons related to accessibility. A facility of this nature should be provided at a location with good accessibility for all sections of the community, and not just those can or wish to travel by private car. Account has been had for all matters raised in support and objection to the application, but there are no material considerations which justify approval of planning permission contrary to the provisions of the development plan.

Human Rights Implications

The decision to refuse this application has potential implications for the applicant in terms of his entitlement to peaceful enjoyment of his possessions (First Protocol, Article 1). For the reasons referred to elsewhere in this report justifying the decision in planning terms, it is considered that any actual or apprehended infringement of such Convention Rights, is justified. Any interference with the applicant's right to peaceful enjoyment of his possessions by refusal of the present application is in compliance with the Council's legal duties to determine this planning application under the Planning Acts and such refusal constitutes a justified and proportionate control of the use of property in accordance with the general interest and is necessary in the public interest with reference to the Development Plan and other material planning considerations as referred to in the report.

Decision

The application is refused

Reason(s) for Decision:

1. The development would result in an unsustainable pattern of travel and development and

would not be accessible by a choice of transport modes, increasing reliance on the private car in a situation where access to walking, cycling and public transport is poor. The proposal is therefore contrary to TAYplan policies 1 and 2, Angus Local Development Plan policies DS2, DS3 and TC8, and Scottish Planning Policy in so far as it relates to locating development in accessible locations.

2. The application is contrary to Policy DS1 of the Angus Local Development Plan 2016 because the scale and nature of the development is not appropriate for its location because it does not enjoy good accessibility, particularly for pedestrians, cyclists and public transport; and because the proposal is not in accordance with other relevant policies, namely policies DS2, DS3 and TC8.

Case Officer: Ed Taylor
Date: 20 January 2021

Appendix 1 - Development Plan Policies

TAYplan

Policy 1 Location Priorities
Principal Settlement Hierarchy
Strategies, plans, programmes and development proposals shall focus the majority of development in the region's principal settlements as shown on Map 1 (opposite):

A. Tier 1 principal settlements which have the potential to accommodate the majority of the region's additional development over the plan period and make a major contribution to the region's economy;

• Within Dundee Core Area in the principal settlements of Dundee City; including Dundee Western Gateway, and Invergowrie, Monifieth, Tayport/Newport/Wormit, Birkhill/Muirhead; and,

• Within Perth Core Area in the principal settlements of Perth City, Scone, Almondbank, Bridge of Earn, Oudenarde, Methven, Stanley, Luncarty, Balbeggie, Perth Airport.

Tier 2 principal settlements which have the potential to make a major contribution to the regional economy but will accommodate a smaller share of the additional development; and,

Tier 3 principal settlements which have the potential to play an important but more modest role in the regional economy and will accommodate a small share of the additional development.

B. Sequential Approach
Strategies, plans and programmes shall prioritise land release for all principal settlements using the sequential approach in this Policy; shall prioritise within each category, as appropriate, the reuse of previously developed land and buildings (particularly listed buildings); and shall ensure that such land is effective or expected to become effective in the plan period, and that a range of sites is made available, as follows:

1. Land within principal settlements; then,

2. Land on the edge of principal settlements; then,

3. Where there is insufficient land or where the nature/scale of land use required to deliver the Plan cannot be accommodated within or on the edge of principal settlements, and where it is consistent with Part A of this policy and with Policy 2, the expansion of other settlements should be considered.

C. Outside of Principal Settlements
Local Development Plans may also provide for some development in settlements that are not defined as principal settlements (Policy 1A). This is provided that it can be accommodated and supported by the settlement, and in the countryside; that the development genuinely contributes to the outcomes of this Plan; and, it meets specific local needs or does not undermine regeneration of the cities or respective settlement.

Proposals for development in the countryside should be assessed against the need to avoid suburbanisation of the countryside and unsustainable patterns of travel and development.

D. Green belts
Local Development Plans shall continue the implementation of green belt boundaries at both St Andrews and Perth to preserve their settings, views and special character including their historic cores; protect and provide access to open space; assist in safeguarding the countryside from encroachment; to manage long term planned growth including infrastructure on Map 10 and Strategic Development Areas in Policy 3; and define the types and scales of development that are appropriate within the green belt based on Scottish Planning Policy.

Policy 2 SHAPING BETTER QUALITY PLACES
To deliver better quality development and places which respond to climate change, Local Development Plans, design frameworks masterplans/briefs and development proposals should be:

A. Place-led to deliver distinctive places by ensuring that the arrangement, layout, design, density and mix of development are shaped through incorporating and enhancing natural and historic assets*, natural processes, the multiple roles of infrastructure and networks, and local design context.

B. Active and healthy by design by ensuring that:

i. the principles of lifetime communities (p. 17) are designed-in;
ii. new development is integrated with existing community infrastructure and provides new community infrastructure/facilities where appropriate;
iii. collaborative working with other delivery bodies concentrates and co-locates new buildings, facilities and infrastructure; and,
iv. transport and land use are integrated to:
a. reduce the need to travel and improve accessibility by foot, cycle and public transport and related facilities;
b. make the best use of existing infrastructure to achieve an active travel environment combining different land uses with green space; and,
c. support land use and transport integration by transport assessments/ appraisals and travel plans where appropriate, including necessary on and off-site infrastructure.

C. Resilient and future-ready by ensuring that adaptability and resilience to a changing climate are built into the natural and built environments through:
i. a presumption against development in areas vulnerable to coastal erosion, flood risk and rising sea levels;
ii. assessing the probability of risk from all sources of flooding;

iii. the implementation of mitigation and management measures, where appropriate, to reduce flood risk; such as those envisaged by Scottish Planning Policy, Flood Risk Management Strategies and Local Flood Risk Management Plans when published;
iv. managing and enhancing the water systems within a development site to reduce surface water runoff including through use of sustainable drainage systems and storage;
v. protecting and utilising the natural water and carbon storage capacity of soils, such as peat lands, and woodland/other vegetation;
vi. Identifying, retaining and enhancing existing green networks and providing additional networks of green infrastructure (including planting in advance of development), whilst making the best use of their multiple roles; and,
vii. design-in and utilise natural and manmade ventilation and shading, green spaces/networks, and green roofs and walls.

D. Efficient resource consumption by ensuring that:
i. waste management solutions are incorporated into development;
ii. high resource efficiency is incorporated within development through:
a. the orientation and design of buildings and the choice of materials to support passive standards; and,
b. the use of or designing in the capability for low/zero carbon heat and power generating technologies and storage to reduce carbon emissions and energy consumption; and,
c. the connection to heat networks or designing-in of heat network capability.

Footnotes
**Natural and historic assets: Landscapes, habitats, wildlife sites and corridors, vegetation, biodiversity, green spaces, geological features, water courses and ancient monuments, archaeological sites and landscape, historic battlefields, historic buildings, townscapes, parks, gardens and other designed landscapes, and other features (this includes but is not restricted to designated buildings or areas).*

Policy 5 TOWN CENTRES FIRST
To protect and enhance the vitality, viability and vibrancy of city/town centres:

A. strategies, plans, programmes and development proposals should focus land uses that generate significant footfall in city/town centres defined in the network of centres (below) ahead of other locations (including retail, commercial leisure, offices, community and cultural facilities, civic activity and, where appropriate public buildings such as libraries, education and health care facilities). Other land uses including residential, hospitality and catering, events and markets should be encouraged in town centres.

B. Local Development Plans should:
i. identify specific boundaries, where appropriate, for each city/town centre, local centre and commercial centre in the network (below); including those subsequently identified in Local Development Plans;
ii. specify the appropriate functions that can take place at individual commercial centres; and,
iii. identify any other town centres and commercial centres, as appropriate; this will be particularly likely in larger, multi-centre settlements such as Dundee, Perth and Arbroath.

C. Local Development Plans and planning decisions should recognise that hospitality, catering and leisure facilities play a prominent role in supporting the visitor function of settlements and in the daytime and evening economy of all centres. They should also support improvements to town centres that enable events, festivals or markets to take place and which improve the general maintenance, character and wellbeing of the centre.

D. planning decisions for land uses that generate significant footfall should be based on the sequential priority (below – taken from Scottish Planning Policy) and other local considerations as appropriate.

Policy 9 MANAGING TAYPLAN'S ASSETS
Land should be identified through Local Development Plans to ensure responsible management of TAYplan's assets by:

A. Finite Resources using the location priorities set out in Policy 1 of this Plan to:
i. identify and protect known deposits of solid, liquid and gas minerals of economic importance;
ii. maintain a minimum of 10 years supply of construction aggregates at all times in all market areas;
iii. identify and protect deposits of nationally important minerals identified on the British Geological Survey's Critical List; and,
iv. protect prime agricultural land or land of lesser quality that is locally important, new and existing forestry areas, and carbon rich soils where the advantages of development do not outweigh the loss of this land.

B. Protecting Natura 2000 sites ensuring development likely to have a significant effect on a designated or proposed Natura 2000 site(s) (either alone or in combination with other sites or projects), will be subject to an appropriate assessment. Appropriate mitigation must be identified, where necessary, to ensure there will be no adverse effect on the integrity of Natura 2000 sites in accordance with Scottish Planning Policy.

C. Safeguarding the integrity of natural and historic assets
i. understanding and respecting the regional distinctiveness and scenic value of the TAYplan area through safeguarding the integrity of natural and historic assets; including habitats, wild land, sensitive green spaces, forestry, water environment, wetlands, floodplains (in-line with the Water Framework Directive), carbon sinks, species and wildlife corridors, and also geo-diversity, landscapes, parks, townscapes, archaeology, historic battlefields, historic buildings and monuments; and by allowing development where it does not adversely impact upon or preferably enhances these assets. Local Development Plans should set out the factors which will be taken into account in development management. The level of protection given to local designations should not be as high as that given to international or national designations. International, national and locally designated areas and sites should be identified and afforded the appropriate level of protection, and the reasons for local designations should be clearly explained and their function and continuing relevance considered, when preparing plans.
ii. Protecting and improving the water environment (including groundwater) in accordance with the legal requirements in the *Water Framework Directive 2000/60/EC* and the *Water Environment and Water Services (Scotland) Act 2003* which require greater integration between planning and water management through River Basin Management Plans.

D. Safeguarding the qualities of unspoiled coast identifying and safeguarding parts of the unspoiled coastline along the River Tay Estuary and in Angus and North Fife, that are unsuitable for development. Local Development Plans should also set out policies for their management; identifying areas at risk from flooding and sea level rise and develop policies to manage retreat and realignment, as appropriate. Local Development Plans should have regard to the National Marine Plan, and Regional Marine Plans, where appropriate.

Angus Local Development Plan 2016

Policy DS1 : Development Boundaries and Priorities

All proposals will be expected to support delivery of the Development Strategy.

The focus of development will be sites allocated or otherwise identified for development within the Angus Local Development Plan, which will be safeguarded for the use(s) set out. Proposals for alternative uses will only be acceptable if they do not undermine the provision of a range of sites to meet the development needs of the plan area.

Proposals on sites not allocated or otherwise identified for development, but within development boundaries will be supported where they are of an appropriate scale and nature and are in accordance with relevant policies of the ALDP.

Proposals for sites outwith but contiguous* with a development boundary will only be acceptable where it is in the public interest and social, economic, environmental or operational considerations confirm there is a need for the proposed development that cannot be met within a development boundary.

Outwith development boundaries proposals will be supported where they are of a scale and nature appropriate to their location and where they are in accordance with relevant policies of the ALDP.

In all locations, proposals that re-use or make better use of vacant, derelict or under-used brownfield land or buildings will be supported where they are in accordance with relevant policies of the ALDP.

Development of greenfield sites (with the exception of sites allocated, identified or considered appropriate for development by policies in the ALDP) will only be supported where there are no suitable and available brownfield sites capable of accommodating the proposed development.

Development proposals should not result in adverse impacts, either alone or in combination with other proposals or projects, on the integrity of any European designated site, in accordance with Policy PV4 Sites Designated for Natural Heritage and Biodiversity Value.

*Sharing an edge or boundary, neighbouring or adjacent

Policy DS2 : Accessible Development
Development proposals will require to demonstrate, according to scale, type and location, that they:

- are or can be made accessible to existing or proposed public transport networks;
- make provision for suitably located public transport infrastructure such as bus stops, shelters, lay-bys, turning areas which minimise walking distances;
- allow easy access for people with restricted mobility;
- provide and/or enhance safe and pleasant paths for walking and cycling which are suitable for use by all, and link existing and proposed path networks; and
- are located where there is adequate local road network capacity or where capacity can be made available.

Where proposals involve significant travel generation by road, rail, bus, foot and/or cycle, Angus Council will require:

- the submission of a Travel Plan and/or a Transport Assessment.
- appropriate planning obligations in line with Policy DS5 Developer Contributions.

Policy DS3 : Design Quality and Placemaking

Development proposals should deliver a high design standard and draw upon those aspects of landscape or townscape that contribute positively to the character and sense of place of the area in which they are to be located. Development proposals should create buildings and places which are:

- o Distinct in Character and Identity: Where development fits with the character and pattern of development in the surrounding area, provides a coherent structure of streets, spaces and buildings and retains and sensitively integrates important townscape and landscape features.
- o Safe and Pleasant: Where all buildings, public spaces and routes are designed to be accessible, safe and attractive, where public and private spaces are clearly defined and appropriate new areas of landscaping and open space are incorporated and linked to existing green space wherever possible.
- o Well Connected: Where development connects pedestrians, cyclists and vehicles with the surrounding area and public transport, the access and parking requirements of the Roads Authority are met and the principles set out in 'Designing Streets' are addressed.
- o Adaptable: Where development is designed to support a mix of compatible uses and accommodate changing needs.
- o Resource Efficient: Where development makes good use of existing resources and is sited and designed to minimise environmental impacts and maximise the use of local climate and landform.

Supplementary guidance will set out the principles expected in all development, more detailed guidance on the design aspects of different proposals and how to achieve the qualities set out above. Further details on the type of developments requiring a design statement and the issues that should be addressed will also be set out in supplementary guidance.

Policy DS4 : Amenity
All proposed development must have full regard to opportunities for maintaining and improving environmental quality. Development will not be permitted where there is an unacceptable adverse impact on the surrounding area or the environment or amenity of existing or future occupiers of adjoining or nearby properties.
Angus Council will consider the impacts of development on:

- Air quality;
- Noise and vibration levels and times when such disturbances are likely to occur;
- Levels of light pollution;
- Levels of odours, fumes and dust;
- Suitable provision for refuse collection / storage and recycling;
- The effect and timing of traffic movement to, from and within the site, car parking and impacts on highway safety; and
- Residential amenity in relation to overlooking and loss of privacy, outlook, sunlight, daylight and overshadowing.

Angus Council may support development which is considered to have an impact on such considerations, if the use of conditions or planning obligations will ensure that appropriate mitigation and / or compensatory measures are secured.

Applicants may be required to submit detailed assessments in relation to any of the above criteria to the Council for consideration.

Where a site is known or suspected to be contaminated, applicants will be required to undertake investigation and, where appropriate, remediation measures relevant to the current or proposed use to prevent unacceptable risks to human health.

Policy TC8 : Community Facilities and Services
The Council will encourage the retention and improvement of public facilities and rural services.

Proposals resulting in the loss of existing public community facilities will only be supported where it can be demonstrated that:

- o The proposal would result in the provision of alternative facilities of equivalent community benefit and accessibility; or
- o The loss of the facility would not have an adverse impact on the community; or
- o The existing use is surplus to requirements or no longer viable; and
- o No suitable alternative community uses can be found for the buildings and land in question.

The Council will seek to safeguard rural services that serve a valuable local community function such as local convenience shops, hotels, public houses, restaurants and petrol stations. Proposals for alternative uses will only be acceptable where it can be demonstrated that:

- o the existing business is no longer viable and has been actively marketed for sale as a going concern at a reasonable price/rent for a reasonable period of time;
- o the building is incapable of being reused for its existing purpose or redeveloped for an appropriate local community or tourism use; or
- o equivalent alternative facilities exist elsewhere in the local community.

New community facilities should be accessible and of an appropriate scale and nature for the location. In the towns of Angus, and where appropriate to the type of facility, a town centre first approach should be applied to identifying a suitable location.

Policy TC15 Employment Development
Proposals for new employment development (consisting of Class 4, 5, or 6) will be directed to employment land allocations or existing employment areas within development boundaries, subject to the application of the sequential approach required by Policy TC19 Retail and Town Centre Uses for office developments of over 1,000 square metres gross floorspace.

Proposals for employment development outside of employment land allocations or existing employment areas, but within the development boundaries of the towns and the settlements within the rural area will be supported where:

- there are no suitable or viable sites available within an employment land allocation or existing employment area; or
- the use is considered to be acceptable in that location; and
- there is no unacceptable impact on the built and natural environment, surrounding amenity, access and infrastructure.

Proposals for employment development (consisting of Class 4, 5, or 6) outwith development boundaries will only be supported where:

- the criteria relating to employment development within development boundaries are met;
- the scale and nature of the development is in keeping with the character of the local landscape and pattern of development; and
- the proposal constitutes rural diversification where:

- o the development is to be used directly for agricultural, equestrian, horticultural or forestry operations, or for uses which by their nature are appropriate to the rural character of the area; or
- o the development is to be used for other business or employment generating uses, provided that the Council is satisfied that there is an economic and/or operational need for the location.

Policy TC17 : Network of Centres
Angus Council will seek to protect and enhance the scale and function of the centres as set out in Table 2 below.

A town centre first policy is applied to uses including retail, commercial leisure, offices, community and cultural facilities that attract significant numbers of people. Support will be given to development proposals in town centres which are in keeping with the townscape and pattern of development and which conform with the character, scale and function of the town centres.

All development proposals within a Commercial Centre will have to satisfy criteria within Policy TC19 Retail and Town Centre Uses.

Policy TC19 : Retail and Town Centre Uses
Proposals for retail and other town centre uses* over 1000 m2 gross floorspace (including extensions) on the edge of or outside of defined town centres (including in out of town locations) will be required to submit relevant assessments (including retail/town centre impact and transport assessments) and demonstrate that the proposal:

- o has followed a sequential approach to site selection, giving priority to sites within the defined town centre before edge of centre, commercial centre or out of centre sites which are, or can be made accessible;
- o does not individually or cumulatively undermine the vibrancy, vitality and viability of any of the town centres identified in Table 2 in Angus;
- o tackles deficiencies in existing provision, in qualitative or quantitative terms; and
- o is compatible with surrounding land uses and there is no unacceptable impact on the built and natural environment, surrounding amenity, access and infrastructure.

Proposals for retail and other town centre uses8 under 1000 m2 gross floorspace (including extensions) on the edge of or outside of defined town centres may be required to submit relevant assessments (including retail / town centre impact, transport and sequential assessments) where it is considered that the proposal may have a significant impact on the vibrancy, vitality and viability of any of the town centres in Angus.

*Town centre uses include commercial leisure, offices, community and cultural facilities.

Policy PV5 : Protected Species
Angus Council will work with partner agencies and developers to protect and enhance all wildlife including its habitats, important roost or nesting places. Development proposals which are likely to affect protected species will be assessed to ensure compatibility with the appropriate regulatory regime.

European Protected Species
Development proposals that would, either individually or cumulatively, be likely to have an unacceptable adverse impact on European protected species as defined by Annex 1V of the Habitats Directive (Directive 92/24/EEC) will only be permitted where it can be demonstrated to the satisfaction of Angus Council as planning authority that:

- o there is no satisfactory alternative; and
- o there are imperative reasons of overriding public health and/or safety, nature, social or economic interest and beneficial consequences for the environment, and
- o the development would not be detrimental to the maintenance of the population of a European protected species at a favourable conservation status in its natural range

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Other Protected Species
Development proposals that would be likely to have an unacceptable adverse effect on protected species unless justified in accordance with relevant species legislation (Wildlife and Countryside Act 1981 and the Protection of Badgers Act 1992) subject to any consequent amendment or replacement.

Further information on protected sites and species and their influence on proposed development will be set out in a Planning Advice Note.

Policy PV6 : Development in the Landscape
Angus Council will seek to protect and enhance the quality of the landscape in Angus, its diversity (including coastal, agricultural lowlands, the foothills and mountains), its distinctive local characteristics, and its important views and landmarks.

Capacity to accept new development will be considered within the context of the Tayside Landscape Character Assessment, relevant landscape capacity studies, any formal designations and special landscape areas to be identified within Angus. Within the areas shown on the proposals map as being part of 'wild land', as identified in maps published by Scottish Natural Heritage in 2014, development proposals will be considered in the context of Scottish Planning Policy's provisions in relation to safeguarding the character of wild land.

Development which has an adverse effect on landscape will only be permitted where:

- o the site selected is capable of accommodating the proposed development;
- o the siting and design integrate with the landscape context and minimise adverse impacts on the local landscape;
- o potential cumulative effects with any other relevant proposal are considered to be acceptable; and
- o mitigation measures and/or reinstatement are proposed where appropriate.

Landscape impact of specific types of development is addressed in more detail in other policies in this plan and work involving development which is required for the maintenance of strategic transport and communications infrastructure should avoid, minimise or mitigate any adverse impact on the landscape.

Further information on development in the landscape, including identification of special landscape and conservation areas in Angus will be set out in a Planning Advice Note.

Policy PV7 : Woodland, Trees and Hedges
Ancient semi-natural woodland is an irreplaceable resource and should be protected from removal and potential adverse impacts of development. The council will identify and seek to enhance woodlands of high nature conservation value. Individual trees, especially veteran trees or small groups of trees which contribute to landscape and townscape settings may be protected through the application of Tree Preservation Orders (TPO).

Woodland, trees and hedges that contribute to the nature conservation, heritage, amenity, townscape or landscape value of Angus will be protected and enhanced. Development and planting proposals should:

- o protect and retain woodland, trees and hedges to avoid fragmentation of existing provision;
- o be considered within the context of the Angus Woodland and Forestry Framework where woodland planting and management is planned;
- o ensure new planting enhances biodiversity and landscape value through integration with and contribution to improving connectivity with existing and proposed green infrastructure and use appropriate species;
- o ensure new woodland is established in advance of major developments;
- o undertake a Tree Survey where appropriate; and
- o identify and agree appropriate mitigation, implementation of an approved woodland management plan and re-instatement or alternative planting.

Angus Council will follow the Scottish Government Control of Woodland Removal Policy when considering proposals for the felling of woodland.

Policy PV15 : Drainage Infrastructure
Development proposals within Development Boundaries will be required to connect to the public sewer where available.

Where there is limited capacity at the treatment works Scottish Water will provide additional wastewater capacity to accommodate development if the Developer can meet the 5 Criteria*. Scottish Water will instigate a growth project upon receipt of the 5 Criteria and will work with the developer, SEPA and Angus Council to identify solutions for the development to proceed.

Outwith areas served by public sewers or where there is no viable connection for economic or technical reasons private provision of waste water treatment must meet the requirements of SEPA and/or The Building Standards (Scotland) Regulations. A private drainage system will only be considered as a means towards achieving connection to the public sewer system, and when it forms part of a specific development proposal which meets the necessary criteria to trigger a Scottish Water growth project.

All new development (except single dwelling and developments that discharge directly to coastal waters) will be required to provide Sustainable Drainage Systems (SUDs) to accommodate surface water drainage and long term maintenance must be agreed with the local authority. SUDs schemes can contribute to local green networks, biodiversity and provision of amenity open space and should form an integral part of the design process.

Drainage Impact Assessment (DIA) will be required for new development where appropriate to identify potential network issues and minimise any reduction in existing levels of service.

*Enabling Development and our 5 Criteria (http://scotland.gov.uk/Resource/0040/00409361.pdf)

Policy PV17 : Waste Management Facilities
Existing waste management facilities will be safeguarded from alternative development except where it is demonstrated that they are surplus or no longer suitable to meet future requirements or where alternative provision of equal or improved standard is provided on another site.

Development proposals adjacent to existing or proposed waste management facilities should not directly or indirectly compromise the present or future operation of the facility.

Proposals for new waste management facilities will be supported where they deliver the objectives outlined in the Zero Waste Plan (to prevent, reduce, recycle, recover and pre-treat waste).

The preferred location for new waste management facilities will be within or adjacent to existing waste management sites or on land identified for employment or industrial use. Former mineral sites and derelict or degraded land may also be acceptable. Such facilities should have regard to the local townscape and pattern of development.

Outwith these locations, proposals for new waste management facilities may be acceptable where they meet an identified community need and are in a location that minimises travel distances for that community.

Proposals will be supported where:

- o impacts on the natural and built environment, amenity, landscape character, visual amenity, air quality, water quality, groundwater resources, site access, traffic movements, road capacity and road safety are acceptable or could be satisfactorily mitigated through planning conditions or planning agreement; and
- o appropriate details of restoration, aftercare and after use are submitted for approval by Angus Council, recognising that ecological solutions are the preferred from of restoration. Opportunities to enhance, extend and / or link to existing green networks should be investigated. Prior to commencement of development Angus Council may require a bond to cover the cost of the agreed scheme of restoration, aftercare and after use.

Energy from waste recovery facilities will also be assessed against Policy PV9 Renewable and Low Carbon Energy Development and the Scottish Environment Protection Agency's Thermal Treatment of Waste Guidelines 2014.

Policy PV20 : Soils and Geodiversity
Development proposals on prime agricultural land will only be supported where they:

- o support delivery of the development strategy and policies in this local plan;
- o are small scale and directly related to a rural business or mineral extraction; or
- o constitute renewable energy development and are supported by a commitment to a bond commensurate with site restoration requirements.

Design and layout should minimise land required for development proposals on agricultural land and should not render any farm unit unviable.

Development proposals affecting deep peat or carbon rich soils will not be allowed unless there is an overwhelming social or economic need that cannot be met elsewhere. Where peat and carbon rich soils are present, applicants should assess the likely effects of development proposals on carbon dioxide emissions.
All development proposals will incorporate measures to manage, protect and reinstate valuable soils, groundwater and soil biodiversity during construction.

Tuesday, 22 December 2020

Local Planner
Planning Service
Angus Council
Forfar
DD8 1AN

Dear Sir/Madam

SITE: Land North East Of, Duntrune House, Duntrune
PLANNING REF: 20/00830/FULL
OUR REF: DSCAS-0029300-LPJ
PROPOSAL: Erection Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosuresof Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

Please quote our reference in all future correspondence

Audit of Proposal

Scottish Water has no objection to this planning application; however, the applicant should be aware that this does not confirm that the proposed development can currently be serviced and would advise the following:

Water Capacity Assessment

Scottish Water has carried out a Capacity review and we can confirm the following:

- There is currently sufficient capacity in the Clatto Water Treatment Works to service your development. However, please note that further investigations may be required to be carried out once a formal application has been submitted to us.

Waste Water Capacity Assessment

- Unfortunately, according to our records there is no public Scottish Water, Waste Water infrastructure within the vicinity of this proposed development therefore we would advise applicant to investigate private treatment options.

Please Note

- The applicant should be aware that we are unable to reserve capacity at our water and/or waste water treatment works for their proposed development. Once a formal connection application is submitted to Scottish Water after full planning permission has been granted, we will review the availability of capacity at that time and advise the applicant accordingly.

Surface Water

For reasons of sustainability and to protect our customers from potential future sewer flooding, Scottish Water will not accept any surface water connections into our combined sewer system.

There may be limited exceptional circumstances where we would allow such a connection for brownfield sites only, however this will require significant justification from the customer taking account of various factors including legal, physical, and technical challenges.

In order to avoid costs and delays where a surface water discharge to our combined sewer system is anticipated, the developer should contact Scottish Water at the earliest opportunity with strong evidence to support the intended drainage plan prior to making a connection request. We will assess this evidence in a robust manner and provide a decision that reflects the best option from environmental and customer perspectives.

General notes:

- Scottish Water asset plans can be obtained from our appointed asset plan providers:
    - Site Investigation Services (UK) Ltd
    - Tel: 0333 123 1223
    - Email: sw@sisplan.co.uk
    - www.sisplan.co.uk
- Scottish Water's current minimum level of service for water pressure is 1.0 bar or 10m head at the customer's boundary internal outlet. Any property which cannot be adequately serviced from the available pressure may require private pumping arrangements to be installed, subject to compliance with Water Byelaws. If the developer wishes to enquire about Scottish Water's procedure for checking the water pressure in the area, then they should write to the Customer Connections department at the above address.
- If the connection to the public sewer and/or water main requires to be laid through land out-with public ownership, the developer must provide evidence of formal approval from the affected landowner(s) by way of a deed of servitude.
- Scottish Water may only vest new water or waste water infrastructure which is to be laid through land out with public ownership where a Deed of Servitude has been obtained in our favour by the developer.

- The developer should also be aware that Scottish Water requires land title to the area of land where a pumping station and/or SUDS proposed to vest in Scottish Water is constructed.
- Please find information on how to submit application to Scottish Water at our Customer Portal.

Next Steps:

- **All Proposed Developments**

  All proposed developments require to submit a Pre-Development Enquiry (PDE) Form to be submitted directly to Scottish Water via our Customer Portal prior to any formal Technical Application being submitted. This will allow us to fully appraise the proposals.

  Where it is confirmed through the PDE process that mitigation works are necessary to support a development, the cost of these works is to be met by the developer, which Scottish Water can contribute towards through Reasonable Cost Contribution regulations.

- **Non Domestic/Commercial Property:**

  Since the introduction of the Water Services (Scotland) Act 2005 in April 2008 the water industry in Scotland has opened to market competition for non-domestic customers. All Non-domestic Household customers now require a Licensed Provider to act on their behalf for new water and waste water connections. Further details can be obtained at www.scotlandontap.gov.uk

- **Trade Effluent Discharge from Non Dom Property:**

  - Certain discharges from non-domestic premises may constitute a trade effluent in terms of the Sewerage (Scotland) Act 1968. Trade effluent arises from activities including; manufacturing, production and engineering; vehicle, plant and equipment washing, waste and leachate management. It covers both large and small premises, including activities such as car washing and launderettes. Activities not covered include hotels, caravan sites or restaurants.
  - If you are in any doubt as to whether the discharge from your premises is likely to be trade effluent, please contact us on 0800 778 0778 or email TEQ@scottishwater.co.uk using the subject "Is this Trade Effluent?". Discharges that are deemed to be trade effluent need to apply separately for permission to discharge to the sewerage system. The forms and application guidance notes can be found here.
  - Trade effluent must never be discharged into surface water drainage systems as these are solely for draining rainfall run off.

- For food services establishments, Scottish Water recommends a suitably sized grease trap is fitted within the food preparation areas, so the development complies with Standard 3.7 a) of the Building Standards Technical Handbook and for best management and housekeeping practices to be followed which prevent food waste, fat oil and grease from being disposed into sinks and drains.
- The Waste (Scotland) Regulations which require all non-rural food businesses, producing more than 50kg of food waste per week, to segregate that waste for separate collection. The regulations also ban the use of food waste disposal units that dispose of food waste to the public sewer. Further information can be found at www.resourceefficientscotland.com

I trust the above is acceptable however if you require any further information regarding this matter please contact me on **0800 389 0379** or via the e-mail address below or at planningconsultations@scottishwater.co.uk.

Yours sincerely,

Planning Application Team
Development Operations Analyst
developmentoperations@scottishwater.co.uk

Scottish Water Disclaimer:

"It is important to note that the information on any such plan provided on Scottish Water's infrastructure, is for indicative purposes only and its accuracy cannot be relied upon. When the exact location and the nature of the infrastructure on the plan is a material requirement then you should undertake an appropriate site investigation to confirm its actual position in the ground and to determine if it is suitable for its intended purpose. By using the plan you agree that Scottish Water will not be liable for any loss, damage or costs caused by relying upon it or from carrying out any such site investigation."

Angus Council
Comhairle Aonghais

Memorandum

Infrastructure
Roads & Transportation

TO: DEVELOPMENT STANDARDS MANAGER, PLANNING

FROM: TRAFFIC MANAGER, ROADS

YOUR REF:

OUR REF: CH/AB/TD1.3

DATE: 19 JANUARY 2021

SUBJECT: **PLANNING APPLICATION REF. NO. 20/00830/FULL – PROPOSED ERECTION OF A CREMATORIUM ON LAND NORTH-EAST OF DUNTRUNE HOUSE, DUNTRUNE**

I refer to the above planning application.

The National Roads Development Guide, adopted by the Council as its road standards, is relative to the consideration of the application and the following comments take due cognisance of that document.

The site is located on the north side of the unnumbered classified, Monifieth to Kingennie to Duntrune road near to Duntrune Hill. The roads in the vicinity of the site are typical of rural roads in Angus, being twisty and relatively narrow in some places. Carriageway widths between the site and the B978 Broughty Ferry to Wellbank to Draffin road typically vary between 4.65 to 5.7 metres.

The proposal is for a 120-seat crematorium with 90 car parking spaces, including overflow. However, the submitted site plan shows only 61 general parking spaces and 8 disabled spaces. No provision is made for the parking of bicycles, motorbikes or coaches. Although coach waiting areas are sited in front of the indicated overflow parking areas.

A Transport Assessment (TA) has been submitted in support of the application.

Pedestrian Accessibility

Due to the rural location there are no formalised pedestrian links in the immediate vicinity of the crematorium site. There is no footpath provision from the site until the Poplar Drive, Ballumbie junction with the B978 (Kellas Road), approximately 1.4 kilometres from the proposed crematorium site.

Cycling Accessibility

Due to the rural location there are no formalised cycling links in the immediate vicinity of the crematorium site, so attending cyclists will be required to share the surrounding carriageways with vehicular traffic. This is not unusual for rural sites throughout Angus. As a result, no public cycling parking facilities are proposed to be provided for those who wish to cycle to the crematorium. Such provision should therefore be conditional, based on the requirements within the Angus Council parking standards.

Public Transport

There are no public transport stops within the immediate vicinity of the site. The nearest bus stops are on Poplar Drive, Ballumbie and Kellas Road near the junction with Fithie Bank, Dundee. These stops are approximately 1.5 kilometres walking distance from the site which is well in excess of the accepted 400 metres or so that would serve to encourage travel by public transport. A further bus stop is located at Braeside Cottages, Duntrune, approximately 1.2 kilometres from the site. The infrequency of service at these stops is an additional barrier to this sustainable mode of transport. A more frequent service is available on Ballumbie Road, off the Drumgeith Road/Berwick Drive, Dundee but that is approximately 2.5 kilometres from the site.

The scarcity of dedicated footways or off-road footpaths between the identified bus stops and the site will also reduce the likelihood of visitors using public transport to access the site. Indeed, it is accepted within the TA that given the rural nature of the site there is little opportunity for crematorium staff or visitors to travel to and from the site by public transport. Therefore, the only travel to the site by bus would be via private hire where parking would be available on the allocated overspill parking area. Only 3% of funerals are expected to generate travel by private coach hire.

Road Network & Access

The TA has considered access to the site via the following roads:

- B978 Broughty Ferry – Wellbank – Draffin / Baldovie Road / B961 Drumgeith Road;
- Monifieth – Kingennie – Duntrune (C4);
- Dundee – Tealing – Auchterhouse (C6);
- Unclassified, [U315] West of Westhall (C4 – B978).

The B961/B978 road junction is in the Dundee City Council administrative area. Dundee City Council has been consulted and has raised no concerns with the TA.

Having reviewed the above road junctions and carriageway widths in the vicinity of the application site, mitigation measures are proposed by way of improvements to the public roads. Those improvements include, the widening of the carriageway of the Monifieth to Duntrune road (C4) along the entire site frontage, the provision of passing places on that road as well as the unclassified, (U315) West of Westhall road, and the provision of additional road directional signs to encourage traffic to use the West of Westhall road as the preferred access route from the B978.

Traffic counts and speed surveys were carried out in October 2019 to inform the production of the TA. Speed surveys show that the 85^{th} percentile speeds (the speed at which 85% of traffic is travelling at or below) on the C4 adjacent to the proposed site access were 40mph eastbound and 42mph westbound. On the B978 near to its junction with the U315 the respective 85th percentile speeds were measured at 48mph eastbound and 49mph westbound.

Network Analysis

The TA has assessed the surrounding road network based on an anticipated opening year of 2021. This would appear optimistic given the current status of the planning application and the national pandemic that is presently upon us.

Trip generation has been based on two similar crematoria developments at Parkgrove, Friockheim and 100 Acre Wood in Fife.

It was agreed with the consultant at the scoping stage that a population gravity/distribution model should be used to determine the percentage distribution of the generated trips. A population gravity model was thereafter considered for use to determine the percentage trip distribution however it was felt that this would likely lead to a disproportionately high proportion of trips from Dundee given its high population and short distance to the site. The distribution is therefore based on a population distribution model which has been determined using the populations of nearby electoral wards. This has considered the catchment area of the crematorium to be within the Angus and Dundee City electoral wards.

Although it was anticipated that funerals will take place an hour apart the TA has assessed the generated trips for the eventuality of two funerals taking place back to back. This is seen as the worst-case scenario with the vehicles for two funerals arriving and leaving within the same hourly period.

Using the above distribution model parameters, it was determined that the majority (61.4%) of traffic generated by the development is likely to arrive via the B978 Broughty Ferry to Wellbank road, as opposed to 38.5% via the C6 Dundee to Tealing to road.

Based on the surveyed and predicted trip generation figures it was shown that due to the relatively low pre-existing traffic flows on the minor roads there is likely to be a large percentage increase in post development traffic flows as a result of the proposed development with a 27% increase on the C4 past the site frontage during the AM peak period. In comparison, surveyed and predicted traffic flows on the busier B978 Broughty Ferry to Wellbank road would result in an increase of 3.3% in traffic flows on the B978 between Drumgeith Road and the U315 West of Westhall during the AM and PM peak periods. An increase in traffic flows from between 5% and 10% is usually acceptable on unsensitive roads as this is within the daily levels of traffic flow fluctuation that is commonly experienced under normal road traffic conditions.

It was therefore accepted that the resultant, aggregated traffic flows are anticipated to be below those expected to cause capacity and queuing issues. In the circumstances, no further junction capacity analysis was required to be undertaken.

Parking

The proposed car parking provisions were assessed based on the existing provisions at Parkgrove Crematorium in Friockheim which has a capacity of 164 seats; compared to the 120 seats proposed in this application. At Parkgrove, 24 formal car parking spaces are provided with provision for overspill increasing the maximum capacity to 100 spaces.

It is claimed that on average 3 funeral services are undertaken each day with vehicles occupied on average by 3 persons, however no documented surveys are provided to support this statement.

As previously indicated, there is no proposed provisions for the parking of bicycles.

In accordance with Angus Council's parking standards the following rates for parking should apply:

Mode	Standard requirement	Spaces
Bicycle	Non specific	
Motorcycle	Non specific	
Cars	1 space per seat	120
Disabled Bays	Non specific	

The proposal includes for the provision of 50 standard parking spaces with allowance for overspill parking to increase numbers to 90 spaces. The provision of four disabled spaces is included within the proposals as are four staff spaces.

The proposed overspill parking areas should be increased to provide a minimum of 120 general car parking spaces with an additional minimum of 7 disabled bays provided.

Mitigating Measures

It is proposed to provide road directional signage so that those accessing the site from the C4 are directed to use the U315 unclassified road rather than the C4 (Westhall section) between the U315 and B978 Kellas Road due to this section of the C4 having a narrower road width than the unclassified road. In addition, the sightlines at the junction of the C4 with the B978 Kellas Road are sub-standard and are lesser than those at the U315 junction with the B978. A mandatory "Stop" sign exists at the C4 junction to emphasise the poor visibility available.

In order to assist the free flow of traffic on the public roads between the site and the B978, road widenings and passing places are proposed at the various locations to provide a carriageway width of 5.5 metres. This means that a number of additional passing places will be provided along the C4 and U315, as identified on the drawings in Appendix B of the TA. To allow for the passing of large agricultural vehicles with funeral cortege vehicles the passing places should be extended to 20 metres in length.

The carriageway on the C4 along the full length of the site frontage will be widened to 5.5m.

In taking account of the surveyed traffic speeds and in order to provide safe and satisfactory access to the site, the following new and improved visibility sightlines are proposed:

- 4.5 x 120 metres on both sides of the proposed site access at its junction with the C4;
- 4.5 x 160 metres on the south side of the U315 at its junction with the B978; and
- 2.4 x 160 metres on the north side of the U315 at its junction with the B978.

While it is noted that not all visibility splays shown on the drawings are appropriately sized or drafted to the carriageway edge or nearest tangent point, to suit a 50mph design speed, the desirable visibility sightlines at the junction of the U315 unclassified road with the B978 Kellas Road are 4.5 metres by 160 metres with a relaxation allowable to 2.4 x 160 metres. Bushes and shrubs within the adopted road verge require to be cleared for this to be achieved. Once the clearing is undertaken it will improve the existing visibility at the junction which will provide a benefit to the wider community.

As a result of the low traffic impact on the surrounding road network and the proposed mitigating improvements to existing roads and visibility splays, I am minded that there is no significant cause to object to the planning application by reason of traffic impacts.

I have considered the application in terms of the traffic likely to be generated by it, and its impact on the public road network. As a result, I do not object to the application but would recommend that any consent granted shall be subject to the following conditions:

1 That, prior to the commencement of development, visibility splays shall be provided at the junction of the proposed site access with the C4 Monifieth – Kingennie – Duntrune road giving a minimum sight distance of 120 metres in each direction at a point 4.5 metres from the nearside channel line of the C4 Monifieth – Kingennie – Duntrune road.
Reason: to enable drivers of vehicles leaving the site to have a clear view over a length of road sufficient to allow safe exit.

2 That, prior to the commencement of development, a visibility splay shall be provided at the junction of the U315 West of Westhall (C4 – B978) with the B978 Broughty Ferry – Wellbank – Draffin road giving a minimum sight distance of 160 metres in a southerly direction at a point 4.5 metres from the nearside channel line of the B978 Broughty Ferry – Wellbank – Draffin road.
Reason: to enable drivers of vehicles leaving the site to have a clear view over a length of road sufficient to allow safe exit.

3 That, prior to the commencement of development, a visibility splay shall be provided at the junction of the U315 West of Westhall (C4 – B978) with the B978 Broughty Ferry – Wellbank – Draffin road giving a minimum sight distance of 160 metres in a northerly direction at a point 2.4 metres from the nearside channel line of the B978 Broughty Ferry – Wellbank – Draffin road.
Reason: to enable drivers of vehicles leaving the site to have a clear view over a length of road sufficient to allow safe exit.

4 That, within the above visibility splays nothing shall be erected, or planting permitted to grow to a height in excess of 1050 millimetres above the adjacent road channel level.
Reason: to enable drivers of vehicles leaving the junctions to have a clear view over a length of road sufficient to allow safe exit.

5 That, prior to the commencement of development, further details of the proposed scheme of improvements to the public roads, shown on drawing numbers A/190889/901 Revision 1; 902 Revision 1, 903 Revision 1, 904, 905 & 906 shall be submitted for the consideration of the planning authority. The scheme of improvements shall include correctly drafted visibility sightlines, full construction details, material specifications, road sign designs and extended passing places. The development shall not commence until the planning authority has agreed the scheme of improvements in writing. The scheme of improvements to the public roads shall thereafter be completed prior to the opening of the building for cremations.

Reason: to provide a safe and suitable standard of access, to maintain the free flow of traffic on the roads leading to the site and to prevent extraordinary damage being caused to the nearby public roads.

6 *That, the proposed gully on the site access nearest to the public road, shown on drawing no. 920 Revision 1, shall not connect to Soakaway 2 but shall outfall to Soakaway 1 or another suitably formed soakaway beyond the resulting extents of the public road.*
Reason: to prevent the flow of surface water from within the site being carried onto the public road or into its drainage system.

7 That, prior to the occupation or use of the crematorium, additional parking spaces shall be provided within the site at the following minimum rates:

Cycles: 10 spaces
Motorcycles: 6 spaces
Cars: 120
Disabled Bays: 7 spaces

The provision for cyclists shall be conveniently located for the main public entrance to the building and shall be covered, lit and adequately signed.
Reason: to ensure that suitable parking arrangements are provided to the standards of Angus Council in a timely manner.

8 That, an advisory, informative note be added to the decision notice to inform the applicant that the improvements to the public roads must be formed and constructed in accordance with the standards of Angus Council.

I trust the above comments are of assistance but should you have any queries, please contact Andrew Barnes on extension 1770.

From: BarnesA
Sent: Tue, 2 Feb 2021 15:10:16 +0000
To: MacKenzieF
Subject:RE: 20/00830/FULL ROADS CONSULTATION

Afternoon Fraser

Most of the trips to crematoria will be outside of the AM and PM peak hours and as there are no issues identified with the junction capacities in the original TA, I would not expect the additional trips from Shanks of Omachie would have a significant impact on the spare capacity.

That does not mean that the TA should not be updated to take account of the committed development.

Regards

Andrew Barnes | Team Leader - Traffic | Angus Council | Tel: 01307 491770 | Email: barnesa@angus.gov.uk | www.angus.gov.uk

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 02 February 2021 14:24
To: BarnesA <BarnesA@angus.gov.uk>
Subject: RE: 20/00830/FULL ROADS CONSULTATION

Good Afternoon Andy,

Thank you again for this. I've had a chance to review fully now. I'm still waiting of the full response from Dundee City Council but this should be here by the end of the week.

Ed noticed that the applicant's TA does not take account of the approved housing and leisure site at Shanks of Omachie in terms of 'Committed Developments. We will be raising this with the applicant but how does that affect your comments and capacity at junctions?

Please don't hesitate to get in touch to discuss further.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: BarnesA <BarnesA@angus.gov.uk>
Sent: 20 January 2021 11:52
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: FW: 20/00830/FULL ROADS CONSULTATION

Regards

Andrew Barnes | Team Leader - Traffic | Angus Council | Tel: 01307 491770 | Email: barnesa@angus.gov.uk | www.angus.gov.uk

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Think green – please do not print this email

From: BarnesA
Sent: 06 January 2021 15:28
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: 20/00830/FULL ROADS CONSULTATION

Thanks Fraser

I'll have a look and submit a revised response to take account.

Have you formed an opinion on the way its likely to go yet?

Regards

Andrew Barnes | Team Leader - Traffic | Angus Council | Tel: 01307 491770 | Email: barnesa@angus.gov.uk | www.angus.gov.uk

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Think green – please do not print this email

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 06 January 2021 11:05
To: BarnesA <BarnesA@angus.gov.uk>
Subject: RE: 20/00830/FULL ROADS CONSULTATION

Thank you Andy,

Please see attached an independent assessment of the TA that an objector to the proposal has commissioned. Again, before I make your response public, I thought I'd best let you review in case there are any points raised in this?

Please don't hesitate to contact me to discuss further.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

Think green – please do not print this email.

COVID-19

For the latest information on how our service has been affected CLICK HERE

From: BarnesA <BarnesA@angus.gov.uk>
Sent: 06 January 2021 10:20
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: FW: 20/00830/FULL ROADS CONSULTATION

Fraser

Conditions 2 and 3 require different sightlines in different directions.

The reference to consultation with Dundee City Council relates to the TA email you have also seen from Mike Giblin, nothing else.

Regards.

Andrew Barnes | Team Leader - Traffic | Angus Council | Tel: 01307 491770 | Email: barnesa@angus.gov.uk | www.angus.gov.uk

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 05 January 2021 17:08
To: BarnesA <BarnesA@angus.gov.uk>
Subject: FW: 20/00830/FULL ROADS CONSULTATION

Thank you Andy. Conditions 2 and 3 appear to be a duplicate.

Also, I was going to request clarification on the consultation with Dundee City Council. Is this direct consultation you or the applicant has undertaken? The reason I ask is that I'm awaiting the formal consultation response from DCC, so I don't want there to be anything in this that could contradict anything they say in their forthcoming consultation response. The only thing I've seen so far is an e-mail from Mike Giblin at DCC Roads providing comment to the TA.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: BarnesA <BarnesA@angus.gov.uk>
Sent: 30 December 2020 17:38
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Cc: GwynneAG <GwynneAG@angus.gov.uk>
Subject: RE: 20/00830/FULL ROADS CONSULTATION

Regards

Andrew Barnes | Team Leader - Traffic | Angus Council | Tel: 01307 491770 | Email: barnesa@angus.gov.uk | www.angus.gov.uk

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From: PLNProcessing <PLNProcessing@angus.gov.uk>
Sent: 18 December 2020 16:39
To: Rdspln <rdspln@angus.gov.uk>
Subject: 20/00830/FULL ROADS CONSULTATION

Land North East Of Duntrune House

Duntrune

Fraser MacKenzie

From: Andy Barnes
Sent: 21 June 2021 11:53
To: Fraser MacKenzie
Subject: RE: 20/00830/FULL ROADS CONSULTATION

Fraser

Sorry for the delay in responding to your below email.

Visibility Sightlines at C4/B978

Drawing No. A/190889 – 906 shows visibility sightlines at the junctions of the C4 Monifieth – Kingennie – Duntrune road at its junctions with B978 Broughty Ferry – Wellbank – Draffin road south of Kellas.

The following sightlines are shown on the drawing from the C4:

- C4 Western leg (Duntrune): 1.8 x 55 metres northwards and 1.7 x 39 metres southwards
- C4 Eastern leg (Murroes): 5 x 160 metres northwards and 3 x 160 metres southwards

The western leg sightlines stipulate ‘x’ distances that are less than the required minimum of 2. 4 metres and the ‘y’ distances show the sightlines to be sub-standard. The sightlines on the western leg are impacted and lessened further at the car drivers’ eye height by way of stonework boundary walls.

I consider the realistic sightlines on the Duntrune leg to be 2.4 x 12 metres, northwards and 2.4 x 21 metres, southwards. These sightlines are significantly sub-standard but the junction appears to operate in an acceptable manner with no accidents being reported within the latest three year reporting period.

Standard sightlines of 2.4 x 160 metres are available on both sides of the Murroes leg.

Visibility Sightlines at U315/B978

Further to your email of 2 June 2021, I would agree with the comments of Dougall Ballie Associates in that the proposed south-westerly sightline of 4.5 x 160 metres is obstructed by the natural topography of the B978 . I would further agree that the maximum sightline available in this case is in the region of 4.5 x 110 metres.

In a similar vein to the C4 junctions, no accidents have been reported at or in the vicinity of this junction within the latest three year reporting period. This indicates that the junction is operating safely under the existing conditions.

If Committee is minded to grant consent for this application it would be inappropriate to make such consent conditional upon the provision of a sightline that cannot be achieved. To that end, if approved the stipulated sightline should be 4.5 x 100 metres.

I hope this helps.

Regards

Ed Taylor

From: Andy Barnes
Sent: 13 August 2021 09:35
To: Ed Taylor
Subject: FW: 20/00830/FULL; Erection of Crematorium on Land North East of Duntrune House, Duntrune
Attachments: 20231let03.pdf

Ed

Further to the above planning application and with reference to the letter of representation submitted of behalf of a local resident by Dougall Ballie Associates Ltd on 01 July 2021.

Visibility Sightline at U315/B978

As stated by DBA it is appropriate to consider the requirements for visibility splays as set out in the DMRB. This is the relevant advice to be used for new and improved all-purpose and motorway trunk roads. While the DMRB applies directly to trunk roads it is also adopted for use on higher speed local authority roads where there is a need to depart from the Scottish Planning Policy document Designing Streets, since the advice on sightlines in Designing Street does not extend to roads subject to speed limits in excess of 37mph (60kph).

The National Road Development Guide (NRDG) compares situations where DMRB may be used in preference to Designing Streets and recommends that on roads where the movement function outweighs the place function the DMRB should be applied. However, the NRDG also accepts that local authority roads should not require such strict adherence to the design parameters of the DMRB. It is accepted that the desirable minimum values for stopping sight distances should be provided, except where a relaxation is permitted.

The NRDG recognises that relaxations within the DMRB may be allowed on trunk roads by application to Transport Scotland. Similarly, such relaxations may be permitted by the local roads authority when dealing with issues on local roads. Relaxations are considered to be in compliance with the design standards and therefore do not render the relaxed sightlines as sub-standard.

While an original relaxation of one step below the minimum desirable standard was recommended in this case, a relaxation of three steps is permitted. Allowing a three step relaxation would result in a requirement for sightlines of 4.5 x 90 metres at this junction. Taking the B978 road layout and local topography into consideration the final recommended relaxation of the sightlines at this junction to 4.5 x 110 metres is therefore without the scope permitted by the roads authority and therefore remains to meet the aim of ensuring that drivers of vehicles leaving the U315 have a clear view over a length of road sufficient to allow safe exit. As previously commented, this is in part borne out by the lack of accidents over the latest three year period.

It is normal practice, when performing accident cluster analysis, for Angus Council to use the accident data available over the previous 3 years. To consider accidents over longer periods, such as twenty years, is not truly representative of current traffic flows and makes no allowance for changes in local traffic patterns or driving styles.

Visibility Sightline at C4/B978

The comments of DBA are noted with respect to the above junction and I can confirm that this is the reasoning for the erection of the mandatory stop sign in this case.

Regards

Andrew Barnes | Team Leader - Traffic | Angus Council | Tel: 01307 491770 | Email: barnesa@angus.gov.uk
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Angus Council
Comhairle Aonghais

Memorandum

Infrastructure
Roads & Transportation

TO: DEVELOPMENT STANDARDS MANAGER, PLANNING

FROM: TRAFFIC MANAGER, ROADS

YOUR REF:

OUR REF: CH/AB/TD1.3

DATE: 14 DECEMBER 2021

SUBJECT: **PLANNING APPLICATION REF. NO. 20/00830/FULL – PROPOSED ERECTION OF A CREMATORIUM ON LAND NORTH-EAST OF DUNTRUNE HOUSE, DUNTRUNE**

Further to the above application, I refer to the letter submitted by Dougal Bailie Associates, dated 1 September 2021, the comments in representations with respect to a recent spate of accidents in the vicinity of the site and public transport service updates that are provided in Revision 3 of the applicant's Transport Assessment.

Visibility Sightlines at U315 West of Westhall (C4 – B978) /B978 Kellas Road

I agree that the DMRB is an established road design document and therefore provides a good basis for the application of safe road design parameters. The DMRB provides requirements and advice for all aspects of highway link design to be used for both new and improved all-purpose and motorway trunk roads. In that respect, it is noted that DBA accepts that local authorities have a degree of flexibility in how the DMRB standards are applied on their own local roads network.

However, I do concur with DBA in that DMRB CD109, Section 2.13 annotates that in respect of relaxations below desirable minimum in stopping sight distance, desirable minimum vertical curvature for crest curves and sag curves, described in Sections 3 and 5 of the document, shall not be used on the immediate approaches to junctions.

In consideration of the sightlines at the U315/B978 junction due regard is given to the Transport Assessment and associated drawings submitted by the applicant. Paragraph 2.6 of the TA states, "*…the desired visibility in both directions at the Unclassified Road junction with Kellas Road is 4.5m x 160m as a result of the weekly average 85%tile surveyed speeds being 48mph eastbound and 49mph westbound. This corresponds to a 50mph or 85A kph design speed.*" In accordance with the applicant's survey derived design speed the 4.5 by 160 metres sightline is proposed on the southwest side of the junction, and a sightline of

2.2 by 160 metres is proposed on the northeast side of the junction, each as detailed on submitted drawing no. A/190889 - 905. It should be noted that an ‘x’ distance of 2.2 metres is generally insufficient to prevent the nose of vehicles from overhanging the give way line when giving way at the junction if the full ‘y’ distance of 160 metres is to be relied upon.

Having reviewed the TA information, it is apparent that the sightline to the southwest cannot be achieved due to the topography of the road. However, it may be possible for the applicant to improve the topography of the B978 as part of the development mitigation to provide a visibility splay that complies with the 85%ile speed of traffic, that is, the applicant’s originally proposed sightline of 4.5 by 160 metres. No evidence has been provided so far to suggest that the applicant can provide the sightlines that they have indicated are required. The physical works to do this would require the vertical alignment of the B978 to be lowered on the north-eastbound approach to the junction. Those works would be significant in engineering terms and may require land beyond the extents of the existing public road (B978).

If the application is approved, a negative suspensive condition should be attached that requires provision of the full 4.5 by 160 metres sightline, in both directions, prior to the commencement of development on site. The intensification of use of a sub-standard junction by concentrated levels of new traffic is undesirable and has the potential to be detrimental to road safety.

Visibility Sightlines at U315 West of Westhall (C4 – B978)/C4 Monifieth – Kingennie – Duntrune

The proposed sightlines for this junction are detailed on drawing no. A/190889 – 904 and are stated as being 2.1 by 160 metres to the northwest and 1.65 by 160 metres to the southeast. In a similar circumstance to the above B978 Kellas Road junction the stated ‘x’ distances are sub-standard.

At the standard ‘x’ distance it is estimated that existing sightlines of 2.4 by 14.5 metres to the northwest and 2.4 by 100 metres to the southeast are currently available. Provision of sightlines that comply with DMRB requires provision of the full 2.4 by 160 metres sightline, in both directions, and may require land which is beyond the control of the applicant. Given the nature of the development and associated traffic movement it would be desirable to see the sightlines improved.

If the application is approved, a negative suspensive condition should be attached that requires provision of the full 2.4 by 160 metres sightline, in both directions, prior to the commencement of development on site. The intensification of use of a sub-standard junction by concentrated levels of new traffic is undesirable and has the potential to be detrimental to road safety.

Accidents

Concerns have been raised and evidence provided through representations relating to a recent spate of six collisions in the Duntrune and Murroes area during late October/early November 2021.

Since December 2012 the Roads service has received data from Police Scotland relating to injury collisions only. Record are no longer kept of collisions resulting in damage only, therefore, not all collisions will be reported to Police Scotland. The recorded collision data for the most recent three-year recording period, from 30/10/2018 to 29/10/2021, is now available. The recorded data shows that three collisions have been reported, as follows.

Collison 1:

- 27/8/20 at 6.15pm – **slight** injury at the junction of Poplar Drive with B978 Kellas Road

"V001 was travelling east and exiting the junction to turn south on the B978. V001 pulled out of the junction and failed to give way to V002 which was travelling north on the B978. V002 has taken evasive action and skidded across the junction behind V001, colliding with V003 which was also exiting the junction at the same time to travel north".

Collison 2:

- 02/01/2021 at 7.40am – **slight** injury at C4 Ballumbie to Burnside of Duntrune road - 87 metres from junction with unclassified road

"V001 travelling south-eastwards having negotiated a right bend to travel, however lost control, collided with verge and overturned".

Collison 3:

- 11/10/2021 at 4.00pm – **slight** injury at C6 near junction with unclassified road

"Vehicle 1 travelling west lost control on left hand bend, collides with wall on nearside, causing rear of vehicle to step out colliding with vehicle 2 which was travelling in the opposite direction, extensively damaging both vehicles".

As evidenced, the number of collisions that resulted in injury in the vicinity of the site over the last three years is low. While damage only collisions are no longer recorded and therefore are not normally considered by the traffic authority when analysing collision data, that does not mean to imply that the concerns raised by local residents are not valid.

Public Transport

Previous comments regarding the poor accessibility of the site by sustainable means have been further considered in Revision 3 of the Transport Assessment which at paragraph 3.6 states, *"There is currently two existing bus services that run directly past the proposed crematorium site. The A17 & A38 which run one in each direction each working day. Bus services in this area run on a hail and ride basis and as such would stop outside the site, even if no fixed stop was installed should someone require."*

These services are school bus services and operate before and after school, on school days only during term time.

Two additional local bus services (No's. 22 & 139) are cited as running approximately 450 metres west of the proposed site access. However, this is above the recommended desirable walking catchment distance of 400 metres.

The frequency of bus services is very low and no footways are provided between the site and the bus route. The nature of the road is such that it would not be desirable to encourage pedestrians to walk on a section of carriageway which is twisty, with changes in level, darkened by tree canopy, unlit, and with a verge with limited opportunities for harbourage by pedestrians to allow vehicles to pass. As such, it is not a route which we would wish to see pedestrians walk from a bus route to the crematorium facility.

Suggested options for enhancements to public transport facilities are provided in paragraphs 3.12 and 3.13 of the updated TA and include the provision of an appropriate bus stop or pull in area, or alternatively, the incorporation of a call-up service for users who wished to be collected from the nearest, existing bus stops. It is suggested that such a service could be provided by way of electric vehicles to keep emissions to an absolute minimum.

Given the location of the site and the fact that the existing public transport services are very low in frequency, the site is not readily accessible by sustainable means of transport. The provision of bus stops/pull in area alone would not address the fact that the bus frequency would remain very low. Similarly, the provision of a call up service to collect people from the nearest bus stops would not address the infrequent nature of existing bus services and could not be regarded as convenient. However, if the application is approved these measures should be secured by planning condition.

Summary

As discussed above, if the application is approved, I would recommend that negative suspensive conditions should be attached to the approval as described above.

I trust the above is of assistance and will now allow you to progress to determination of the application.

pp

Murroes and Wellbank Community Council

Fraser McKenzie
Planning Service
Angus Council

Dear Mr McKenzie

Concern over Planning Application No 20/00830/FULL

Erection of Crematorium Building and Associated Parking. Access, Turning Space, Landscaping and Boundary Enclosure/Land North East of Duntrune House

We as a Community Council firmly believe in supporting the entrepreneur in developing new business opportunities in the local community. However the Community Council is concerned about the impact of amenity, the Angus Development Plan designation, traffic safety on local residents, public access, public transport provision, flooding, drainage provision and suitability of access roads in the area surrounding the proposed planning application.

1. **Policy DS1, Development Boundaries & Priorities;**

   - **Location Priorities**; This proposal will bring suburbanisation to the countryside along with associated additional vehicles mainly cars due to the limited access by public transport, walking or cycling.

     The proposed development is located on a Greenfield site and is not in accordance with the policies of the Angus Local Development Plan (ALDP). **Policy TC9 Safeguard of land for Cemetery Use** confirms that land is reserved for cemetery purposes at Aberlemno, Dunnichen Cemetery, Kirkton of Auchterhouse, Liff and Panbride. This very significant and specific cemetery policy and wider Local Development Plan makes no requirement for a new crematorium in Angus which is already well served by the existing facility in Froickheim.

2. **Traffic, Policy DS2 Accessible Development;**

   - **Accessible to existing or proposed public transport networks;** This proposal does not provide suitable access to public transport with the nearest bus stop/bus route being 1.6Km from the development. There is no form of pedestrian access from the nearest public transport point to the proposed development.

- **Make provision for suitably located public transport infrastructure such as bus stops, shelters, lay-bys;** There is no provision for any public transport infrastructure as part of this proposed development.

- **Allow easy access for people with restricted mobility;** There is no suitable access to the proposed development for individuals with restricted mobility other than motor vehicle. There is no suitable access from any of the built up areas surrounding the development.

- **Adequate local road network capacity or where capacity can be made available;** The road network surrounding the proposed development is mainly narrow country roads with acute bends with poor visibility. The proposal to install passing places to accommodate traffic where in excess of 360 vehicles potentially attending this facility a day, will seriously impact school bus transport, local farming activities and residents going about their daily lives. The ingress and egress from the Kellas Road will be a significant safety concern due to the visibility, speed of traffic and blind summit. The build up of additional traffic at the Kellas Road/Drumgieth Road/Drumsturdy Road will only exacerbate the problem of traffic delays at this busy junction.

3. **Policy DS3 Design Quality and Place making;**

- **Designing Places;** Concerns this development does not meet the six qualities of a successful place and in particular the development being well connected. This proposal does not provide connectivity for pedestrians, cyclist, provides NO options to use public transport safely and as such every attendee to the premises will require to use a motor vehicle and as such we feel the parking available is not suitable.
- **Designing Streets;** Concerns are raised regarding the position over the narrow network of roads surrounding the facility and the capacity to sustain the increased level of traffic without significant widening of all C4 roads leading to the facility. Suitable pedestrian access is not part of this design proposal and therefore not providing safe/low cost access for people unable to drive.

4. **Policy DS4 Amenity;**

- **Air Quality;** Concern with the carbon emissions of the proposed boilers for this development. For every gas cremation Approx 245kg of carbon is released into the atmosphere and there for releasing hundreds of tonnes each year. The NOx emissions produced by crematorium has raised concerns and such emissions are a danger to public health especially children. There is also a concern with potential mercury pollution, which again is linked to health issues.

- **Levels of odour, fumes and dust;** Concerns with the potential impact on the residents living in close proximity of the development and the impact of odours, burnt particles and fumes on gardens, washing and property. Not only from the proposed development, but the significant concentration of vehicles attending the premises on a daily basis.

- **The effect and timing of traffic movement to, car parking and impacts on highway safety;** Concerns with the provision of onsite parking for large mourner groups and the impact on the surrounding residents, safety of road users when mourners are parking on the verges and on the sides of an already narrow carriageway, creating difficulties for local farmers, businesses and residents. Lack of suitable footpaths may result in visitors attending funerals who have no option but to walk from the nearest bus stops, the added danger of walking on 60mph roads, putting them and other road users at danger.

- **Residential amenity in relation to overlooking and loss of privacy;** Concerns for the residents surrounding the development who have set up home in this quiet tranquil location, to obtain some form of peaceful lifestyle and who now are going to potentially have imposed on them, hundreds of people parking outside their properties, looking into their homes and daily experiencing the upset of people having endured a personal loss.

5. **Policy TC8 Community Facilities and Services;**

- The ALDP aims to ensure that new facilities are accessible and of an appropriate scale and nature for their location. This Crematorium proposal does not fulfil this policy due to the access availability and we feel the access routes via the road network fall short in providing safe access and egress for the users of the facility and the impact of local residents and businesses surrounding the facility.

6. **Policy PV11 Energy Efficiency;**

- Concerns this proposed development does not meet the ethos of reducing carbon output based on the methods of operating the facility, increase in car transport and as such will only increase the carbon output into the atmosphere. It is considered that the proposed development does not follow in line with Government reduction Green House gas targets.

7. **ALDP**;

- We consider this application is in conflict with the approved development plan, land designation, carbon reduction targets, connectivity, impact on the amenity of local residents and the safety of road users.

Murroes and Wellbank Community Council

Murroes and Wellbank Community Council

Ed Taylor
Planning Service
Angus Council

Dear Mr Taylor

Concern over Planning Application No 20/00830/FULL

Erection of Crematorium Building and Associated Parking. Access, Turning Space, Landscaping and Boundary Enclosure/Land North East of Duntrune House

In regards to the additional Transport Assessment submission along with the Planning and Design statement on the 29th Sept 2021 by the applicant, the Community Council would like to reiterate and add to the previous concerns raised on the 3rd Jan 2021.

The Community Council is concerned about the impact of the traffic safety on local residents, public access, public transport provision and suitability of access roads in the area surrounding the proposed planning application.

1. Traffic, Policy DS2 Accessible Development;

- **Accessible to existing or proposed public transport networks;** This proposal does not provide suitable access to public transport in our opinion and to propose the use of Fisher Tours Bus No A17/A38 as per point 3.6 of the revised Transport Assessment gives the Community Council, Parents and Residents in the area significant concerns. To suggest/promote the use of Murroes Primary School Bus and Monifieth High School Bus, full of children to commute mourners to and from the crematorium is disappointing.
  There is no form of pedestrian access from the nearest public transport point to the proposed development, this would include from the suggested bus service 22/139, where the nearest drop off and pick up would be more than 450m distance and would require mourners to walk along a 60mph, Unlit, Twisting Country Road. The Moffat & Wiliamson No 78C/78A/79A would also require mourners to walk on 60mph, Unlit Country Roads. The suggestion for mourners to access the Moffat & Williamosn, No 88 at Hawick Drive would have the added danger for mourners to walk along a high volume 60mph, Unlit, B978 Kellas Road on a blind bend to reach the nearest pavement some 1.4km from the proposed Crematorium, with a total of 2.4km to reach the No 88.

- **Make provision for suitably located public transport infrastructure such as bus stops, shelters, lay-bys;** There is no provision for any public transport infrastructure as part of this proposed development, with the nearest footpath and bus stop 1.4Km away from the proposed Crematorium.

- **Allow easy access for people with restricted mobility;** There is no suitable access to the proposed development for individuals with restricted mobility other than motor vehicle. There is no suitable access from any of the built up areas surrounding the development.

- **Adequate local road network capacity or where capacity can be made available;** The road network surrounding the proposed development is mainly narrow country roads with acute bends and poor visibility. The proposal to only install passing places to accommodate the increase of traffic potentially attending this facility, will seriously impact school bus transport, local farming activities and residents going about their daily lives. The ingress and egress from the Kellas Road will be a significant safety concern due to the visibility, speed of traffic and a blind summit. The safety of road users and residents will be impacted significantly by this development particularly considering the danger of the roads, with a further 4No road accident having taken place on the 4th October, 8th October, 11th October and the 21st October 2021. The increase in road traffic and the potential additional pedestrian traffic on these country roads will only increase the risk of further serious incidents.

Murroes and Wellbank Community Council

From: Claire Herbert
Sent: Tue, 29 Dec 2020 16:00:19 +0000
To:PLNProcessing
Cc: MacKenzieF
Subject: Planning consultation 20/00830/FULL - Archaeology response

Planning Reference: 20/00830/FULL

Case Officer Name: Fraser MacKenzie

Proposal: Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

Site Address: Land North East Of Duntrune House Duntrune

Site Post Code:

Grid Reference: NO 4492 3511

Thank you for consulting us on the above application. I can advise that in this particular instance, no archaeological mitigation is required.

Should you have any comments or queries regarding the above, please do not hesitate to contact me

Kind regards,

Claire

Claire Herbert MA(Hons) MA MCIfA

Archaeologist
Archaeology Service, Planning and Environment Service, Infrastructure Services
Aberdeenshire Council, Woodhill House, Westburn Road, Aberdeen, AB16 5GB

T: 01467 537717

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W: https://online.aberdeenshire.gov.uk/smrpub

Archaeology Service for Aberdeenshire, Moray, Angus & Aberdeen City Councils

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From: GrahamIH
Sent: Mon, 11 Jan 2021 15:04:22 +0000
To: MacKenzieF
Cc: ThomsonSD
Subject:20/00830/FULL Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures Land North East Of Duntrune House Duntrune

Fraser

I refer to the above application and would thank you for the opportunity to provide comment in respect of potential amenity impacts that may arise.

The cremation and associated processes have the potential to give rise to both air quality and noise impacts. In respect of air quality I note that reports containing monitoring data obtained from other installations has been submitted but no site specific assessment has been undertaken. I am aware that there are existing residential properties nearby therefore a detailed assessment of the potential impact of emissions to air from the operation of the cremator at the proposed location requires to be undertaken. The assessment should be undertaken in accordance with the Local Air Quality Management Technical Guidance TG(16) and should also consider potential odour impacts at sensitive locations. It is strongly recommended that any assessment methodology is agreed in writing with this Service prior to any monitoring/modelling work being undertaken. In terms of noise I am satisfied that any emissions are likely to meet our standard conditions for fixed plant within rural locations however any available noise data relating to the proposed equipment that can be submitted would be helpful.

I trust you find the above acceptable but please do not hesitate to contact me if you wish to discuss anything further at this stage.

Regards

Iain

Iain Graham | Environmental Health Officer | Angus Council - Place | Housing, Regulatory and Protective Services | Angus House, Orchardbank Business Park, Forfar, DD8 1AN | ☎01307 492026

From: Iain H Graham
Sent:14 May 2021 11:16:35 +0100
To: Fraser MacKenzie
Cc: Steven D Thomson
Subject:20/00830/FULL Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures Land North East Of Duntrune House Duntrune

Fraser

I refer to the above application and would advise that as requested in my previous email both an Air Quality Impact Assessment and an Odour Impact Assessment have now been submitted on behalf of the applicant. I have looked at both documents and would provide the following comments:

Air Quality

An assessment of cremation process pollutants has been undertaken by using emission dispersion modelling software (ADMS 5.0.0.1) which is widely used and deemed acceptable for such applications. The predicted pollutant process contributions are then added to background levels and the summed levels are compared against the corresponding Air Quality Objective where one exists. The assessment adopts a number of assumptions which results in very much a worse case scenario and these are as follows:

- The relevant pollutant emission rates are assumed to be the maximum permissible in terms of PG 5/12 at all times. (NB PG 5/12 Process Guidance Note is likely to form the basis of assessing initial and ongoing compliance with any emissions to air requirements included in any authorisation that may be issued by SEPA in the future.)
- All particulate matter emitted is assumed to be PM_{10} and all NO and NO_2 emitted is assumed to be NO_2.
- Emissions equivalent to the maximum levels above are assumed as being emitted 24 hrs a day, 365 days a year.
- Predicted pollutant levels at receptor locations are based on each receptor being downwind of all emissions.
- The highest levels predicted within the model (at 100m from the stack) have been used for comparison against the relevant Air Quality Objectives rather than the lower levels predicted at the nearest locations with relevant exposure (~200m).

The assessment report concludes that the proposed cremation process would result in a negligible increase in relevant pollutant levels and that these will remain significantly below the respective Air

Quality Objectives. This Service is satisfied that both the assessment methodology and data inputs are appropriate and accepts the report findings.

Odour

The submitted Odour Impact Assessment has been undertaken using a source-pathway-receptor model utilising the “FIDOL” system contained within guidance issued by the Institute of Air Quality Management. The assessment report concludes that no significant loss of amenity should occur as a result of odours arising from the proposed cremation process. This Service is satisfied that both the assessment methodology and data inputs are appropriate and accepts the findings of the report.

Noise

I indicated in my previous email to you that whilst I was satisfied that noise from the proposed development was unlikely to give rise to significant amenity impacts due to the distances to the nearest sensitive receptors this Service would look to safeguard this position by requesting a standard noise condition be attached to any planning consent that may be granted. I would therefore be obliged if the following condition could be attached to any consent issued:

- Noise from any fixed plant associated with this development shall not give rise to a noise level assessed within any dwelling or noise sensitive building with windows partially open for ventilation, in excess of that equivalent to Noise Rating Curve 30 between 0700 and 2200 and Noise Rating Curve 20 at all other times.

I trust you find the above response acceptable and I thank you for the opportunity to comment on this application. Should you wish to discuss anything further please do not hesitate to contact me.

Regards

Iain

Iain Graham | Environmental Health Officer | Angus Council - Place | Housing, Regulatory and Protective Services | Angus House, Orchardbank Business Park, Forfar, DD8 1AN | ☎01307 492026

From: Caitlin Duffy
Sent: Thu, 4 Feb 2021 14:34:32 +0000
To: MacKenzieF;PLNProcessing
Cc:customerservices
Subject: Consultation Response 20/00830/FULL

Dear Mr Mackenzie,

TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997 as amended
PROPOSED CREMATORIUM BUILDING AND ASSOCIATED PARKING, ACCESS, TURNING SPACE, LANDSCAPING AND BOUNDARY ENCLOSURES
LAND NORTH EAST OF DUNTRUNE HOUSE, DUNTRUNE, ANGUS
APPLICATION REFERENCE NO 20/00830/FULL

I refer to your email correspondence dated 6 January 2021 regarding the above planning application which you have referred to Dundee City Council as a development adjacent to the Dundee City Council /Angus Council boundary with potential cross-boundary issues.

The application proposes the development of a crematorium with associated works on land north east of Duntrune House, Duntrune. The site is around 1km away from the Dundee City Council boundary. The Transport Assessment has been reviewed and there are no comments on the application from a roads perspective.

I consider that the planning application does not raise any issues of strategic significance for Dundee City Council and we have no objections to the proposal.

Yours faithfully

Caitlin Duffy
Planning Officer
Planning Team
City Development Department
Dundee City Council
50 North Lindsay Street
Dundee
DD1 1LS

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Corporate Web Site http://www.dundeecity.gov.uk

Caitlin Duffy
Planning Officer

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Corporate Web Site http://www.dundeecity.gov.uk

From: Caitlin Duffy
Sent: Mon, 15 Feb 2021 10:06:06 +0000
To: MacKenzieF
Cc: Gary Knox
Subject: Re: Consultation Response 20/00830/FULL
Attachments:DCC Shank Omachie response.pdf

Hello Fraser

The below regarding the Shank of Omachie does not have any bearing on the Dundee City Council response.

I trust this is of assistance to you.

Regards

Caitlin Duffy
Planning Officer
Planning Team
City Development Department
Dundee City Council
50 North Lindsay Street
Dundee
DD1 1LS

Telephone: +44 (0) 1382 433806
E-mail: caitlin.duffy@dundeecity.gov.uk
Corporate Web Site http://www.dundeecity.gov.uk

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 08 February 2021 16:26
To: Caitlin Duffy <caitlin.duffy@dundeecity.gov.uk>
Subject: RE: Consultation Response 20/00830/FULL

Good Afternoon Caitlin,

Thank you again for providing the consultation response on this.

Something that's been noticed in the applicant's supporting information is that the applicant's Transport Assessment does not take account of the approved housing and leisure site at Shank of Omachie in terms of the 'Committed Developments' section.

We will be raising this with the applicant but, before I make your consultation response available on Public Access, does it have any bearing on DCC's consultation response? It's noted that DCC did object to the outline planning permission for the Shank of Omachie development ref. 09/00695/OUT. I've attached a copy of DCC's response for reference.

Please let me know if this has any bearing on your response for the current cemetery application and please don't hesitate to get in touch to discuss further.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I
mackenzief@angus.gov.uk I www.angus.gov.uk

From: Caitlin Duffy <caitlin.duffy@dundeecity.gov.uk>
Sent: 04 February 2021 14:35
To: MacKenzieF <MacKenzieF@angus.gov.uk>; PLNProcessing <PLNProcessing@angus.gov.uk>
Cc: customerservices <customerservices@dundeecity.gov.uk>
Subject: Consultation Response 20/00830/FULL

Dear Mr Mackenzie,

TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997 as amended
PROPOSED CREMATORIUM BUILDING AND ASSOCIATED PARKING, ACCESS, TURNING SPACE, LANDSCAPING AND BOUNDARY ENCLOSURES
LAND NORTH EAST OF DUNTRUNE HOUSE, DUNTRUNE, ANGUS
APPLICATION REFERENCE NO 20/00830/FULL

I refer to your email correspondence dated 6 January 2021 regarding the above planning application which you have referred to Dundee City Council as a development adjacent to the Dundee City Council /Angus Council boundary with potential cross-boundary issues.

The application proposes the development of a crematorium with associated works on land north east of Duntrune House, Duntrune. The site is around 1km away from the Dundee City Council boundary. The Transport Assessment has been reviewed and there are no comments on the application from a roads perspective.

I consider that the planning application does not raise any issues of strategic significance for Dundee City Council and we have no objections to the proposal.

Yours faithfully

Caitlin Duffy

Planning Officer

Planning Team

City Development Department
Dundee City Council
50 North Lindsay Street
Dundee
DD1 1LS

Telephone: +44 (0) 1382 433806

E-mail: caitlin.duffy@dundeecity.gov.uk

Corporate Web Site http://www.dundeecity.gov.uk

Caitlin Duffy

Planning Officer

Planning Team

City Development Department
Dundee City Council
50 North Lindsay Street
Dundee
DD1 1LS

Telephone: +44 (0) 1382 433806

E-mail: caitlin.duffy@dundeecity.gov.uk

Corporate Web Site http://www.dundeecity.gov.uk

From: Emily Platt
Sent: Mon, 22 Mar 2021 13:28:58 +0000
To: MacKenzieF
Subject:RE: consultation request for Angus planning applications

Cheers Fraser, I spoke to Paul this morning ☐ I☐ve recommended getting an ecologist out to just do a walkover. The building footprint is fairly small and while it☐s unlikely there☐s a sett within that, as there☐s possibly been live sightings it☐s better to just make sure.

Kind regards,

Emily Platt

Operations Co-ordinator

Scottish Badgers

[redacted]

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 22 March 2021 10:09
To: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Subject: RE: consultation request for Angus planning applications

Thank you Emily,

I have suggested the agent for the application contacts you directly to establish what supporting information for badgers is required in support of the application. I hope this is ok.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I
mackenzief@angus.gov.uk I www.angus.gov.uk

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COVID-19

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From: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Sent: 15 March 2021 14:31
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: consultation request for Angus planning applications

Hi Fraser,

Apologies for the delay, we☐re in the midst of our busy season right now.

Usually surveys would also include land 100m outside of the site boundary as well, just to make sure any protected species are picked up that are at risk of being affected. I have had members of the public notify me of this proposal and badger presence here in the wider area, although sett locations were not provided. It may be that badgers are using this site to feed, however it☐s worth noting this may well continue after changes of use, so identifying potential local populations will facilitate any need for a further badger protection plan for the work site.

If it☐s of use, we produced guidance a few years ago for LPA☐s regarding badgers - https://www.scottishbadgers.org.uk/wp-content/uploads/2021/01/Protecting-Badgers-Guidance-for-Local-Planning-Authorities_Final-7366698.pdf

Kind regards,

Emily Platt

Operations Co-ordinator

Scottish Badgers

M: [redacted]

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 15 March 2021 12:00
To: operationscoordinator@scottishbadgers.org.uk
Subject: FW: consultation request for Angus planning applications

Good Morning Emily,

I was wondering if you☐ve had a chance to review below? If any investigation or supporting information is required for this application, I will really need to let the applicant know as soon as possible.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: MacKenzieF
Sent: 05 March 2021 10:54
To: operationscoordinator@scottishbadgers.org.uk
Subject: RE: consultation request for Angus planning applications

Good Morning Emily,

Application ref. 20/00830/FULL

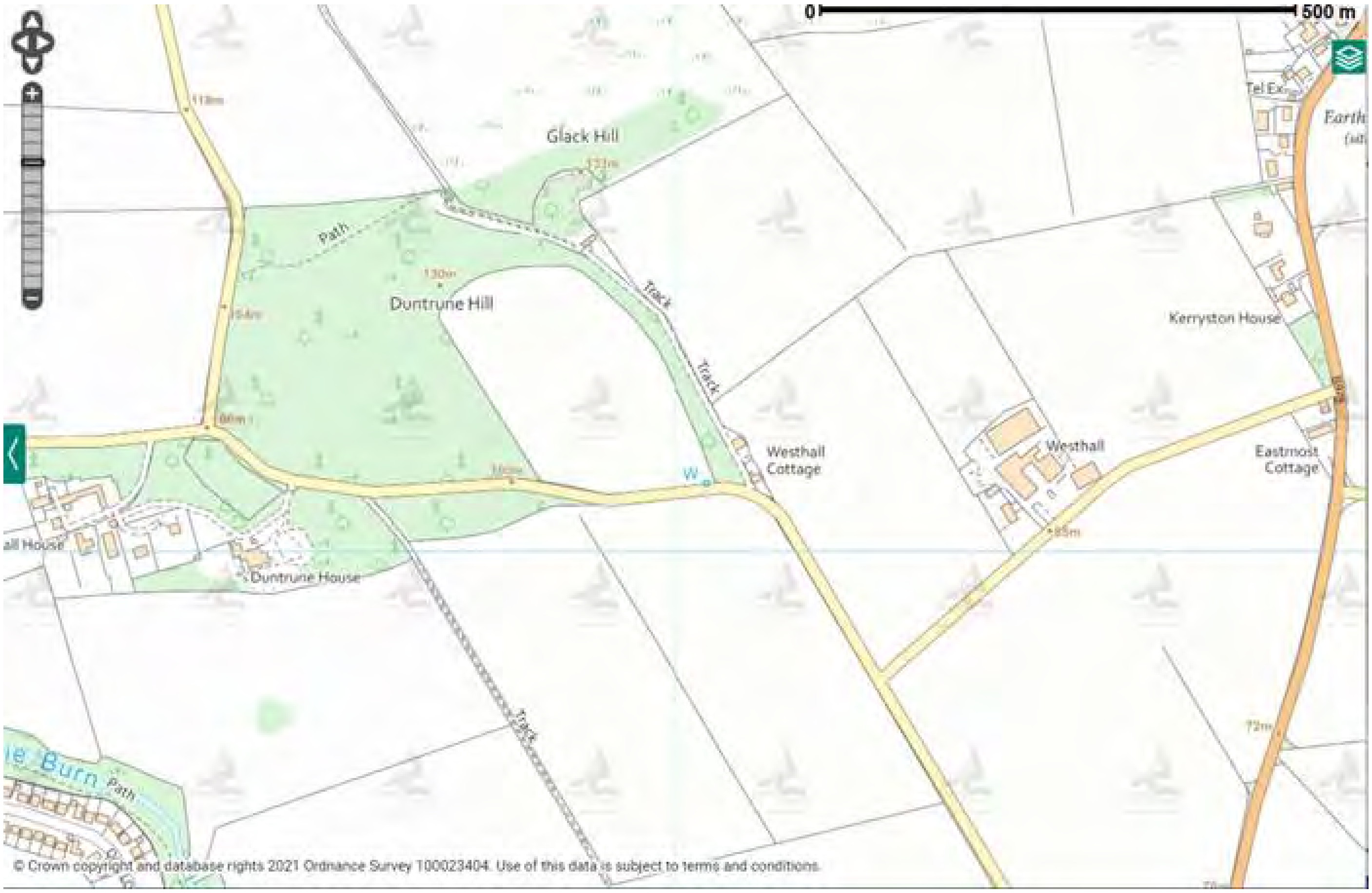
Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

Land North East Of Duntrune House, Duntrune

Thank you again for this advice.

For the above application, the proposal is contained in an area of field, although there is woodland adjacent in all directions, as shown on the plans below. On this basis, the applicant hasn☐t submitted an ecological survey and I don☐t think intends to do so. Given the proposal is not anticipated to result in a loss of woodland, I need to be proportionate in what I request so can you please advise what sort of ecological assessment would be required for badger potential, which I☐m assuming would be in the neighbouring woodland?


Glack Hill
Duntrune Hill
Existing Woodland
New Tree Edge Planting
Post & Wire Fence
New Trees
New Drystone Wall
Existing Woodland
New Access
New Native Hedge
Duntrune House
Eglismonthie
BM 113.55m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Westhall Cottage
Westhall
Kerryston House
Eastmost Cottage
all House
Duntrune House
Track
Burn
Path
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Please don☐t hesitate to contact me to discuss further.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I
mackenzief@angus.gov.uk I www.angus.gov.uk

From: operationscoordinator@scottishbadgers.org.uk <operationscoordinator@scottishbadgers.org.uk>
Sent: 17 February 2021 13:53
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: consultation request for Angus planning applications

Hi Fraser,

Many thanks for getting in touch, please note my email address has changed since our last correspondence.

We are aware of historic badger presence at two of these sites, however our own records do not replace the need for update surveys to be conducted on any sites that provide suitable habitat for badgers, which all three look to be appropriate for. We only provide exact sett location data as part of a data search service for ecological consultants.

It would therefore be prudent to advise these applicants that they require the services of an ecological consultant to survey the area and confirm badger presence. It would be under their guidance of what mitigation is required, hence the requirement of an experienced professional. If necessary we can review any surveys as a consultee to ensure best practise is being followed. I believe badger surveys are valid for a maximum of 18 months, so it☐s good the applicant for the crematorium site will be getting this updated.

Any questions please do let me know.

Kind regards,

Emily Platt

Operations Co-ordinator

Scottish Badgers

M: [redacted]

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 12 February 2021 17:07
To: speciesprotection@scottishbadgers.org.uk
Subject: consultation request for Angus planning applications

Good Afternoon,

I was wondering if you could assist. I have three planning permission applications which our records indicate may be in proximity to locations of badger setts.

I would be obliged if you would review the proposal documents at the links provided below and advise if any of the application sites affect an area of known badger population and, if so, whether further investigation would be required to determine if the badgers would be affected by the impacts of development. Please also advise in terms of any necessary mitigation. This information will of course be treated confidentially and only relayed to third parties (i.e. necessary mitigation measures to the applicant) if necessary.

Application ref. 21/00038/FULL

Erection of 2 glamping pods for holiday lets, including access track, parking space and sewerage treatment system

Land To The East Of The Grange, Kirkton Mill, Inverkeilor

Application ref. 20/00830/FULL

Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

Land North East Of Duntrune House, Duntrune

For the final application, this is a renewal application for a planning permission you were previously consulted on in 2017 (please see your consultation response attached). The current application does not yet have an updated Ecological Survey for, however, the applicant has advised this is forthcoming imminently and I will provide as soon as it☐s available.

Application ref. 20/00666/FULL

Erection of 20 Wigwam Cabins for Holiday Use, Reception Building, Car Parking Area, Access Track and Associated Engineering Works (Renewal of Planning Permission ref. 17/00608/FULL)

Denfind Plantation, Panmure Road, Monikie

Thank you in advance for your assistance with this matter and please don☐t hesitate to contact me if you have any queries or wish to discuss further.

Yours faithfully,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: Emily Platt
Sent:14 May 2021 12:53:18 +0100
To: Fraser MacKenzie
Subject:RE: consultation request for Angus planning applications

Hi Fraser,

Many thanks for passing that on, that looks absolutely fine from a badger perspective. While no foraging was noted from what I can gather by badgers in the area, there should be considerations during any construction to ensure any open pits are covered of an evening to avoid anything falling down them as an aside.

Kind regards,

Emily Platt

Operations Co-ordinator

Scottish Badgers

M: [redacted]

From: Fraser MacKenzie <MacKenzieF@angus.gov.uk>
Sent: 07 May 2021 11:45
To: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Subject: RE: consultation request for Angus planning applications

Good Morning Emily,

Application ref. 20/00830/FULL

Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

Land North East Of Duntrune House, Duntrune

I hope you□re well.

I write with reference to the above application and can advise the attached Ecology Report, which covers badgers, has been submitted. Can you please review and advise if this is acceptable for Scottish Badgers in terms of this development proposal?

Please don□t hesitate to contact me if you have any queries or wish to discuss further?

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I
mackenzief@angus.gov.uk I www.angus.gov.uk

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COVID-19

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From: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Sent: 23 March 2021 10:46
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: consultation request for Angus planning applications

Hi Fraser,

Yes that should be fine.

Kind regards,

Emily Platt

Operations Co-ordinator

Scottish Badgers

M: [redacted]

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 22 March 2021 13:58
To: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Subject: RE: consultation request for Angus planning applications

That☐s great Emily. Thank you for keeping me updated. Once a walkover is done, will Scottish badgers be in a position to provide a final consultation response for this proposal?

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Sent: 22 March 2021 13:29
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: consultation request for Angus planning applications

Cheers Fraser, I spoke to Paul this morning ☐ I☐ve recommended getting an ecologist out to just do a walkover. The building footprint is fairly small and while it☐s unlikely there☐s a sett within that, as there☐s possibly been live sightings it☐s better to just make sure.

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Emily Platt

Operations Co-ordinator

Scottish Badgers

M: [redacted]

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 22 March 2021 10:09
To: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Subject: RE: consultation request for Angus planning applications

Thank you Emily,

I have suggested the agent for the application contacts you directly to establish what supporting information for badgers is required in support of the application. I hope this is ok.

Kind Regards,

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mackenzief@angus.gov.uk I www.angus.gov.uk

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From: Emily Platt <operationscoordinator@scottishbadgers.org.uk>
Sent: 15 March 2021 14:31
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: consultation request for Angus planning applications

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M: [redacted]

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Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: MacKenzieF
Sent: 05 March 2021 10:54
To: operationscoordinator@scottishbadgers.org.uk
Subject: RE: consultation request for Angus planning applications

Good Morning Emily,

Application ref. 20/00830/FULL

Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

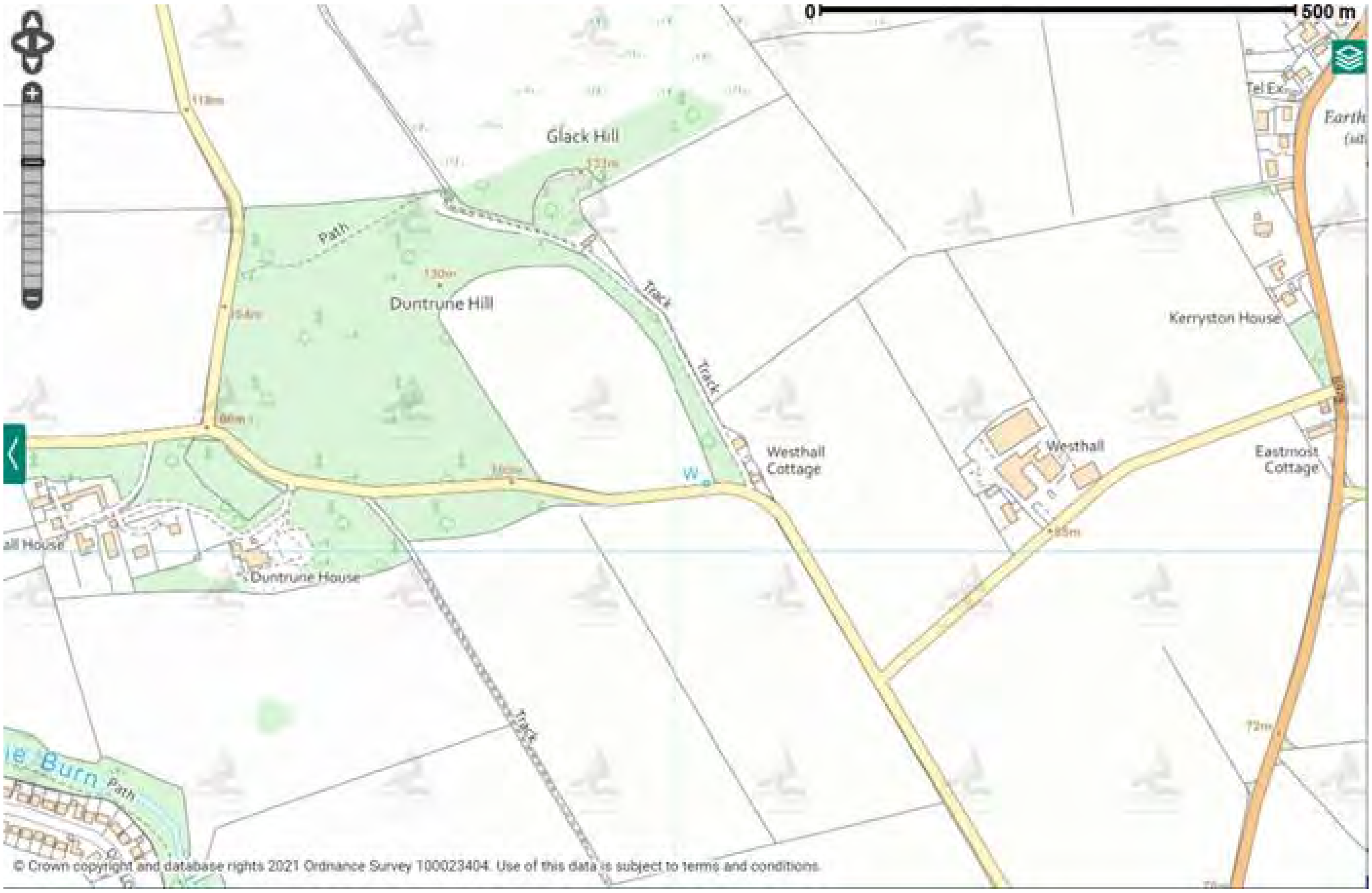
Land North East Of Duntrune House, Duntrune

Thank you again for this advice.

For the above application, the proposal is contained in an area of field, although there is woodland adjacent in all directions, as shown on the plans below. On this basis, the applicant hasn☐t submitted an ecological survey and I don☐t think intends to do so. Given the proposal is not anticipated to result in a loss of woodland, I need to be proportionate in what I request so can you please advise what sort of ecological assessment would be required for badger potential, which I☐m assuming would be in the neighbouring woodland?

AC8

Glack Hill
Duntrune Hill
Existing Woodland
Duntrune House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Westhall Cottage
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Kerryston House
Eastmost Cottage
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mackenzief@angus.gov.uk I www.angus.gov.uk

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Sent: 17 February 2021 13:53
To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: RE: consultation request for Angus planning applications

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Any questions please do let me know.

Kind regards,

Emily Platt

Operations Co-ordinator

Scottish Badgers

M: [redacted]

From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 12 February 2021 17:07
To: speciesprotection@scottishbadgers.org.uk
Subject: consultation request for Angus planning applications

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Application ref. 21/00038/FULL

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Application ref. 20/00830/FULL

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Yours faithfully,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: Planning South East
Sent:28 May 2021 13:48:14 +0100
To: Fraser MacKenzie
Cc:PLNProcessing
Subject:20/00830/FULL Crematorium at Land North East of Duntrune House - SEPA comments

OFFICIAL ☐ BUSINESS

Fraser

20/00830/FULL

Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures

Land North East Of Duntrune House, Duntrune

I refer to the application detailed above.

The cremation of human remains is a relevant activity under the Pollution Prevention and Control (PPC) Regulations (chapter 5, Section 5.1 Part B) therefore the applicant will require a permit from SEPA under these Regulations to operate. In line with PAN 51 guidance, we need certain information about a development to be submitted with the planning application in order to be able to provide a view on whether the associated activity is potentially capable of being consented. It is on this basis that our comments in respect of air quality below are made.

Based on the information available to us, we lodge a **holding objection** to this application because there is insufficient information to demonstrate that the proposed stack height has been suitably assessed to ensure it accords with the principle of Best Available Techniques (BAT).

The proposed stack is assumed by us to be 10m based on building design plans, but a stack height assessment should form part of the Air Quality Impact Assessment (AQIA) for BAT purposes

We would request clarification over the receptors. The approach taken to assessment differs from the norm as the applicant has not assessed compliance with air quality standards (AQS) at receptors, rather they have assessed it at the location of highest impact.

We ask for further info in relation to the following:

1. How many receptors are within the scope of the study? Please provide a table of receptors showing distance from proposed site and type (residential or other). The applicant states that there are dwellings within 800 -1000m from the site ☐ have these been included in the assessment? If not please provide a justification for exclusion.
2. Table 5 needs to be amended to show PC, PEC and % of the AQS at each receptor within the scope of the study
3. A stack height assessment should be carried out and included in the AQIA for BAT purposes
4. Please confirm which site the meteorological data is from. We recommend 5 years met data is used for AQIA with the ☐worst case☐ concentrations reported. It appears only 1 year☐s data has been used in this case and the year isn☐t specified.

I trust these comments are of assistance ☐ please do not hesitate to contact me if you require any further information.

Regards

Alasdair

Alasdair Milne

Senior Planning Officer

Scottish Environment Protection Agency

Strathallan House

Castle Business Park

Stirling

FK9 4TZ

Telephone 01786 452537

Mobile [redacted]

www.sepa.org.uk

Disclaimer This advice is given without prejudice to any decision made on elements of the proposal regulated by us, as such a decision may take into account factors not considered at this time. We prefer all the technical information required for any SEPA consents to be submitted at the same time as the planning or similar application. However, we consider it to be at the applicant's commercial risk if any significant changes required during the regulatory stage necessitate a further planning application or similar application and/or neighbour notification or advertising. We have relied on the accuracy and completeness of the information supplied to us in providing the above advice and can take no responsibility for incorrect data or interpretation, or omissions, in such information. If we have not referred to a particular issue in our response, it should not be assumed that there is no impact associated with that issue. For planning applications, if you did not specifically request advice on flood risk, then advice will not have been provided on this issue. Further information on our consultation arrangements generally can be found on our website planning pages

OFFICIAL ☐ BUSINESS

Ed Taylor

From: Milne, Alasdair <alasdair.milne@SEPA.org.uk>
Sent: 07 September 2021 13:50
To: Ed Taylor
Subject: RE: 20/00830/FULL - Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures on Land North East Of Duntrune House Duntrune

OFFICIAL – BUSINESS

Ed

20/00830/FULL - Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures
Land North East Of Duntrune House, Duntrune

I refer to the application detailed above, to SEPA's holding objection dated 28 May and to the further information received from the applicant by way of the email from Fraser MacKenzie of 7 July. I am now able to update you on our position.

We have reviewed the additional information (Ethos Environmental 'Response to SEPA Comments' and Ethos Environmental 'Technical Report' Rev3) and are satisfied that our objection can now be **withdrawn**.

The applicant should liaise with SEPA's permitting team in relation to the required permit under the Pollution Prevention and Control (PPC) Regulations.
Further information on this is available on our website at Pollution prevention and control | Scottish Environment Protection Agency (SEPA)

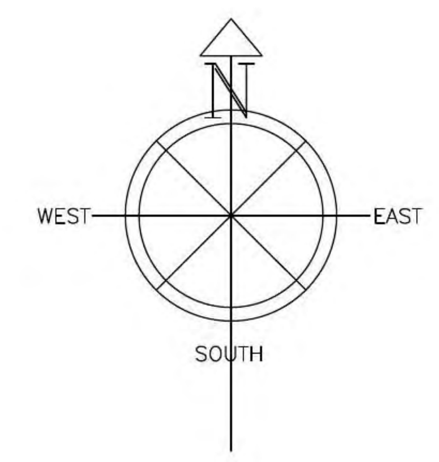
I trust these comments are of assistance – please do not hesitate to contact me if you require any further information.

Regards
Alasdair

Alasdair Milne
Senior Planning Officer
Scottish Environment Protection Agency
Strathallan House
Castle Business Park
Stirling
FK9 4TZ

www.sepa.org.uk

NOTES



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CLIENT
Duntrune Ltd.
Kinnells Mill
Friockheim
Angus
DD11 4UL

PROJECT
Proposed New Crematorium
Burnside of Duntrune
By Dundee
Angus

DRAWING TITLE
Context Plan

SCALE	DATE
1:2500	May 2020
CAD FILE	DRAWN BY
1266	PF

@rchitects
15 West High Street
Forfar, Angus
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

DWG NO.
1266 / PD / 03 Rev B

NOTES

WEST EAST SOUTH N

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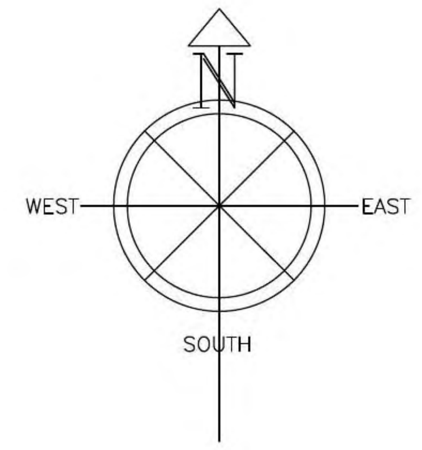
CLIENT	PROJECT
Duntrune Ltd. Kinnells Mill Friockheim Angus DD11 4UL	Proposed New Crematorium Burnside of Duntrune By Dundee Angus
SCALE 1:1250 / DATE May 2020	DRAWING TITLE Site Plan
CAD FILE 1266 / DRAWN BY PF	DWG NO. 1266 / PD / 02 Rev C

@rchitects
chartered architects
15 West High Street
Forfar, Angus
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

NOTES



0 1 2 3 4 5 10 15 20
Scale : 1:200

REVISIONS

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CLIENT
Duntrune Ltd.
Kinnells Mill
Friockheim
Angus
DD11 4UL

SCALE 1:200
DATE May 2020
CAD FILE 1266
DRAWN BY PF

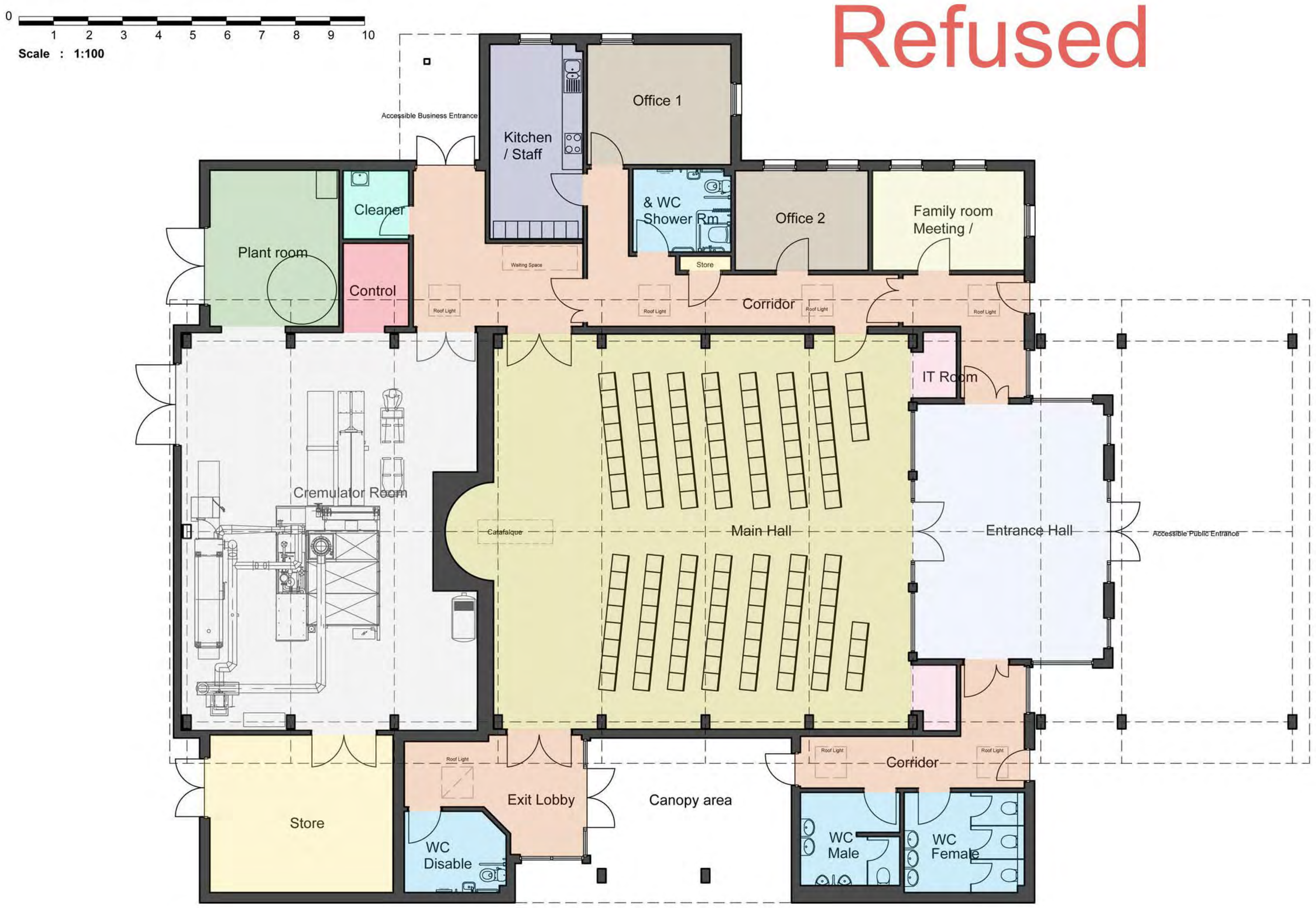
PROJECT
Proposed New Crematorium
Burnside of Duntrune
By Dundee
Angus

DRAWING TITLE
Building & External Works Plan

@rchitects
15 West High Street
Forfar, Angus
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

DWG NO.
1266 / PD / 01 Rev C

Refused

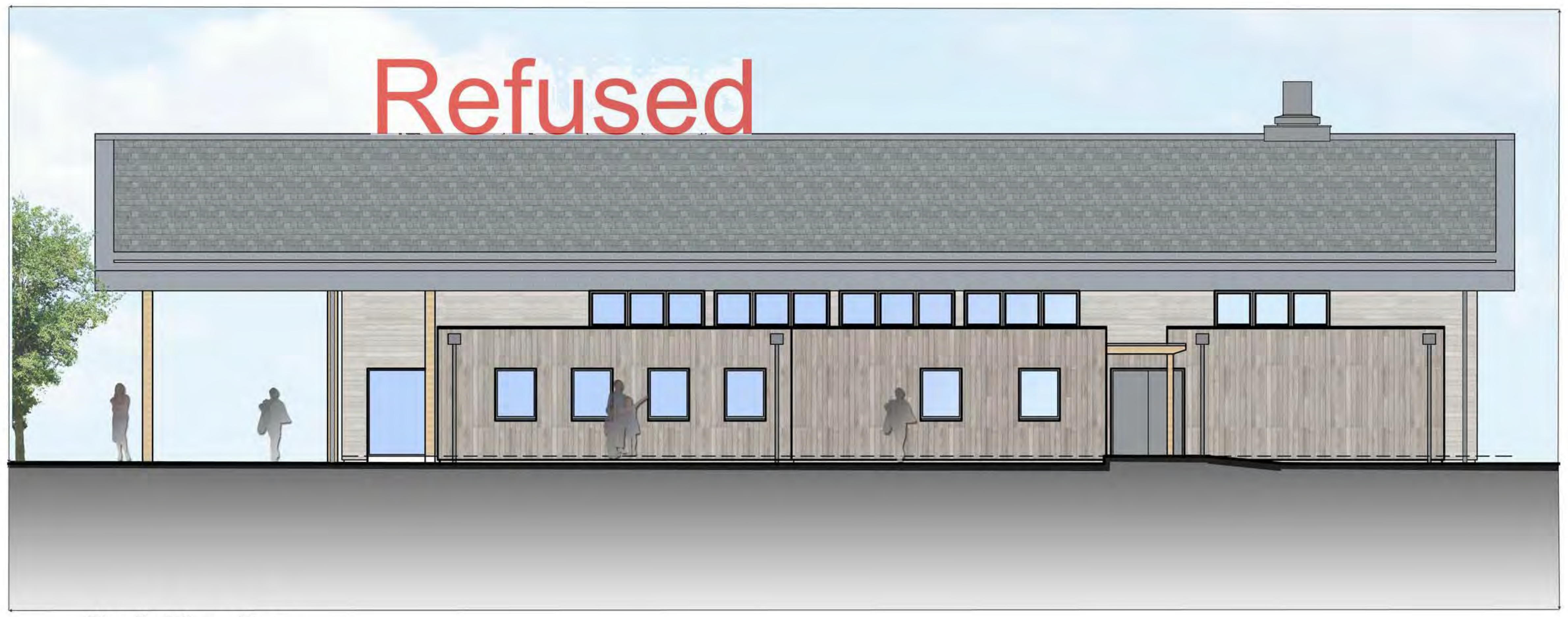


Ground Floor Plan

Refused

East Elevation

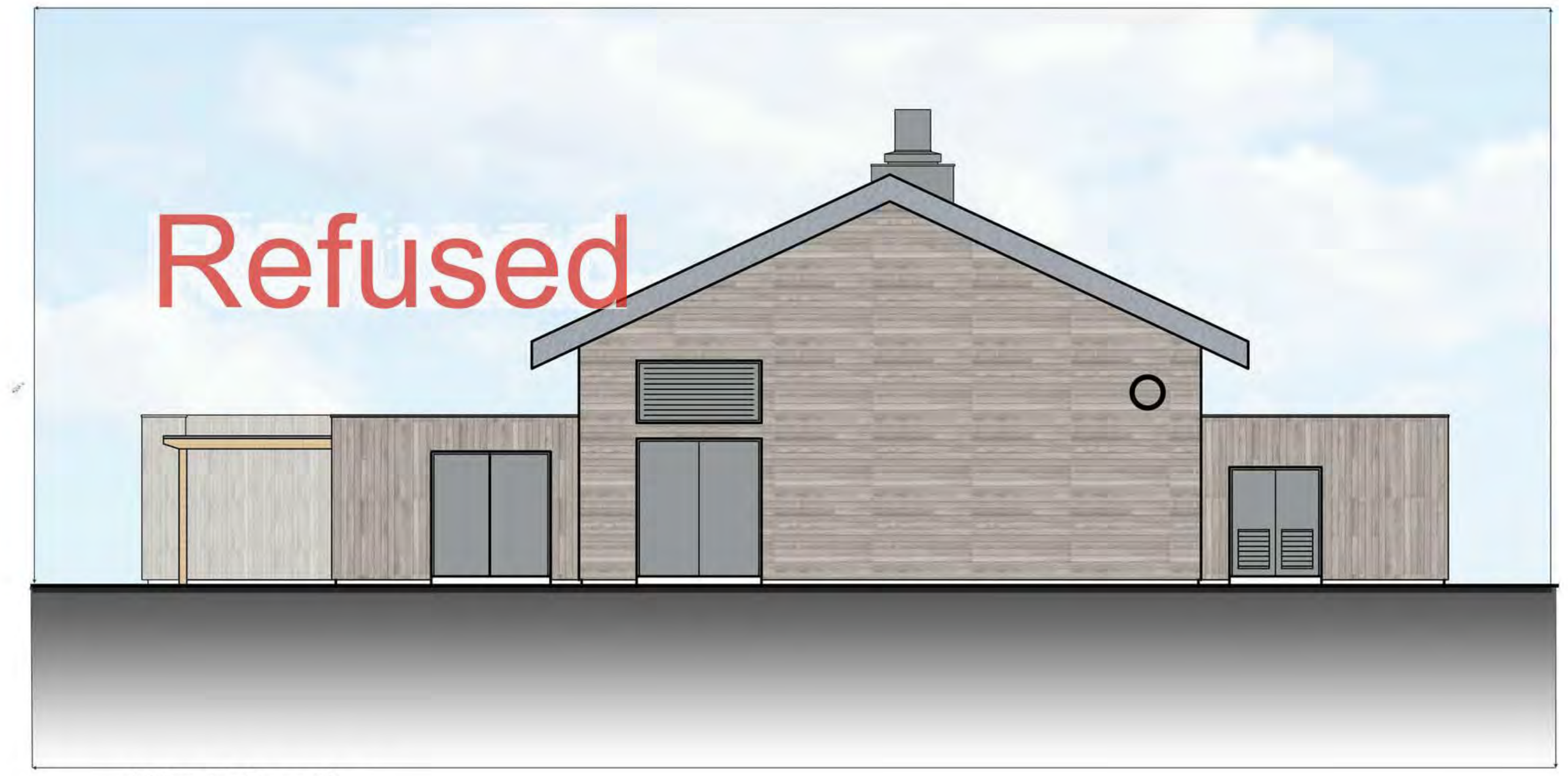
Refused



North Elevation

Refused

South Elevation



West Elevation

NOTES

Materials

Walls - Grey Cladding

Frame - Timber Glulam

Roof - Main Roof Slate with Grey Aluminium Perimeter

Flat Roof - Grey Single Ply Membrane

Windows/Doors - Grey Aluclad Windows

REVISIONS

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CLIENT
Duntrune Ltd.
Kinnells Mill
Friockheim
Angus
DD11 4UL

PROJECT
Proposed New Crematorium
Burnside of Duntrune
By Dundee
Angus

DRAWING TITLE
Elevations & Section

SCALE	DATE
1:100	May 2020
CAD FILE	DRAWN BY
1266	PF

@rchitects
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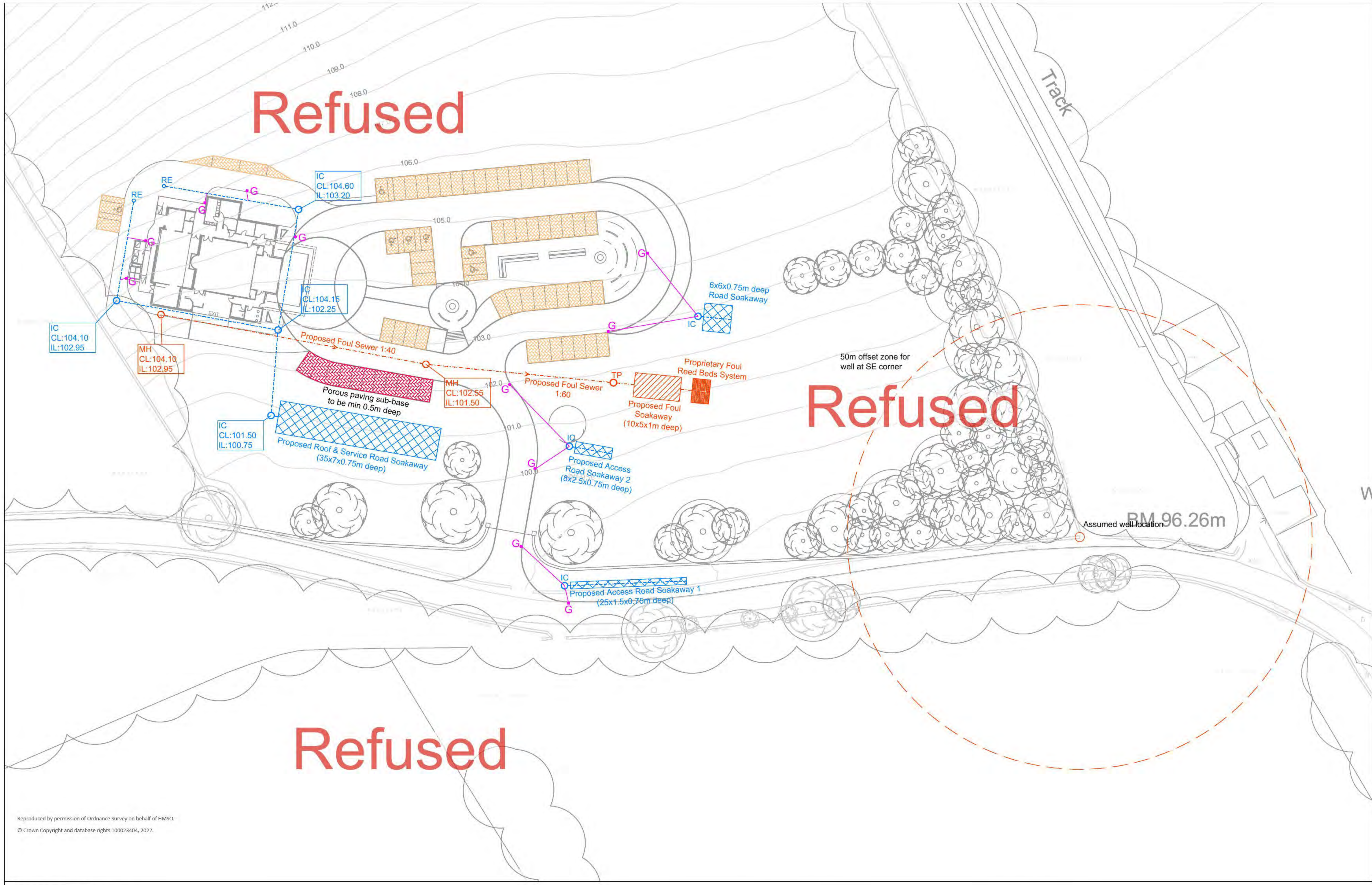
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

DWG NO.
1266 / PD / 05

FIGURED DIMENSIONS ONLY TO BE USED



Reproduced by permission of Ordnance Survey on behalf of HMSO.

Drainage Layout

Scale 1:500

General notes:

This drawing is to be read in conjunction with all relevant engineers and architects drawings.

Drainage - all sewers to be constructed in accordance with Scottish water's publication "Sewers for Scotland (4th edition) a policy, design and construction guide for developers in Scotland"

Sewers laid within roads should have a minimum cover of 1.5m from final road surface to pipe soffit level. Where this cannot be achieved then ridged pipes shall be protected by a full concrete surround, similarly, flexible pipes shall be protected by a concrete slab at a depth less than 1.2m.

The contractor is responsible for checking the line and level of all existing services prior to commencement of works. Any discrepancies from design information must be reported to the site manager and site engineer in writing.

The contractor should allow for CCTV camera survey of entire drainage system upon substantial completion of works. If any remedial works are required a repeat survey should also be carried out prior to formal submission to Engineer together with as-built drawing including manhole co-ordinates, cover and invert levels and pipe gradients .

Surface Drainage Legend

- Surface water sewer (uPVC Marley Quantum rigid solid pipework) unless otherwise noted on drawing.
- Surface Water Soakaway
- Porous Paving with standard 450mm deep sub-base
- Porous Paving with increased depth of sub-base
- S1 Surface Water Manhole with Reference Number
- IC Surface Water Inspection Chamber
- RE Surface Water Rodding Eye
- G Road Gully with associated tail

Foul Drainage Legend

- Foul water sewer (uPVC Marley Quantum rigid solid pipework) unless otherwise noted on drawing.
- Foul Infiltration Bed
- 8No Klargester Foul Reed Beds
- F1 Foul Water Manhole with Reference Number
- TP Denotes Klargester BioFicient 6 Treatment Plant (30 Person Unit)

Drainage tail positions to be confirmed on site to suit house type discharge points. A surface water and foul water branch should be established for each plot.

Refer to Architects drawings for internal drainage runs and details.

Note:-

Soakaway to be least 5m from building foundations.

Maintenance of proposed surface water drainage

1.Soakaway
Inlet chamber to be checked at six monthly intervals and any organic matter and silt build up removed. Soakaway to be checked also to ensure that there is no build up of standing water once a rainfall event has passed (six monthly). Surface over soakaway to be constructed of material that is easily removed (e.g. lock block) to allow filter gravel to be replaced if required in the future. No trees or large shrubs to be planted within 5 metres of the soakaway.

2.Drainage Pipes
Inlet pipes to be checked at six month intervals for blockages and silt build up. Blockages and structural damage to be repaired or cleaned as necessary.

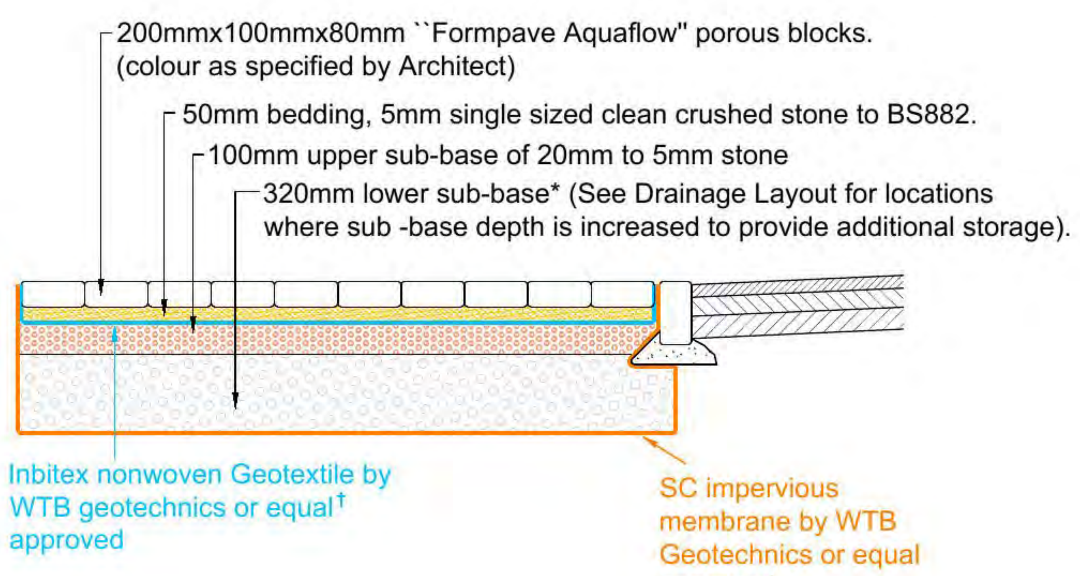
Notes:

Supplied by WTB Geotextiles

* Specification for sub-base, laying course and blinding layer: the crushed stone must possess well defined edges and have a minimum 10% fines value of 150kN when tested in accordance with BS812 Part 111.

Grading of Sub-base stone

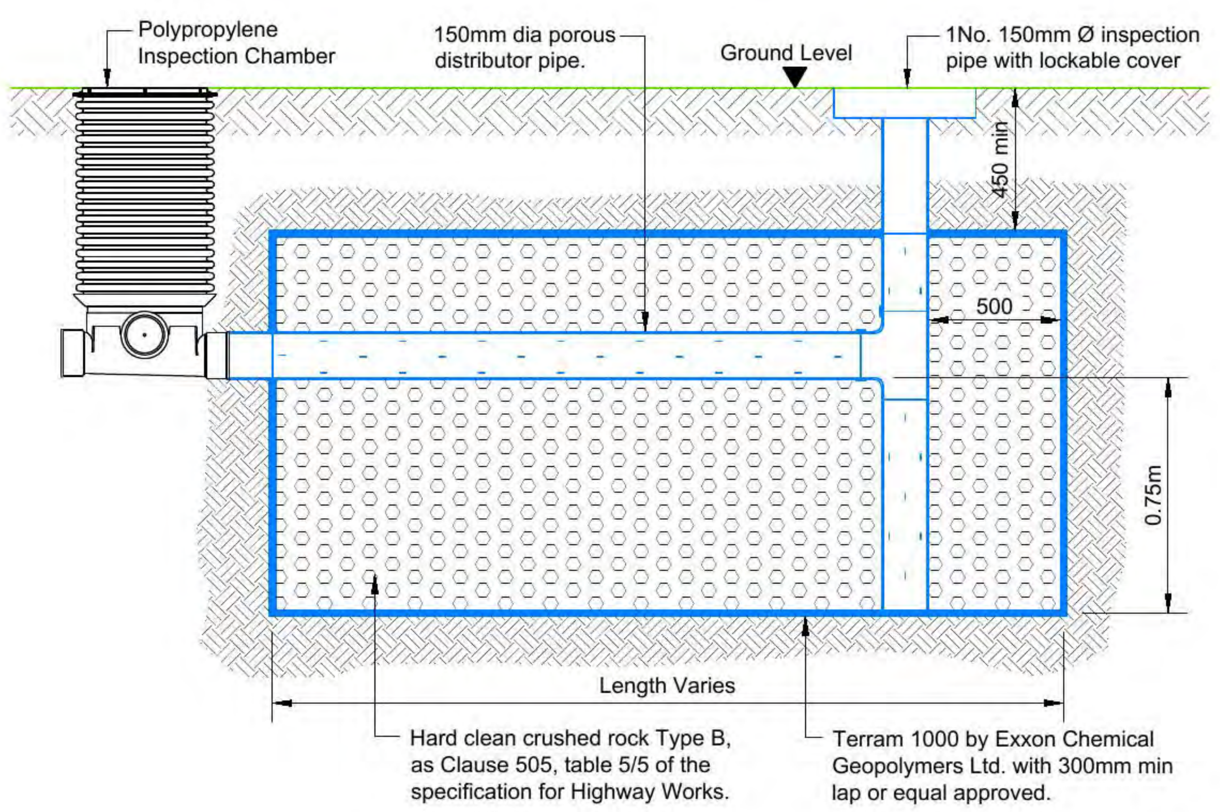
SIEVE SIZE	% PASSING
100mm	100
75mm	80-100
60mm	60-80
37.5mm	30-60
20mm	0-20
10mm	0-5



SECTION THROUGH POROUS PAVING

Scale 1:20

Note:- Sub-base to be increased to as per depth noted on plan



TYPICAL PRIVATE SURFACE WATER SOAKAWAY LONGITUDINAL SECTION

Scale 1:20

Note:

Soakaway dimensions based on a soil infiltration rate (f) = 8.85x10^{-5} m/sec as determined by Cameron + Ross' site investigation of 09/10/2019 in accordance with in BRE Digest 365 with 30% free volume of fill material.

Issue	Revision	Initial	Date
1	Drainage updated to suit amended layout	SAD/BAC	19/11/2020

Cameron + Ross

CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB
Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Drainage Layout

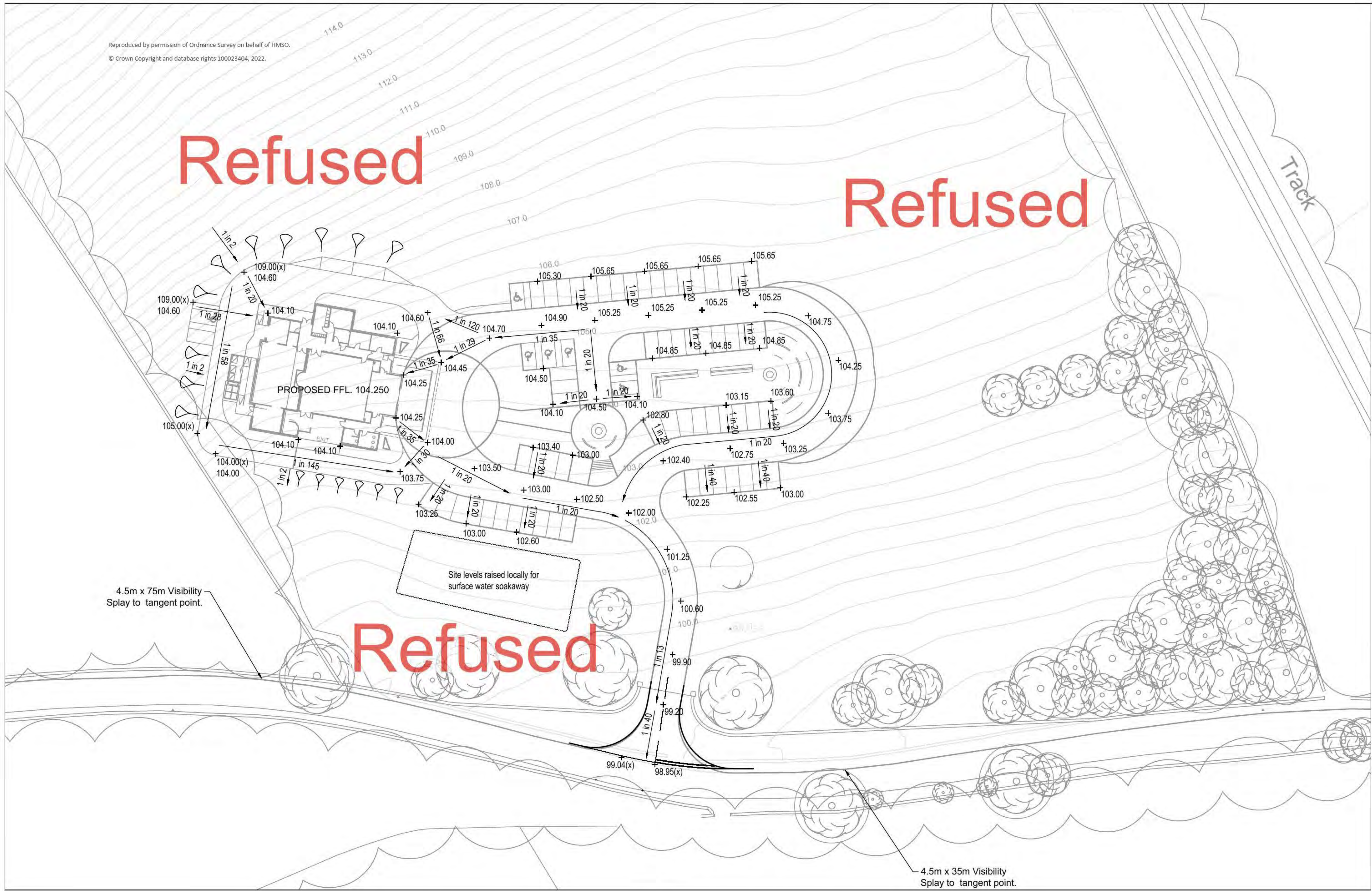
Status:
Planning

North

Scale:	1:500 @ A1	Date:	31/08/2020
By: SAD	Checked: BAC	Approved: RAG	

Dwg. No.
A/190889 – 920

Rev.
1



Site Layout
Scale 1:500

FIGURED DIMENSIONS ONLY TO BE USED

Legend

FFL ??.??	Finished Floor Level
+ ??.??	Proposed Ground Level
+ ??.??(x)	Existing Ground Level
1 in ??	Gradient

Issue	Revision	Initial	Date
1	Site Levels updated to suit amended layout	SAD/BAC	19/11/2020

Cameron+Ross
CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB
Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Site Access Road Layout Plan

Status:
Planning

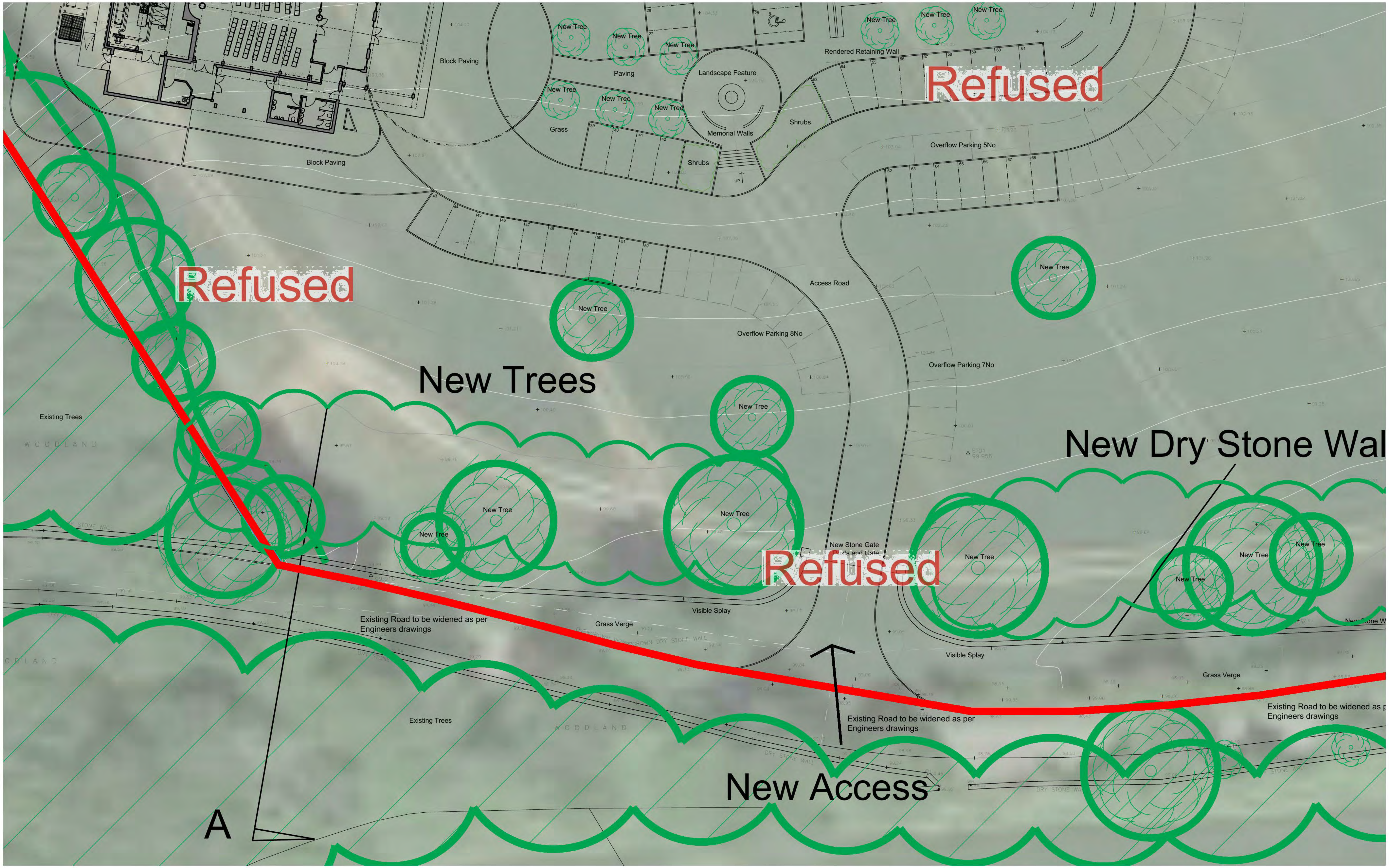
North

Scale: 1:500 @ A1		Date: 31/08/2020	
By: SAD	Checked: BAC	Approved: RAG	

Dwg. No.
A/190889 – 910

Rev.
1

NOTES



Scale : 1:200

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CLIENT
Duntrune Ltd.
Kinnells Mill
Friockheim
Angus
DD11 4UL

PROJECT
Proposed New Crematorium
Burnside of Duntrune
By Dundee
Angus

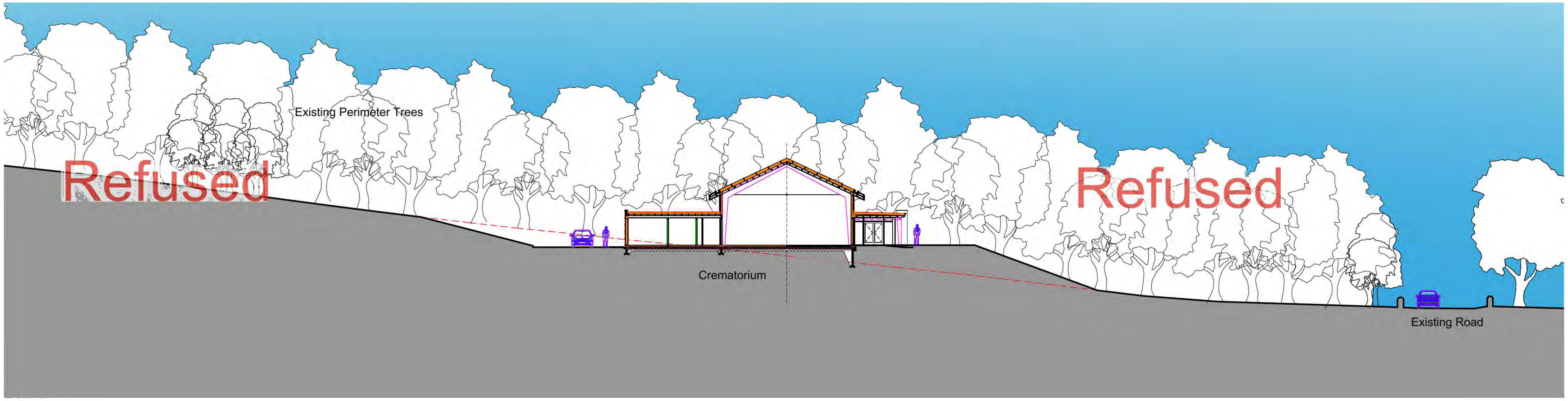
DRAWING TITLE
Road Access

SCALE 1:200
DATE May 2020
CAD FILE 1266
DRAWN BY PF

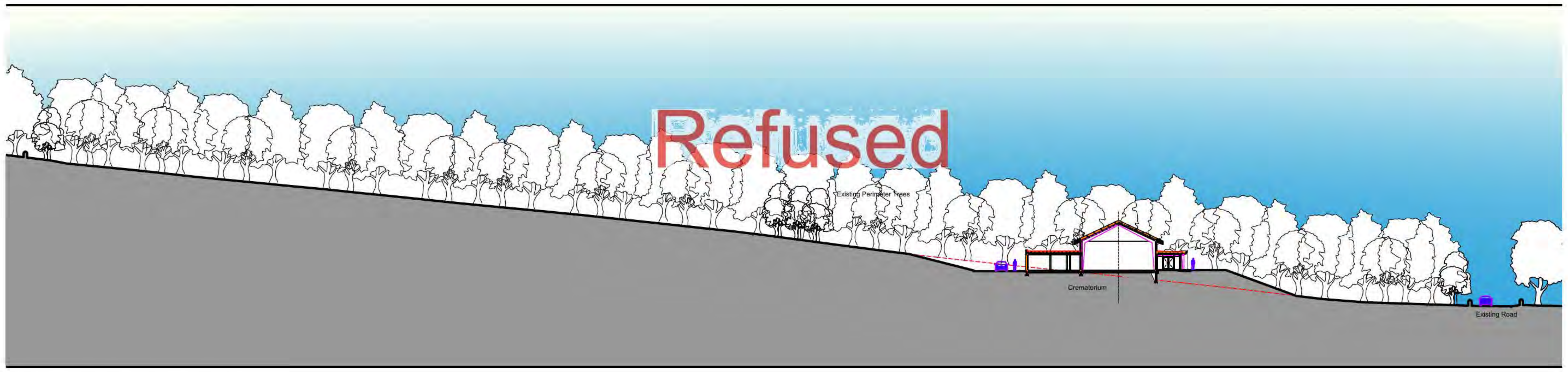
@rchitects
15 West High Street
Forfar, Angus
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

DWG NO.
1266 / SK / 06 Rev C

NOTES



Section A-A



Section A-A in context

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CLIENT
Duntrune Ltd.
Kinnells Mill
Friockheim
Angus
DD11 4UL

SCALE: 1:500 & 1:200
DATE: May 2020
CAD FILE: 1266
DRAWN BY: PF

PROJECT
Proposed New Crematorium
Burnside of Duntrune
By Dundee
Angus

DRAWING TITLE
Site Section

@rchitects
Chartered Architects
15 West High Street
Forfar, Angus
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

DWG NO.
1266 / PD / 04 Rev B

NOTES

REVISIONS

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CLIENT
Duntrune Ltd.
Kinnells Mill
Friockheim
Angus
DD11 4UL

PROJECT
Proposed New Crematorium
Burnside of Duntrune
By Dundee
Angus

DRAWING TITLE
Survey Plan

SCALE	DATE
1:500	May 2020

CAD FILE	DRAWN BY
1266	PF

@rchitects
Chartered Architects
15 West High Street
Forfar, Angus
DD8 1BE
Tel: 01307 466480
Email: paul@rchitects.org.uk

DWG NO.
1266 / SD / 01

FIGURED DIMENSIONS ONLY TO BE USED

North

Issue	Revision	Initial	Date
1	Visibily splay to Tangent added	BAC	15.02.21

Cameron+Ross

CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB

Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Visibility Splays
Sheet 3 of 3

Status:
Concept

Scale: 1:500 @ A1	Date: 20/02/2020	
By: CRM	Checked: BAC	Approved: RAG

Dwg. No.
A/190889 – 906

Rev.
1

ANGUS COUNCIL

AC12

TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997
(AS AMENDED)
TOWN AND COUNTRY PLANNING (DEVELOPMENT MANAGEMENT PROCEDURE)
(SCOTLAND)
REGULATIONS 2013

PLANNING PERMISSION REFUSAL
REFERENCE : 20/00830/FULL

To **Duntrune Ltd**
c/o @rchitects Scotland Ltd
Paul Fretwell
15 West High Street
Forfar
DD8 1BE

With reference to your application dated 14 December 2020 for planning permission under the above mentioned Acts and Regulations for the following development, viz.:-

Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures at **Land North East Of Duntrune House Duntrune** for **Duntrune Ltd**

The Angus Council in exercise of their powers under the above mentioned Acts and Regulations hereby **Refuse Planning Permission (Delegated Decision)** for the said development in accordance with the particulars given in the application and plans docqueted as relative hereto in paper or identified as refused on the Public Access portal.

The reasons for the Council's decision are:-

1. The development would result in an unsustainable pattern of travel and development and would not be accessible by a choice of transport modes, increasing reliance on the private car in a situation where access to walking, cycling and public transport is poor. The proposal is therefore contrary to TAYplan policies 1 and 2, Angus Local Development Plan policies DS2, DS3 and TC8, and Scottish Planning Policy in so far as it relates to locating development in accessible locations.

2. The application is contrary to Policy DS1 of the Angus Local Development Plan 2016 because the scale and nature of the development is not appropriate for its location because it does not enjoy good accessibility, particularly for pedestrians, cyclists and public transport; and because the proposal is not in accordance with other relevant policies, namely policies DS2, DS3 and TC8.

Amendments:

1. Building and External Works Plan drawing no. 1226 / PD / 01 Revision C dated May 2020 amends and supersedes all previous Building and External Works Plan drawings and includes overflow car parking resulting in total of 124 car parking spaces (72 plus 52 overflow spaces).

2. Site Plan drawing no. 1266 / PD / 02 Revision C dated May 2020 amends and supersedes all previous Site Plan drawings and includes overflow car parking resulting in total of 124 car parking spaces (72 plus 52 overflow spaces).

3. Road Access drawing no. 1266 / SK / 06 Revision C dated May 2020 amends and supersedes all previous Road Access drawings and includes overflow car parking and annotates 'Existing Road to be widened as per Engineers drawings' on the public road.

Dated this **24 January 2022**

AC12

Jill Paterson
Service Lead
Planning and Sustainable Growth
Angus Council
Angus House
Orchardbank Business Park
Forfar
DD8 1AN

Planning Decisions – Guidance Note

Please retain – this guidance forms part of your Decision Notice

You have now received your Decision Notice. This guidance note sets out important information regarding appealing or reviewing your decision. There are also new requirements in terms of notifications to the Planning Authority and display notices on-site for certain types of application. You will also find details on how to vary or renew your permission.

Please read the notes carefully to ensure effective compliance with the new regulations.

DURATION

This permission will lapse 3 years from the date of this decision, unless there is a specific condition relating to the duration of the permission or development has commenced by that date.

PLANNING DECISIONS

Decision Types and Appeal/Review Routes

The 'decision type' as specified in your decision letter determines the appeal or review route. The route to do this is dependent on the how the application was determined. Please check your decision letter and choose the appropriate appeal/review route in accordance with the table below. Details of how to do this are included in the guidance.

Determination Type	What does this mean?	Appeal/Review Route
Development Standards Committee/Full Council	National developments, major developments and local developments determined at a meeting of the Development Standards Committee or Full Council whereby relevant parties and the applicant were given the opportunity to present their cases before a decision was reached.	***DPEA (appeal to Scottish Ministers) – See details on attached Form 1***
Delegated Decision	Local developments determined by the Service Manager through delegated powers under the statutory scheme of delegation. These applications may have been subject to less than five representations, minor breaches of policy or may be refusals.	***Local Review Body – See details on attached Form 2***
Other Decision	All decisions other than planning permission or approval of matters specified in condition. These include decisions relating to Listed Building Consent, Advertisement Consent, Conservation Area Consent and Hazardous Substances Consent.	***DPEA (appeal to Scottish Ministers) – See details on attached Form 1***

Notification of initiation of development (NID)

Once planning permission has been granted and the applicant has decided the date they will commence that development they must inform the Planning Authority of that date. The notice must be submitted before development commences – failure to do so would be a breach of planning control. The relevant form is included with this guidance note.

Notification of completion of development (NCD)

Once a development for which planning permission has been given has been completed the applicant must, as soon as practicable, submit a notice of completion to the planning authority. Where development is carried out in phases there is a requirement for a notice to be submitted at the conclusion of each phase. The relevant form is included with this guidance note.

Display of Notice while development is carried out

For national, major or 'bad neighbour' developments (such as public houses, hot food shops or scrap yards), the developer must, for the duration of the development, display a sign or signs containing prescribed information.

The notice must be in the prescribed form and:-

- displayed in a prominent place at or in the vicinity of the site of the development;
- readily visible to the public; and
- printed on durable material.

A display notice is included with this guidance note.

Should you have any queries in relation to any of the above, please contact:

Angus Council
Angus House
Orchardbank Business Park
Forfar
DD8 1AN

Telephone 01307 492076 / 492533
E-mail: planning@angus.gov.uk
Website: www.angus.gov.uk

FORM 1

TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997 (AS AMENDED)

The Town & Country Planning (Development Management Procedure) (Scotland) Regulations 2013 – Schedule to Form 1

Notification to be sent to applicant on refusal of planning permission or on the grant of permission subject to conditions decided by Angus Council

1. If the applicant is aggrieved by the decision of the planning authority-

   a) to refuse permission for the proposed development;
   b) to refuse approval, consent or agreement required by condition imposed on a grant of planning permission;
   c) to grant planning permission or any approval, consent or agreement subject to conditions,

the applicant may appeal to the Scottish Ministers to review the case under section 47 of the Town and Country Planning (Scotland) Act 1997 within three months beginning with the date of this notice. The notice of appeal should be addressed to The Planning and Environmental Appeals Division, Scottish Government, Ground Floor, Hadrian House, Callendar Business Park, Callendar Road, Falkirk, FK1 1XR. Alternatively you can submit your appeal directly to DPEA using the national e-planning web site https://eplanning.scotland.gov.uk.

2. If permission to develop land is refused or granted subject to conditions and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, the owner of the land may serve on the planning authority a purchase notice requiring the purchase of the owner of the land's interest in the land in accordance with Part 5 of the Town and Country Planning (Scotland) Act 1997.

TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997 (AS AMENDED)

The Town & Country Planning (Development Management Procedure) (Scotland) Regulations 2013 – Schedule to Form 2

Notification to be sent to applicant on refusal of planning permission or on the grant of permission subject to conditions decided through Angus Council's Scheme of Delegation

1. If the applicant is aggrieved by the decision of the planning authority-

   a) to refuse permission for the proposed development;
   b) to refuse approval, consent or agreement required by condition imposed on a grant of planning permission;
   c) to grant planning permission or any approval, consent or agreement subject to conditions,

   the applicant may require the planning authority to review the case under section 43A of the Town and Country Planning (Scotland) Act 1997 within three months beginning with the date of this notice. The notice of review should be addressed to Committee Officer, Angus Council, Resources, Legal & Democratic Services, Angus House, Orchardbank Business Park, Forfar, DD8 1AN.

   A Notice of Review Form and guidance can be found on the national e-planning website https://eplanning.scotland.gov.uk. Alternatively you can return your Notice of Review directly to the local planning authority online on the same web site.

2. If permission to develop land is refused or granted subject to conditions and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, the owner of the land may serve on the planning authority a purchase notice requiring the purchase of the owner of the land's interest in the land in accordance with Part 5 of the Town and Country Planning (Scotland) Act 1997.

PLANNING

Your experience with Planning

Please indicate whether you agree or disagree with the following statements about your most recent experience of the Council's handling of the planning application in which you had an interest.

Q.1 I was given the advice and help I needed to submit my application/representation:-

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	It does not apply
☐	☐	☐	☐	☐	☐

Q.2 The Council kept me informed about the progress of the application that I had an interest in:-

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	It does not apply
☐	☐	☐	☐	☐	☐

Q.3 The Council dealt promptly with my queries:-

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	It does not apply
☐	☐	☐	☐	☐	☐

Q.4 The Council dealt helpfully with my queries:-

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	It does not apply
☐	☐	☐	☐	☐	☐

Q.5 I understand the reasons for the decision made on the application that I had an interest in:-

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	It does not apply
☐	☐	☐	☐	☐	☐

Q.6 I feel that I was treated fairly and that my view point was listened to:-

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	It does not apply
☐	☐	☐	☐	☐	☐

OVERALL SATISFACTION: Overall satisfaction with the service: ……………………………………………………

Q.7 Setting aside whether your application was successful or not, and taking everything into account, how satisfied or dissatisfied are you with the service provided by the council in processing your application?

Very satisfied	Fairly satisfied	Neither Satisfied nor Dissatisfied	Fairly Dissatisfied	Very Dissatisfied
☐	☐	☐	☐	☐

OUTCOME: Outcome of the application:

Q.8 Was the application that you had an interest in:-

Granted Permission/Consent ☐ Refused Permission/Consent ☐ Withdrawn ☐

Q.9 Were you the:- Applicant ☐ Agent ☐ Third Party objector who made a representation ☐

Please complete the form and return in the pre-paid envelope provided.
Thank you for taking the time to complete this form.

Cameron+Ross

DRAINAGE STATEMENT

A/190889 – PORPOSED CREMATORIUM, BURNSIDE OF DUNTRUNE, ANGUS.

1. **EXISTING SITE CONDITIONS.**

The site is 4.5 hectares and is proposed to be developed for a 120-seating capacity crematorium.

Located on the north side of the C4 and the site is set in a rural location around 7km to the northeast of Dundee City Centre and around 0.5km to the east of the village of Burnside of Duntrune. The site location plan is contained below:

Figure 1 – Site Location Plan.

The site is surrounded by wooded areas to the north, east and west beyond which is generally agricultural land. Agricultural land also bounds the site this site to the south of the C4. The site falls from north to south with a typical 1in 12 gradient. The highest level is approximately 114.0m AoD (Above Ordinance Datum) along the north boundary falling to a low of 96.2m AoD in the SE corner.

There are no open watercourses or ditches within the site or its immediate vicinity. There is a small pond/flooded area within the SE corner of the site and this is at the location of a well which is identified on the OS Maps of the site. The well appears to be unused. The client has no knowledge of the well which suggests it has been abandoned.

Although it appears to be abandoned the drainage design will ensure that the minimum offset distances are achieved between the well and any surface or foul water soakaways to ensure that the well can be re-used in the future.

2. GROUND CONDITIONS.

Trial pit investigations were undertaken by Cameron + Ross Ltd on 10th October 2019 and reference should be made to the geotechnical investigation report contained within **Appendix A**. A summary of the trial pit investigation findings is contained below:

Four No trial pits were excavated with the purpose of undertaking infiltration tests in accordance with BRE Digest 365.

Topsoil was encountered as the uppermost horizon on the site with thickness between 0.25m and 0.90m with an average depth of 0.35m. The natural sub-soils are a mix of firm clays and loose to medium dense gravels and were encountered directly below the topsoil down to a typical depth of around 2.0m to 2.5m below ground level(mbgl).

Trial Pits 1, 2 and 12 were undertaken in the field to the south of the C4 which the developer also owns. Trial Pit was excavated to a depth of 2.0mbgl where it was terminated possibly on weathered bedrock. Similarly, Trial Pit Nos 10 and 11 to the north end of the site which is the higher area of the site were also terminated in possible weathered bedrock at 2.5mbgl and 2.0mbgl.

Groundwater

Groundwater was noted within the following trial pits:

TP1 – very slight groundwater entry at 1.2mbgl
TP2 – very slight groundwater entry at 1.2mbgl
TP4A – slow groundwater entry at 2.2mblg after 1 hr water level had settled at 1.9mbgl
TP5 – strong groundwater entry at 1.2mbgl. Water level settled at 0.9mbgl. This is the trial pit undertaken nearest to the well

Cameron+Ross

The remaining 9No trial pits remained dry throughout. The highwater table was therefore limited to the field to the south of the C4 and the SE corner of the site near to the well within the lower part of the site.

Infiltration Testing

Infiltration testing was undertaken in Trial Pit Nos 1 to 4 as this was within the lowest part of the site. The test undertaken in trial pits 1,2 & 3 failed as a result of the groundwater presence.

The infiltration test undertaken in accordance with BRE Digest 365 in TP4 provided a moderately good infiltration value $f=8.85x10^{-5}$m/s. This converts to a Vp value of 113s/mm. As this test result was proven in a clayey soil it is taken that this will eb suitable that this can be used for soakaway design purposes throughout the site provided suitable depth clearance can be provided between the base of any soakaway/infiltration system and the water table.

Given the nature of the development it is expected there will be sufficient space to accommodate shallow infiltration systems within the site layout.

3. FLOOD RISK

A review of the SEPA flood maps (See extract below) has been undertaken which shows that there is no Flood Risk associated with development site. The only surface flooding noted is to the SW of the site which is out with the site and to a lower level than the site therefore this will flow away from the development.

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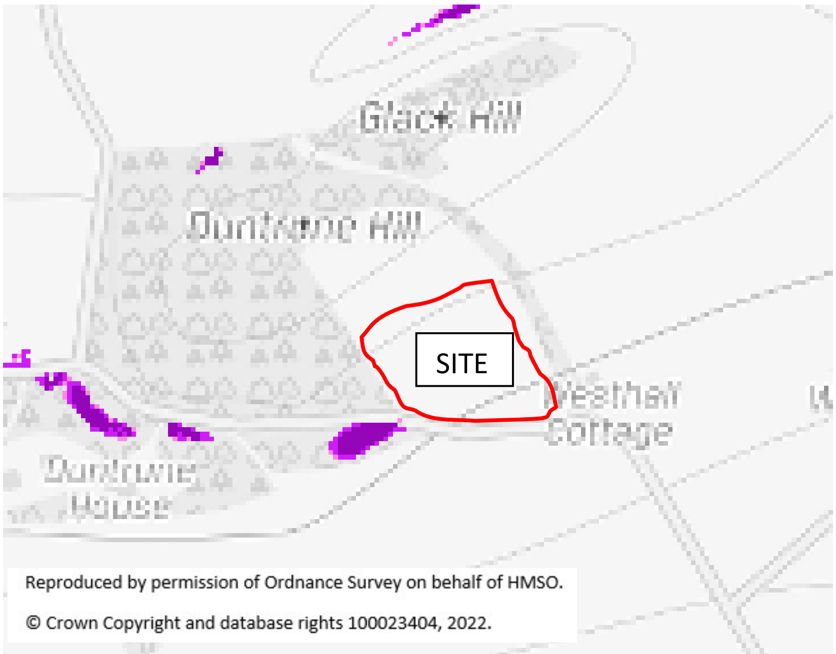

Fig 1 – SEPA Flood Map Extract

4. FOUL DRAINAGE PROPOSALS.

There are no existing Scottish Water sewers within the vicinity of the site given its rural nature.

Therefore it is proposed to design a drainage system based on the Vp value of 113s/mm and ensure that the various criteria as set out in the sections 3.7 and 3.8 of the Non Domestic Building Regulations can be adhered to.

Determine Population Equivalent

The population equivalent is determined using British Flows and Loads Document Version 4.

Based on a worst-case scenario of 5No maximum capacity funerals per day. Therefor the max number of attendees per day = 5x120 = 600 attendees.

From information provided for other crematoriums the rate of usage of toilets is 5% of attendees. Therefore, max number of attendees using toilets per day = 0.05x 600 = 30 attendees. Assume that these toilet usages are before and after funerals then allow for 60 attendees using the toilet per day.

There are 4 full time staff.

4 full time staff (industrial)

- FLOW = 90l/person/day x4 = 360 l/day
- BOD = 38Grams/person/day x4 = 152 Grams/day
- Ammonia = 5/person/day = 5x4 = 20N

60 funeral attendees (Conservatively Assuming all use a WC rather than urinal)

- FLOW = 10l/person/day x 60 = 600l/day
- BOD = 12Grams/person/day x 60 = 720Grams/day
- Ammonia = 2.5/person/day x 60 = 150N

Totals converted to residential equivalent

- FLOW = 960l/day / 150 = 6.4persons
- BOD = 872Grams / 60 = 14.5persons
- Ammonia = 170N / 8 = 21.3persons

Therefore, the foul drainage system is to be designed for a population equivalent (PE) of 22 persons = 22PE.

<u>Foul Drainage System Design</u>

As Vp =113s/mm which is classed as a slow percolation rate as noted in clause 3.9.2 of the Non-Domestic Technical Handbook. Therefore, it is recommended that treatment plant is provided followed by an infiltration bed followed by a reed bed system as per clause 3.9.2a for slow percolation values.

The infiltration bed area must be at least = A = PxVpx0.25 = 22x113x0.25 = 50.25m^2.

The Proposed Drainage Layout is contained within **Appendix B**.

5. SURFACE WATER PROPOSALS.

In accordance with CIRIA document C753 the risk posed by surface water runoff to the receiving environment is a function of the land use, the effectiveness of SuDS treatment components and the sensitivity of the receiving watercourse. Determining the hazard posed by the land use activities at a site can be established by using a simple index approach by allocating pollution hazards indices for the proposed land use as outlined in Table 6.1 below.

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Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other Roofs – i.e. for Crematorium	Low	0.3	0.2	0.05
Individual property driveways, residential car parks, low traffic volume roads (eg culdesacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie <300 traffic movements/day	Low	0.5	0.4	0.4

Table 6.1: Pollution hazard Indices for different land use classifications (Ref Table 26.2 C753)

Where infiltration measures are shown to be viable then the following mitigation indices as per Table 6.2 should be used.

Proposed SUDS Component	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Filter Drain/Soakaway	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Permeable Pavement	0.7	0.6	0.7
Detention Basin	0.5	0.5	0.6

Table 6.2: Indicative SuDS mitigation indices for discharge to surface waters (Ref Table 26.3 C753)

It is proposed where possible to utilise permeable pavement construction and this is expected to be used for the private road and car parking areas. The extended depth of sub-base will be designed to accommodate the 1 in 200-year storm event. The porous paving mitigation indices in Table 6.2 exceed the required treatment levels required for road and car park areas as outlined in Table 6.1 above.

For any tarmac access road areas, the gradients will be designed as such that the surface water will fall to porous paved areas where possible. The lower section of access road will be tarmac and will drain to a roadside filter drain/soakaway which will be designed to store up to the 1 in 200-year storm event.

All soakaways are designed with an allowance for 30% for climate change plus a 10% urban creep factor.

The roofwater runoff will drain to a separate roofwater soakaway again designed for the 1 in 200-year storm duration. The filter drain (soakaway) treatment mitigation score as outlined in Table 6.2 above exceeds the required treatment level for roofs as outlined in Table 6.1 above.

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There was high ground water table found in the lower part of the south focused in the SE corner. However as the site development is focused further up the hill where the water table was not encountered, therefore the high water table should not pose a problem to the use of soakaways, porous paving further up the site, however these will be restricted in depth to minimise the risk of the water table reaching the depth of the soakaways.

The proposed drainage layout is contained within **Appendix B and the drainage calculations are contained in Appendix C**.

6. CONSTRUCTION PHASE.

The measures for controlling surface water run-off will be continually reviewed in line with each stages of construction and any influencing factors. A site-specific surface water management strategy will be prepared by the contractor prior to commencement of works on site.

The above strategy will be based on the preliminary Surface Water Runoff Method Statement prepared by Cameron + Ross and will incorporate the following measures in order to protect the existing water environment and prevent run-off and sediment from the construction works impacting on the existing water environment.

Control: The contractor should give consideration, in the main, to surface water runoff during and after topsoil strip, as well as after re-grading of the land during site construction. Stripping of topsoil and vegetation is to be limited wherever possible and undertaken just prior to the construction in that particular area. This is to provide a means of reducing run off and to remove silts/fines from the water and aid natural absorption into the soils.

Interception: Temporary ditches / channels should be constructed around areas of work to provide localised interception. The use of temporary settlement ponds, check dams and / or silt traps will encourage settlement from retained water. Additional protection can be provided by use of straw bales (or similar) with high level outlets which will allow treated runoff to pass through prior to discharge.

The existing network of field drainage will inevitably be cut off by the development, therefore, should it prove necessary, these will be redirected and / or connected to a new perimeter land drain to intercept any ground water.

Prevention: Protection of the permanent drainage system is extremely important, as such, surface water run-off from the construction areas, where practicable, will not drain to the permanent drainage system thus avoiding build-up of silt and other construction debris. Where the use of the permanent drainage system cannot be avoided the removal of any silts, leaves, or litter as well as rodding / jetting should be carried out at regular intervals. If required Geotextile Membrane will be temporally inserted into gully frames / silt traps to remove silts prior to entering the surface water system.

The installation of the drains, SUDS measures and roadways will follow the earthworks operation continually improving the overall site drainage. SUDS facilities will be installed at the outset of the sewer works and will be utilised as temporary sediment control. It is therefore essential these are reinstated or reconstructed at the end of construction works and before adoption by the local authority.

7. FUTURE MAINTENANCE.

It is proposed that the foulwater sewers together with treatment plant foul infiltration bed (soakaway) a proprietary reed bed system will be maintained by the developer.

The private road and roofwater drainage will be adopted and maintained by the developer as will any SUDs measures.

The developer will require a suitable maintenance regime and therefore the soakaways/porous paving should be inspected on an annual basis. The distribution pipe system should be monitored for blockages and if necessary, the end caps removed and the pipes flushed through with a high volume, high pressure pump to dislodge any silts / sludge which may be causing blockage.

Communal areas of car parking/private access roads will not be adopted by the local authority and therefore, will remain the responsibility of the developer or appointed factor / maintenance company. These will be maintained by regular inspection to clear any debris, areas of porous blocks will be power washed on a six monthly basis and vacuumed out on an annual basis to remove all silts. Private gullies will be inspected on a six-monthly basis and cleared of any silt debris as required.

In addition to the above it is recommended that a suitably qualified person carries out regular visual inspections of all SUDS devices to reduce the risks of blockage.

In the event of a failure, the failed element will be excavated and replaced to the same specification as existing.

A more detailed outline maintenance schedule as taken from CIRIA SUDS C753 for porous paving and filter drains (soakaways) is shown below.

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TABLE 16.1 Operation and maintenance requirements for filter drains		
Maintenance schedule	**Required action**	**Typical frequency**
Regular maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (eg NJUG, 2007 or BS 3998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

TABLE 20.15 Operation and maintenance requirements for pervious pavements		
Maintenance schedule	**Required action**	**Typical frequency**
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

End of Report
BAC 19.11.2020

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APPENDIX A - SITE INVESTIGATION REPORT

Meeting Report	Representing C+R Bruce Clark	CAMERON+ROSS
Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium	Contract No. A/ 190889
Contract Title Burnside of Duntrune Crematorium		Distribution Aberdeen File 1 Paul Fretwell 1
Other Parties Present Digger Driver from Iain Smith Bulders		

Geotechnical Investigation

1. The following confirms the findings of the trial pit investigation and infiltration testing undertaken on the 10th of October 2019.
2. The trial pits were undertaken to ascertain ground bearing conditions for foundation design purposes only and no samples and/or geotechnical or environmental testing was undertaken.
3. The scope of the investigation as agreed with the Architect included the lower half of the site where development is anticipated to be limited too due the sloping nature of the site which rises from the road to the South with increasing steepness to the North boundary. The proposals for the site is for a Crematorium plus associated car parking.
4. See attached site layout drawing over marked with the trial pit locations.
5. See record photos saved in project folder.
6. Infiltration tests were undertaken at Trial Pits 1, 2, 3 & 4.

Trial Pit 1 – in Field South of Road

0.0-0.3mbgl:	dark brown topsoil
0.3m – 1.20mbg:	light brown medium dense silty very clayey sand and gravel with occasional cobbles.

Trial pit dry at time of excavation. Very slight water ingress at 1.2m depth when returning to carry out infiltration tests ½ hr later. Trial pit sides stable.

Infiltration Test Undertaken at1.2mbgl = Failed due to /gw level

Trial Pit 2 – in Field South of Road

0-0.2mbgl:	dark brown topsoil
0.2-1.20mbgl	light brown medium dense silty very clayey sand and gravel with occasional cobbles.

Trial pit dry at time of excavation. Very slight water ingress at 1.2m depth when returning to carry out infiltration tests ½ hr later. Trial pit sides stable

Infiltration Test undertaken at 1.2mbgl = Failed due to GW level

Cameron+Ross

Meeting Report	Representing C+R Bruce Clark

CAMERON+ROSS CONSULTING CIVIL & STRUCTURAL ENGINEERS

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium
Contract Title Burnside of Duntrune Crematorium	
Other Parties Present Digger Driver from Iain Smith Builders	

Contract No. A/ 190889	
Distribution	
Aberdeen File	1
Paul Fretwell	1

Trial Pit 3

0-0.3mbgl	over grown grass on topsoil
0.3- 1.3mbgl	brown loose to medium dense very clayey silty sand. becoming denser with depth.

TP dry and stable. Infiltration test failed due to groundwater level.

Trial Pit 4

0-0.3mbgl	overgrown grass on topsoil
0.3-0.7mbgl	brown soft to firm silty sandy clay with occasional gravel
0.7-1.3mbgl	firm silty sandy clay occasional cobbles

TP stable.
Infiltration Test done at1.3mbgl. Infiltration Test undertaken at 1.3mbgl to BRE Digest 365 f = 8.85x10^{-5}m/s. This converts to a Vp value of 113s/mm.

Trial Pit 4A

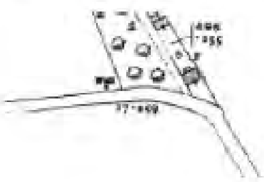
0-0.4mbgl	overgrown grass on topsoil
0.4-0.7mbgl	soft to firm silty sandy clay
0.7-2.50mbgl	firm very silty sandy clay with occasional cobbles

TP dry and stable. Slow groundwater ingress at 2.2mbgl. After 1hr groundwater had settled within the pit to 1.9mbgl.

Trial Pit 5

0-0.5mbgl	overgrown grass onto topsoil
0.5-0.8mbgl	soft sandy clay with some topsoil intermixed.
0.8-1.2mbgl	loose to medium dense sand and gravel

Strong groundwater entry at 1.2mbgl. Groundwater level settled at 0.9mbgl. TP5 was undertaken close to the SE corner of the site where there is a permanent pool situated which is believed to be attributing to the high water table in this area. This is recorded as a well on the historical maps as shown below:



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Meeting Report	Representing C+R Bruce Clark
Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium
Contract Title Burnside of Duntrune Crematorium	
Other Parties Present Digger Driver from Iain Smith Bulders	

Contract No. A/ 190889	
Distribution	
Aberdeen File	1
Paul Fretwell	1

Trial Pit 6

0-0.25mbgl	overgrown grass on topsoil
0.25-2.4mbgl	medium dense light brown silty clayey sand with occasional cobbles and boulders.

TP dry and stable.

Trial Pit 7

0-0.25mbgl	overgrown grass on topsoil
0.25-2.4mbgl	medium dense light brown silty clayey sand with occasional cobbles and boulders.

TP dry and stable.

Trial Pit 8

0-0.30mbgl	overgrown grass on topsoil
0.30-2.3mbgl	medium dense light brown silty clayey sand with occasional cobbles and boulders.

TP dry and stable. After being left open groundwater level had risen to 1.9mbgl

Trial Pit 9

0-0.30mbgl	overgrown grass on topsoil
0.30-2.0mbgl	loose to medium dense light brown silty clayey sand with occasional cobbles.

TP dry and stable.

Trial Pit 10

0-0.90mbgl	overgrown grass on topsoil
0.90-1.5mbgl	soft to firm grey silty sandy clay
1.5-2.5mbgl	loose to medium dense light brown silty clayey sand with occasional cobbles and boulders. Trial pit ended on potential weathered rock.

TP dry and stable.

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Meeting Report	Representing C+R Bruce Clark

CAMERON+ROSS
CONSULTING CIVIL & STRUCTURAL ENGINEERS

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium
Contract Title Burnside of Duntrune Crematorium	
Other Parties Present Digger Driver from Iain Smith Builders	

Contract No. A/ 190889	
Distribution	
Aberdeen File	1
Paul Fretwell	1

Trial Pit 11

0-0.30mbgl	overgrown grass on topsoil
0.30-2.0mbgl	medium dense silty clayey sand with occasional cobbles. TP ended on potential weathered rock

TP dry and stable.

Trial Pit 12

0-0.30mbgl	overgrown grass on topsoil
0.30-2.0mbgl	medium dense silty clayey sand with occasional cobbles. TP ended on potential weathered rock

TP dry and stable.

Recommendations for Building Foundations

At the time of the investigation there is no proposed site plan available and any foundation recommendations should be reviewed once a site plan is provided.

It is recommended that foundations are situated at a minimum depth of 0.7m below the original ground level on either the firm clay or medium dense gravels. This should ensure foundations are situated below the softer clays and sand and gravels that were typically encountered in the upper substrata horizons immediately below the topsoil layer. These substrata are considered suitable for an allowable bearing pressure of 100kN/m^2

The average topsoil depth encountered across the site is 0.35m with a max depth of 0.9m encountered in TP10.

There was no made ground encountered within the trial pits.

Review of Geological Maps

A review of the British Geological Maps (see extract below) shows that the lower portion of the site drift deposits are recorded as "*Till compact sandy clay containing clasts of local rocks and far-travelled erratics.*". This is in line with the generally mix of clays and sand encountered in the substrata within the trial pits.

The upper part of the site is recorded as "Bedrock at or near surface". This area is out with the anticipated area for development.

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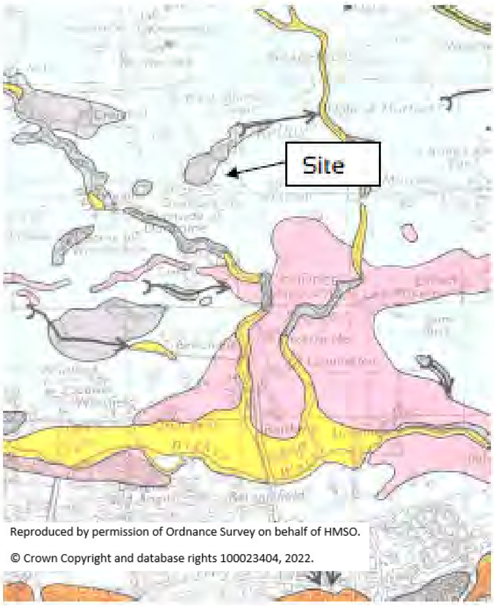
Meeting Report	Representing C+R Bruce Clark	CAMERON+ROSS CONSULTING CIVIL & STRUCTURAL ENGINEERS

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium	Contract No. A/ 190889
Contract Title Burnside of Duntrune Crematorium		Distribution Aberdeen File 1 Paul Fretwell 1
Other Parties Present Digger Driver from Iain Smith Buiders		



<u>Infiltration Test Results</u>

As a result of groundwater presence within trial pits 1,2 & 3 the infiltration tests undertaken in these pits failed.

The infiltration test undertaken in TP4 provided a moderate infiltration value which suggests infiltration systems maybe viable for surface water discharge. This is subject to site level design and provided that good land drainage is provided to take groundwater around the proposed car parking and building areas. Soakaways would only be considered suitable where they are shallow in nature.

For foulwater design will require to comply with Buillding Regs and SEPA requirements. Any infiltration bed would require to be sited in areas where the proposed ground level is raised to ensure the invert level of any distribution pipes is at least 1m above the existing ground water level which can generally be considered over the likely developed part of the site to be around1.2m below original ground level.

END OF REPORT
BAC 31.10.2019

AC13

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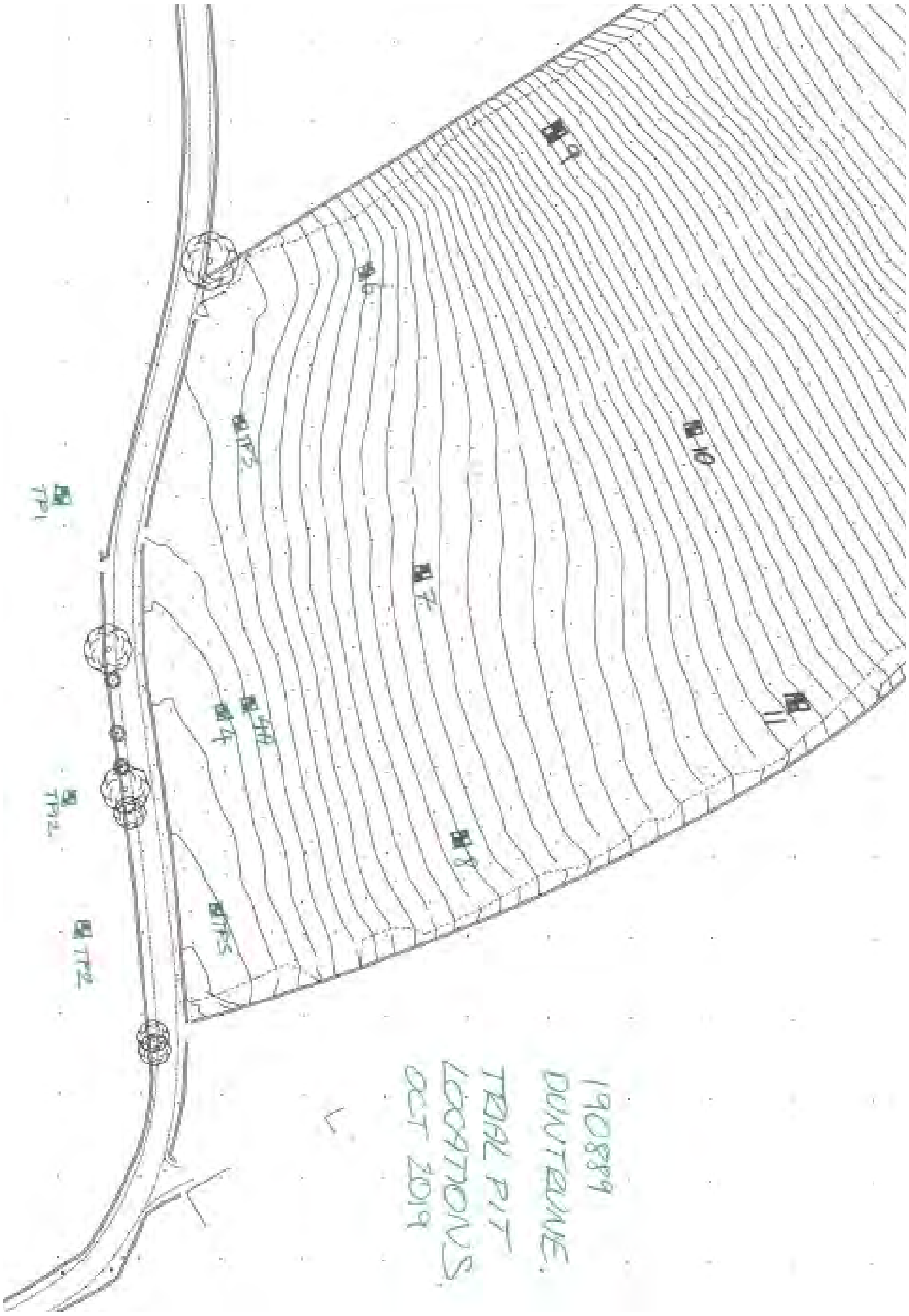

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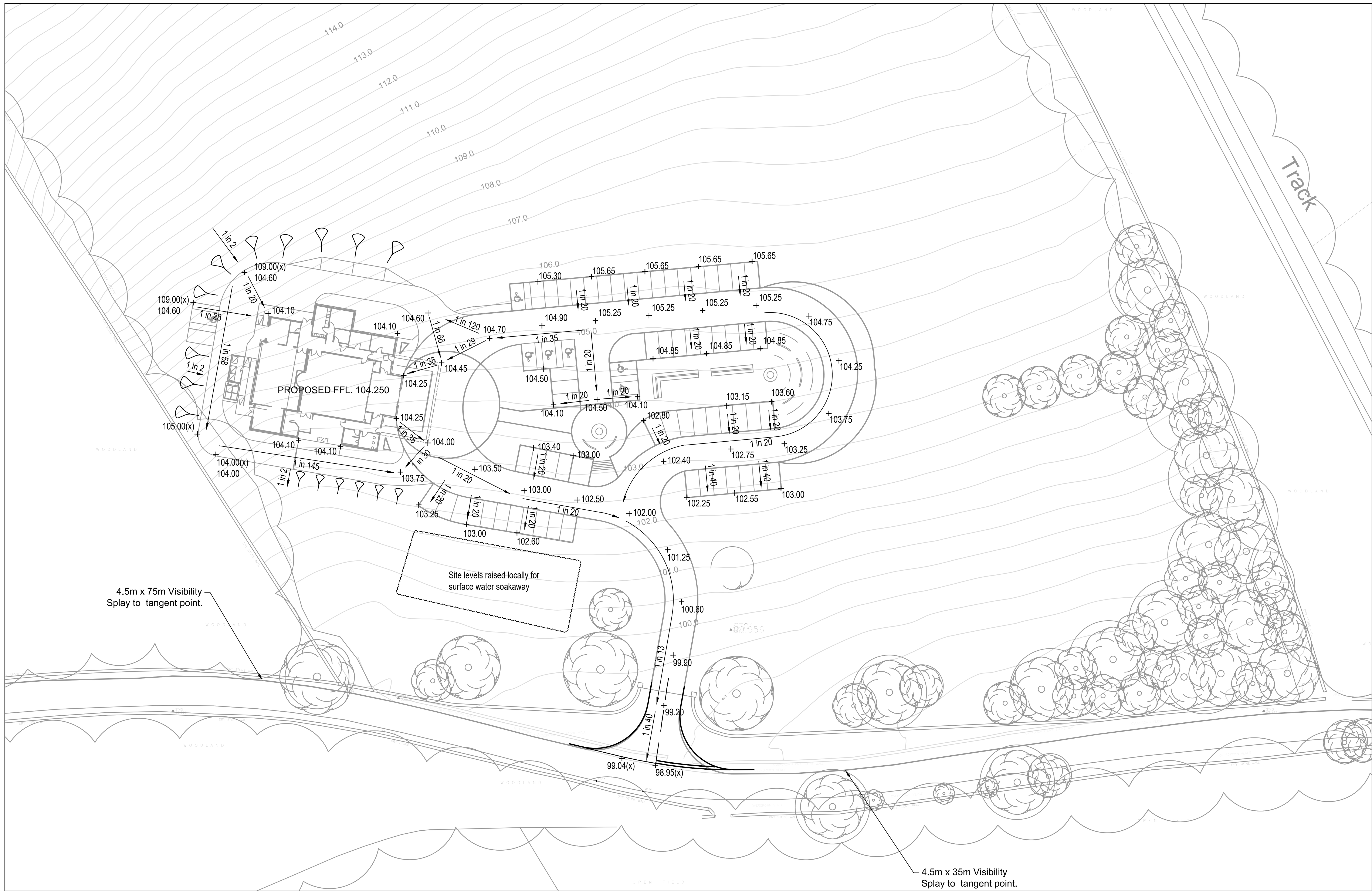
APPENDIX B

Proposed Drainage Layout

FIGURED DIMENSIONS ONLY TO BE USED

Legend

FFL ??.??	Finished Floor Level
+ ??.??	Proposed Ground Level
+ ??.??(x)	Existing Ground Level
1 in ??	Gradient



Site Layout
Scale 1:500

Issue	Revision	Initial	Date
1	Site Levels updated to suit amended layout	SAD/BAC	19/11/2020

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Mulberry House | 39–41 Harbour Road | Inverness | IV1 1UF
t 01463 570 100 | w cameronross.co.uk

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Site Access Road Layout Plan

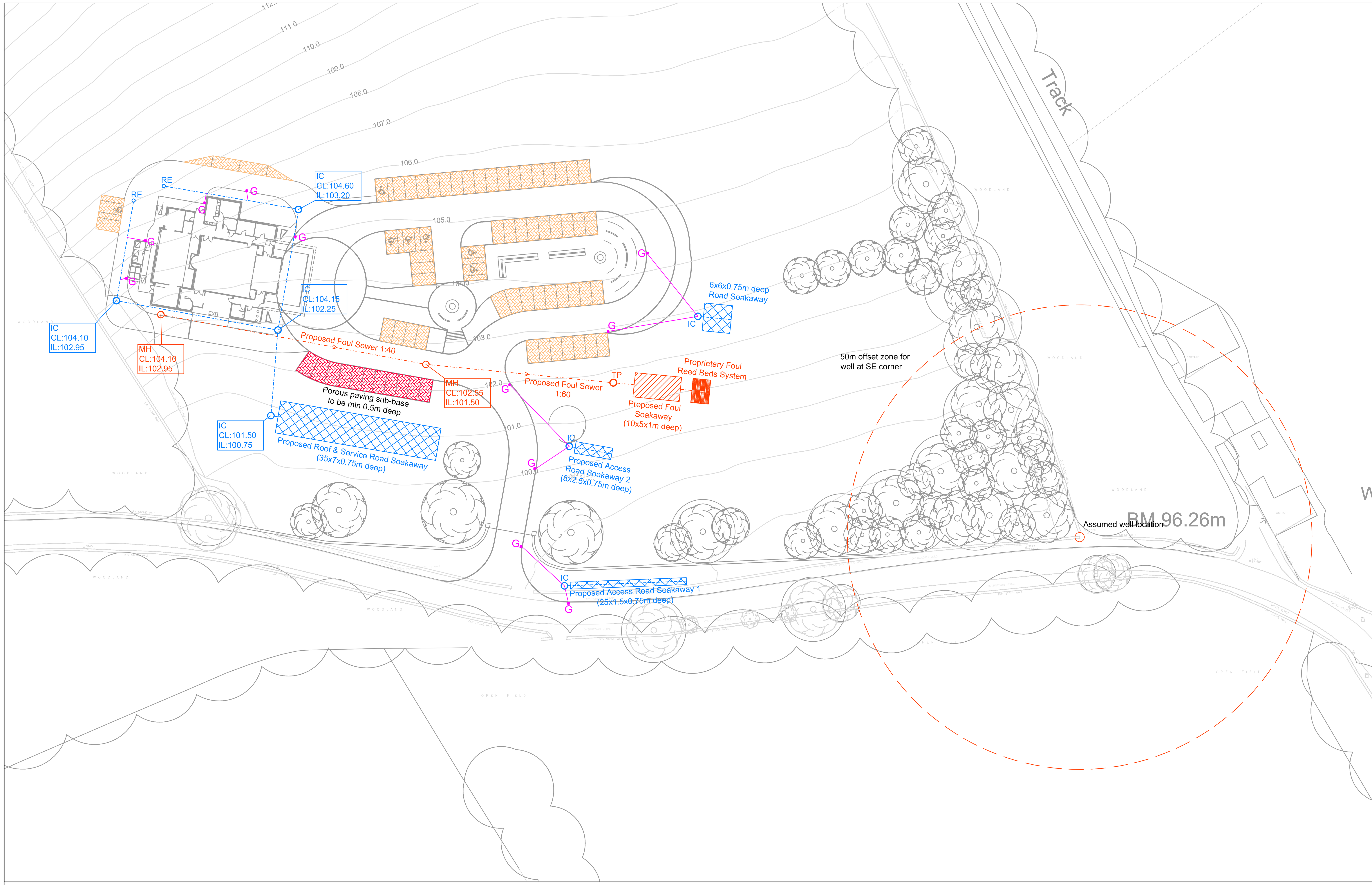
Status:
Planning

North

Scale: 1:500 @ A1		Date: 31/08/2020	
By: SAD	Checked: BAC	Approved: RAG	

Dwg. No. A/190889 – 910
Rev. 1

FIGURED DIMENSIONS ONLY TO BE USED



Drainage Layout

Scale 1:500

General notes:

This drawing is to be read in conjunction with all relevant engineers and architects drawings.

Drainage - all sewers to be constructed in accordance with Scottish water's publication ``Sewers for Scotland (4th edition) a policy, design and construction guide for developers in Scotland"

Sewers laid within roads should have a minimum cover of 1.5m from final road surface to pipe soffit level. Where this cannot be achieved then ridged pipes shall be protected by a full concrete surround, similarly, flexible pipes shall be protected by a concrete slab at a depth less than 1.2m.

The contractor is responsible for checking the line and level of all existing services prior to commencement of works. Any discrepancies from design information must be reported to the site manager and site engineer in writing.

The contractor should allow for CCTV camera survey of entire drainage system upon substantial completion of works. If any remedial works are required a repeat survey should also be carried out prior to formal submission to Engineer together with as-built drawing including manhole co-ordinates, cover and invert levels and pipe gradients .

Surface Drainage Legend

- Surface water sewer (uPVC Marley Quantum rigid solid pipework) unless otherwise noted on drawing.
- Surface Water Soakaway
- Porous Paving with standard 450mm deep sub-base
- Porous Paving with increased depth of sub-base
- S1 Surface Water Manhole with Reference Number
- IC Surface Water Inspection Chamber
- RE Surface Water Rodding Eye
- G Road Gully with associated tail

Foul Drainage Legend

- Foul water sewer (uPVC Marley Quantum rigid solid pipework) unless otherwise noted on drawing.
- Foul Infiltration Bed
- 8No Klargester Foul Reed Beds
- F1 Foul Water Manhole with Reference Number
- TP Denotes Klargester BioFicient 6 Treatment Plant (30 Person Unit)

Drainage tail positions to be confirmed on site to suit house type discharge points. A surface water and foul water branch should be established for each plot.

Refer to Architects drawings for internal drainage runs and details.

Note:-

Soakaway to be least 5m from building foundations.

Maintenance of proposed surface water drainage

1.Soakaway
Inlet chamber to be checked at six monthly intervals and any organic matter and silt build up removed. Soakaway to be checked also to ensure that there is no build up of standing water once a rainfall event has passed (six monthly). Surface over soakaway to be constructed of material that is easily removed (e.g. lock block) to allow filter gravel to be replaced if required in the future. No trees or large shrubs to be planted within 5 metres of the soakaway.

2.Drainage Pipes
Inlet pipes to be checked at six month intervals for blockages and silt build up. Blockages and structural damage to be repaired or cleaned as necessary.

Issue	Revision	Initial	Date
1	Drainage updated to suit amended layout	SAD/BAC	19/11/2020

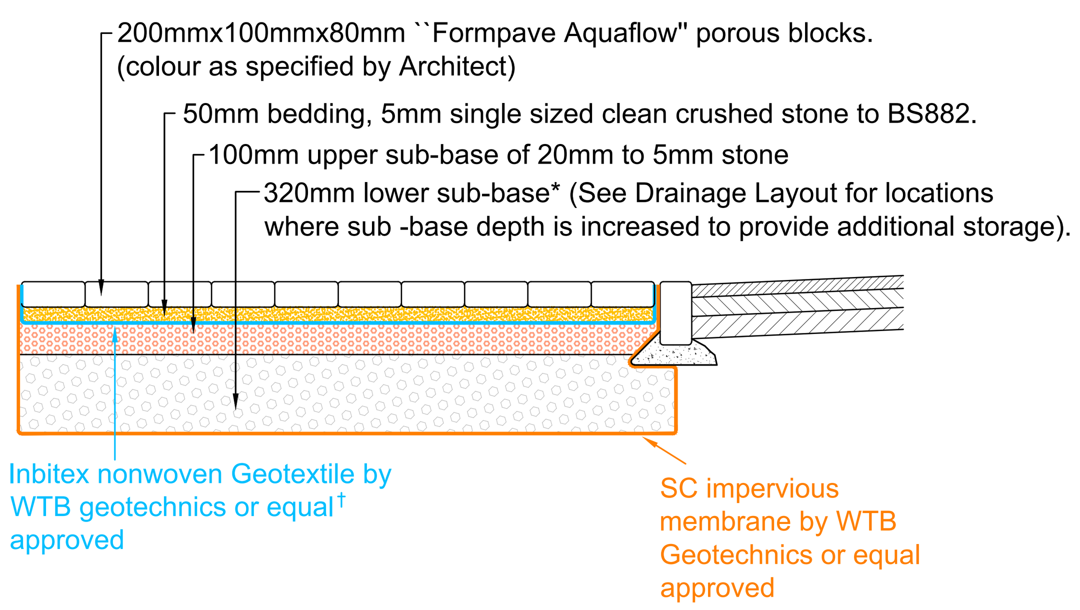
Notes:

Supplied by WTB Geotextiles

* Specification for sub-base, laying course and blinding layer: the crushed stone must possess well defined edges and have a minimum 10% fines value of 150kN when tested in accordance with BS812 Part 111.

Grading of Sub-base stone

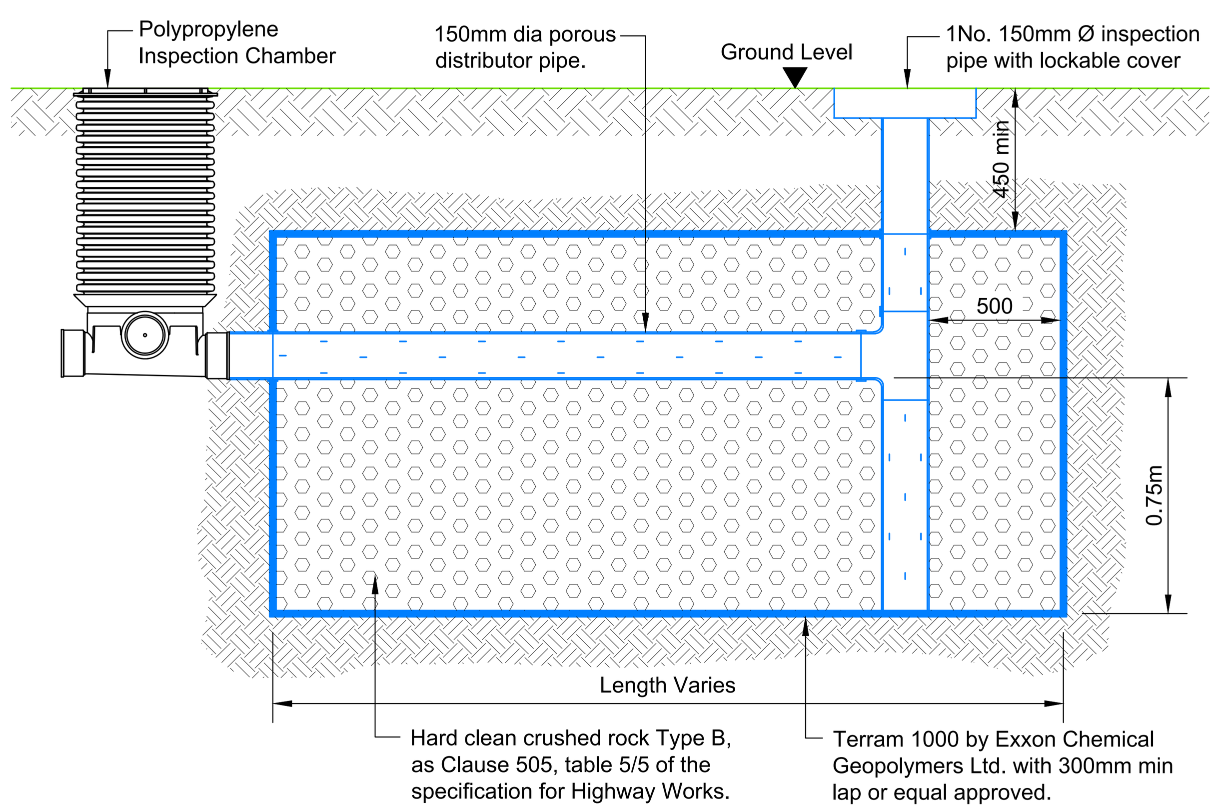
SIEVE SIZE	% PASSING
100mm	100
75mm	80-100
60mm	60-80
37.5mm	30-60
20mm	0-20
10mm	0-5



SECTION THROUGH POROUS PAVING

Scale 1:20

Note:- Sub-base to be increased to as per depth noted on plan



TYPICAL PRIVATE SURFACE WATER SOAKAWAY LONGITUDINAL SECTION

Scale 1:20

Note:

Soakaway dimensions based on a soil infiltration rate (f) = $8.85x10^{-5}$ m/sec as determined by Cameron + Ross' site investigation of 09/10/2019 in accordance with in BRE Digest 365 with 30% free volume of fill material.

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Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client: FM & G Batchelor

Project: Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title: Drainage Layout

Status: Planning

North

Scale: 1:500 @ A1	Date: 31/08/2020	
By: SAD	Checked: BAC	Approved: RAG

Dwg. No. A/190889 – 920

Rev. 1

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APPENDIX C

Drainage Calculations

Contract	Crematorium, Burnside of Duntrune, Angus
Part of Structure	Drainage Calculations Summary

Sheet No.	Rev 0
Contract No.	A190889
Date	28/08/2020
Designer	SAD
Checker	BAC

SURFACE WATER DRAINAGE DESIGN

Total Impermeable Area = 0.295hectares = 2965sqm

Total Road Impermeable Area = 0.234hectares = 2300sqm

Total Roof Impermeable Area = 0.066hectares = 665sqm
Add 10% Urban Creep Allowance = 1.1x665 = **730sqm**

Proposed Hardstanding Road Areas

Area A1 - Tarmac Access Road = 355sqm
Area A2 - Tarmac Access Road = 165sqm
Area B - Tarmac Road Adj to Building Entrance draining to 11 spaces (not including area under canopy) = 440sqm
Area C1 - Service Area behind Building = 205sqm
Area C2 - Service Area behind Building = 140sqm
Area C3 - Service Area behind Building = 210sqm + 10% for main access rd drainage = 230sqm
Area D - Tarmac Road Adj to 5 disabled and 3 normal porous parking spaces = 225sqm
Area E - Tarmac Road draining to 9 porous parking spaces = 140sqm
Area F - Tarmac Road Adj to coach waiting area = 255sqm
Area G - Tarmac Road draining to 7 porous parking spaces = 110sqm
Total Area = **2300sqm**

Proposed Hardstanding Road Car Park Spacing Areas

Area CP1 - 11No Spaces = 140 + Area B = 580sqm
Area CP2 - 6No Spaces + 3 disable = 120sqm + Area D = 345 sqm
Area CP3 - 9No Spaces = 110sqm + Area E = 250 sqm
Area CP3 - 9No Spaces = 85sqm + Area G = 195 sqm
Total Area = **1370sqm**

Proposed Self-Draining Road Areas

Area H - 4No Spaces = 50sqm
Area I - 2No Spaces = 45sqm
Area J - 1No Spaces + 1 Disabled = 40sqm
Area K - 17No Spaces + 1 Disabled = 230sqm
Area L - 9No Spaces = 120sqm
Total Area = **485sqm**

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CONSULTING CIVIL AND STRUCTURAL ENGINEERS

Project:	**Crematorium**	Job No:	**A 190889**
Address:	**Duntrune**	Date:	**Aug 2020**
	Dundee	Calcs by:	**SAD**
Location:	Roof & Service Road Soakaway	Page No:	

Design Rainfall Additional flow multiplier **30%**

From Wallingford Procedure, Volume 3 - Maps
Rainfall Depths (M5 - 60minutes) ***M5_60 =*** **15 mm**

from BRE Digest 365, fig. 1 ***rainfall ratio r =*** ***0.225***

Design Storm Return Period, ***P =*** ***200 years***

D mins	M5_D	Z2	R = MP_D	Rainfall Intensity
5	4.1 mm	2.574	10.6 mm	128 mm/hr
10	6.3 mm	2.619	16.5 mm	99 mm/hr
15	7.9 mm	2.670	21.0 mm	84 mm/hr
30	11.0 mm	2.749	30.3 mm	61 mm/hr
60	15.0 mm	2.761	41.4 mm	41 mm/hr
120	20.0 mm	2.683	53.8 mm	27 mm/hr
240	26.5 mm	2.603	69.1 mm	17 mm/hr
360	31.2 mm	2.546	79.4 mm	13 mm/hr
600	38.2 mm	2.462	94.0 mm	9 mm/hr
1440	53.9 mm	2.340	126.0 mm	5 mm/hr
2880	70.7 mm	2.237	158.0 mm	3 mm/hr

◉ Scotland and Nth Ireland

○ England and Wales

Measured Infiltration Rate
8.85E-05

Infiltration Rate (eff)	8.05E-05	m/s	
Impermeable Area	1320	m^2	
Width	7.00	m	
Depth	0.75	m	
Fixed Lgth (optional)	0	m	

(OR Outlet Flow Rate 0 l/s)
ie 0 m^3/hr

Gravel Pit or Trench Soakaway
Gravel, free volume 30%
Insert 100% for Net Storage Chamber Volume

D	Length	Inflow	Outflow	Storage Req	t_{s50} (hrs)	Storage Prov	Overflow
5	9	14.0	0.3	13.8	2.01	13.8	
10	13	21.8	0.7	21.1	2.38	21.1	
15	17	27.7	1.3	26.4	2.56	26.4	
30	23	40.0	3.3	36.7	2.79	36.7	
60	30	54.7	8.0	46.7	2.93	46.7	
120	34	71.0	17.7	53.3	3.00	53.3	
240	35	91.2	36.3	54.9	3.02	54.9	
360	33	104.8	52.5	52.4	2.99	52.4	
600	29	124.1	78.3	45.8	2.92	45.8	
1440	19	166.4	136.2	30.1	2.65	30.1	
2880	11	208.6	190.8	17.8	2.24	17.8	

Time until system can cope with additional influx of 50% design storage volume < 24 hrs ~ OK

Provide gravel filled soakaway, 35 m x 7 m x 0.75 m deep

Minimum Free Volume = 30%
Total Pit Volume = 183.8m^3

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Project:	**Crematorium**	Job No:	**A 190889**
Address:	**Duntrune**	Date:	**Aug 2020**
	Dundee	Calcs by:	**SAD**
Location:	Area A1 - Access Road	Page No:	

Design Rainfall Additional flow multiplier **30%**

From Wallingford Procedure, Volume 3 - Maps
Rainfall Depths (M5 - 60minutes) ***M5_60 =*** **15 mm**

from BRE Digest 365, fig. 1 ***rainfall ratio r =*** ***0.225***

Design Storm Return Period, ***P =*** ***200 years***

D mins	M5_D	Z2	R = MP_D	Rainfall Intensity
5	4.1 mm	2.574	10.6 mm	128 mm/hr
10	6.3 mm	2.619	16.5 mm	99 mm/hr
15	7.9 mm	2.670	21.0 mm	84 mm/hr
30	11.0 mm	2.749	30.3 mm	61 mm/hr
60	15.0 mm	2.761	41.4 mm	41 mm/hr
120	20.0 mm	2.683	53.8 mm	27 mm/hr
240	26.5 mm	2.603	69.1 mm	17 mm/hr
360	31.2 mm	2.546	79.4 mm	13 mm/hr
600	38.2 mm	2.462	94.0 mm	9 mm/hr
1440	53.9 mm	2.340	126.0 mm	5 mm/hr
2880	70.7 mm	2.237	158.0 mm	3 mm/hr

(●) Scotland and Nth Ireland

( ) England and Wales

Measured Infiltration Rate
8.85E-05

Infiltration Rate (eff)	8.85E-05	m/s
Impermeable Area	355	m^2
Width	1.50	m
Depth	0.75	m
Fixed Lgth (optional)	0	m

(OR Outlet Flow Rate 0 l/s)
ie 0 m^3/hr

Gravel Pit or Trench Soakaway
Gravel, free volume 30%
Insert 100% for Net Storage Chamber Volume

D	Length	Inflow	Outflow	Storage Req	t_{s50} (hrs)	Storage Prov	Overflow
5	10	3.8	0.2	3.5	0.62	3.5	
10	15	5.9	0.7	5.2	0.64	5.2	
15	19	7.5	1.2	6.3	0.65	6.3	
30	23	10.8	2.9	7.8	0.66	7.8	
60	25	14.7	6.3	8.4	0.67	8.4	
120	23	19.1	11.5	7.6	0.66	7.6	
240	18	24.5	18.5	6.0	0.65	6.0	
360	15	28.2	23.2	5.0	0.64	5.0	
600	11	33.4	29.7	3.7	0.62	3.7	
1440	6	44.7	42.7	2.0	0.56	2.0	
2880	3	56.1	55.0	1.1	0.49	1.1	

Provide gravel filled soakaway, 25 m x 1.5 m x 0.75 m deep

Minimum Free Volume = 30%
Total Pit Volume = 28.1m^3

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Project:	**Crematorium**	Job No:	**A 190889**
Address:	**Duntrune**	Date:	**Aug 2020**
	Dundee	Calcs by:	**SAD**
Location:	Area A2 - Access Road	Page No:	

Design Rainfall — Additional flow multiplier **30%**

From Wallingford Procedure, Volume 3 - Maps
Rainfall Depths (M5 - 60minutes) — ***M5_60 =*** **15 mm**

from BRE Digest 365, fig. 1 — ***rainfall ratio r =*** ***0.225***

Design Storm Return Period, ***P =*** ***200 years***

D mins	M5_D	Z2	R = MP_D	Rainfall Intensity
5	4.1 mm	2.574	10.6 mm	128 mm/hr
10	6.3 mm	2.619	16.5 mm	99 mm/hr
15	7.9 mm	2.670	21.0 mm	84 mm/hr
30	11.0 mm	2.749	30.3 mm	61 mm/hr
60	15.0 mm	2.761	41.4 mm	41 mm/hr
120	20.0 mm	2.683	53.8 mm	27 mm/hr
240	26.5 mm	2.603	69.1 mm	17 mm/hr
360	31.2 mm	2.546	79.4 mm	13 mm/hr
600	38.2 mm	2.462	94.0 mm	9 mm/hr
1440	53.9 mm	2.340	126.0 mm	5 mm/hr
2880	70.7 mm	2.237	158.0 mm	3 mm/hr

◉ Scotland and Nth Ireland
○ England and Wales

Measured Infiltration Rate
8.85E-05

Infiltration Rate (eff)	8.85E-05	m/s
Impermeable Area	165	m^2
Width	2.50	m
Depth	0.75	m
Fixed Lgth (optional)	0	m

(OR Outlet Flow Rate 0 l/s)
ie 0 m^3/hr

Gravel Pit or Trench Soakaway
Gravel, free volume 30%
Insert 100% for Net Storage Chamber Volume

D	Length	Inflow	Outflow	Storage Req	t_{s50} (hrs)	Storage Prov	Overflow
5	3	1.8	0.1	1.6	0.63	1.6	
10	4	2.7	0.3	2.5	0.75	2.5	
15	5	3.5	0.5	3.0	0.80	3.0	
30	7	5.0	1.1	3.9	0.86	3.9	
60	8	6.8	2.5	4.4	0.89	4.4	
120	7	8.9	4.7	4.2	0.88	4.2	
240	6	11.4	8.1	3.3	0.83	3.3	
360	5	13.1	10.4	2.7	0.77	2.7	
600	3	15.5	13.7	1.8	0.66	1.8	
1440	1	20.8	20.2	0.6	0.34	0.6	
2880	0	26.1	28.7	0.0	0.00	0.0	

Provide gravel filled soakaway, 8 m x 2.5 m x 0.75 m deep

Minimum Free Volume = 30%
Total Pit Volume = 15m^3

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Project:	**Crematorium**	Job No:	**A 190889**
Address:	**Duntrune**	Date:	**Aug 2020**
	Dundee	Calcs by:	**SAD**
Location:	Area CP1 - 11No Car Park Spaces	Page No:	
	Drainage Adj Tarmac Road		

Design Rainfall Additional flow multiplier **30%**

From Wallingford Procedure, Volume 3 - Maps
Rainfall Depths (M5 - 60minutes) ***M5_60 =*** **15 mm**

from BRE Digest 365, fig. 1 ***rainfall ratio r =*** ***0.225***

Design Storm Return Period, ***P =*** ***200 years***

D mins	M5_D	Z2	R = MP_D	Rainfall Intensity
5	4.1 mm	2.574	10.6 mm	128 mm/hr
10	6.3 mm	2.619	16.5 mm	99 mm/hr
15	7.9 mm	2.670	21.0 mm	84 mm/hr
30	11.0 mm	2.749	30.3 mm	61 mm/hr
60	15.0 mm	2.761	41.4 mm	41 mm/hr
120	20.0 mm	2.683	53.8 mm	27 mm/hr
240	26.5 mm	2.603	69.1 mm	17 mm/hr
360	31.2 mm	2.546	79.4 mm	13 mm/hr
600	38.2 mm	2.462	94.0 mm	9 mm/hr
1440	53.9 mm	2.340	126.0 mm	5 mm/hr
2880	70.7 mm	2.237	158.0 mm	3 mm/hr

◉ Scotland and Nth Ireland

○ England and Wales

Measured Infiltration Rate
8.85E-05

Infiltration Rate (eff)	8.85E-05	m/s	(OR Outlet Flow Rate		0	l/s)
Impermeable Area	580	m^2	save	ie	0	m^3/hr
Width	5.00	m				
Depth	0.50	m	Gravel Pit or Trench Soakaway			
Fixed Lgth (optional)	0	m	Gravel, free volume		30%	
			Insert 100% for Net Storage Chamber Volume			

D	Length	Inflow	Outflow	Storage Req	t_{s50} (hrs)	Storage Prov	Overflow
5	8	6.2	0.2	6.0	1.45	6.0	
10	12	9.6	0.5	9.1	1.67	9.1	
15	15	12.2	0.8	11.4	1.77	11.4	
30	21	17.6	2.0	15.5	1.90	15.5	
60	26	24.0	4.9	19.2	1.97	19.2	
120	28	31.2	10.4	20.8	1.99	20.8	
240	27	40.1	20.1	19.9	1.98	19.9	
360	24	46.1	27.9	18.2	1.95	18.2	
600	20	54.5	39.6	14.9	1.88	14.9	
1440	12	73.1	64.3	8.9	1.65	8.9	
2880	6	91.7	86.9	4.8	1.32	4.8	

Provide gravel filled soakaway, 27.75 m x 5 m x 0.5 m deep

Minimum Free Volume = 30%
Total Pit Volume = 69.4m^3

The design is for a 28m x 5m length of porous paving taking an additional 435m2 tarmac road
The above design shows that a min sub base depth of 0.5m must be provided for the porous car park area .
where accepting tarmac road runoff this includes storage for upto the 1 in 200 year storm duration.

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Project:	Crematorium	Job No:	A 190889
Address:	Duntrune	Date:	Aug 2020
	Dundee	Calcs by:	SAD
Location:	Area F - Road Adj to Coach	Page No:	

Design Rainfall Additional flow multiplier **30%**

From Wallingford Procedure, Volume 3 - Maps
Rainfall Depths (M5 - 60minutes) ***M5_60 =*** **15 mm**

from BRE Digest 365, fig. 1 ***rainfall ratio r =*** ***0.225***

Design Storm Return Period, ***P =*** ***200 years***

D mins	M5_D	Z2	R = MP_D	Rainfall Intensity
5	4.1 mm	2.574	10.6 mm	128 mm/hr
10	6.3 mm	2.619	16.5 mm	99 mm/hr
15	7.9 mm	2.670	21.0 mm	84 mm/hr
30	11.0 mm	2.749	30.3 mm	61 mm/hr
60	15.0 mm	2.761	41.4 mm	41 mm/hr
120	20.0 mm	2.683	53.8 mm	27 mm/hr
240	26.5 mm	2.603	69.1 mm	17 mm/hr
360	31.2 mm	2.546	79.4 mm	13 mm/hr
600	38.2 mm	2.462	94.0 mm	9 mm/hr
1440	53.9 mm	2.340	126.0 mm	5 mm/hr
2880	70.7 mm	2.237	158.0 mm	3 mm/hr

◉ Scotland and Nth Ireland

○ England and Wales

Measured Infiltration Rate
8.85E-05

Infiltration Rate (eff)	8.85E-05	m/s	(OR Outlet Flow Rate 0 l/s)
Impermeable Area	255	m^2	ie 0 m^3/hr
Width	6.00	m	
Depth	0.75	m	Gravel Pit or Trench Soakaway
Fixed Lgth (optional)	0	m	Gravel, free volume 30%

Insert 100% for Net Storage Chamber Volume

D	Length	Inflow	Outflow	Storage Req	t_{s50} (hrs)	Storage Prov	Overflow
5	2	2.7	0.2	2.6	0.68	2.6	
10	3	4.2	0.4	3.9	0.91	3.9	
15	4	5.4	0.6	4.8	1.05	4.8	
30	5	7.7	1.3	6.4	1.25	6.4	
60	6	10.6	2.8	7.8	1.38	7.8	
120	6	13.7	5.7	8.0	1.40	8.0	
240	5	17.6	10.7	7.0	1.31	7.0	
360	4	20.3	14.6	5.7	1.16	5.7	
600	3	24.0	20.5	3.5	0.85	3.5	
1440	0	32.1	34.4	0.0	0.00	0.0	
2880	0	40.3	68.8	0.0	0.00	0.0	

Provide gravel filled soakaway, 6 m x 6 m x 0.75 m deep

Minimum Free Volume = 30%
Total Pit Volume = 27m^3

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Project:	Crematorium	Job No:	A 190889
Address:	Duntrune	Date:	Aug 2020
	Dundee	Calcs by:	SAD
Location:	Car Park Spaces Drainage	Page No:	
	Self Draining		

Design Rainfall Additional flow multiplier **30%**

From Wallingford Procedure, Volume 3 - Maps
Rainfall Depths (M5 - 60minutes) ***M5_60 =*** **15 mm**

from BRE Digest 365, fig. 1 ***rainfall ratio r =*** ***0.225***

Design Storm Return Period, ***P =*** ***200 years***

D mins	M5_D	Z2	R = MP_D	Rainfall Intensity
5	4.1 mm	2.574	10.6 mm	128 mm/hr
10	6.3 mm	2.619	16.5 mm	99 mm/hr
15	7.9 mm	2.670	21.0 mm	84 mm/hr
30	11.0 mm	2.749	30.3 mm	61 mm/hr
60	15.0 mm	2.761	41.4 mm	41 mm/hr
120	20.0 mm	2.683	53.8 mm	27 mm/hr
240	26.5 mm	2.603	69.1 mm	17 mm/hr
360	31.2 mm	2.546	79.4 mm	13 mm/hr
600	38.2 mm	2.462	94.0 mm	9 mm/hr
1440	53.9 mm	2.340	126.0 mm	5 mm/hr
2880	70.7 mm	2.237	158.0 mm	3 mm/hr

◉ Scotland and Nth Ireland

○ England and Wales

Measured Infiltration Rate
8.85E-05

Infiltration Rate (eff)	8.85E-05	m/s
Impermeable Area	50	m^2
Width	5.00	m
Depth	0.11	m
Fixed Lgth (optional)	0	m

(OR Outlet Flow Rate 0 l/s)
ie 0 m^3/hr

Gravel Pit or Trench Soakaway
Gravel, free volume 30%
Insert 100% for Net Storage Chamber Volume

D	Length	Inflow	Outflow	Storage Req	t_{s50} (hrs)	Storage Prov	Overflow
5	3	0.5	0.0	0.5	0.90	0.5	
10	5	0.8	0.1	0.8	1.14	0.8	
15	6	1.0	0.1	1.0	1.26	1.0	
30	8	1.5	0.2	1.3	1.44	1.3	
60	9	2.1	0.5	1.6	1.54	1.6	
120	10	2.7	1.0	1.6	1.57	1.6	
240	9	3.5	2.0	1.5	1.51	1.5	
360	8	4.0	2.7	1.3	1.43	1.3	
600	6	4.7	3.8	0.9	1.26	0.9	
1440	2	6.3	6.0	0.3	0.69	0.3	
2880	0	7.9	8.4	0.0	0.00	0.0	

Provide gravel filled soakaway, 10 m x 5 m x 0.11 m deep

Minimum Free Volume = 30%
Total Pit Volume = 5.5m^3

The design is for a 10m x 5m length of porous paving draining its own area only
The above design shows that a min sub base depth of 0.11m must be provided for the porous car park area .
where draining its own area this includes storage for upto the 1 in 200 year storm duration.

Meeting Report	Representing C+R Bruce Clark

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium	Contract No. A/ 190889
Contract Title Burnside of Duntrune Crematorium		Distribution Aberdeen File 1 Paul Fretwell 1
Other Parties Present Digger Driver from Iain Smith Buiders		

Geotechnical Investigation

1. The following confirms the findings of the trial pit investigation and infiltration testing undertaken on the 10th of October 2019.

2. The trial pits were undertaken to ascertain ground bearing conditions for foundation design purposes only and no samples and/or geotechnical or environmental testing was undertaken.

3. The scope of the investigation as agreed with the Architect included the lower half of the site where development is anticipated to be limited too due the sloping nature of the site which rises from the road to the South with increasing steepness to the North boundary. The proposals for the site is for a Crematorium plus associated car parking.

4. See attached site layout drawing over marked with the trial pit locations.

5. See record photos saved in project folder.

6. Infiltration tests were undertaken at Trial Pits 1, 2, 3 & 4.

Trial Pit 1 – in Field South of Road

0.0-0.3mbgl:	dark brown topsoil
0.3m – 1.20mbg:	light brown medium dense silty very clayey sand and gravel with occasional cobbles.

Trial pit dry at time of excavation. Very slight water ingress at 1.2m depth when returning to carry out infiltration tests ½ hr later. Trial pit sides stable.

Infiltration Test Undertaken at1.2mbgl = Failed due to /gw level

Trial Pit 2 – in Field South of Road

0-0.2mbgl:	dark brown topsoil
0.2-1.20mbgl	light brown medium dense silty very clayey sand and gravel with occasional cobbles.

Trial pit dry at time of excavation. Very slight water ingress at 1.2m depth when returning to carry out infiltration tests ½ hr later. Trial pit sides stable

Infiltration Test undertaken at 1.2mbgl = Failed due to GW level

Meeting Report	Representing C+R Bruce Clark

Date of Meeting	Place of Meeting	Contract No.
09.10.2019	SITE – Burnside of Duntrune Crematorium	A/ 190889
Contract Title Burnside of Duntrune Crematorium		Distribution Aberdeen File 1 Paul Fretwell 1
Other Parties Present Digger Driver from Iain Smith Buiders		

Trial Pit 3

0-0.3mbgl	over grown grass on topsoil
0.3- 1.3mbgl	brown loose to medium dense very clayey silty sand. becoming denser with depth.

TP dry and stable. Infiltration test failed due to groundwater level.

Trial Pit 4

0-0.3mbgl	overgrown grass on topsoil
0.3-0.7mbgl	brown soft to firm silty sandy clay with occasional gravel
0.7-1.3mbgl	firm silty sandy clay occasional cobbles

TP stable.
Infiltration Test done at1.3mbgl. Infiltration Test undertaken at 1.3mbgl to BRE Digest 365 f = $8.85x10^{-5}$m/s. This converts to a Vp value of 113s/mm.

Trial Pit 4A

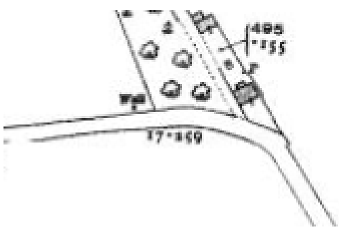
0-0.4mbgl	overgrown grass on topsoil
0.4-0.7mbgl	soft to firm silty sandy clay
0.7-2.50mbgl	firm very silty sandy clay with occasional cobbles

TP dry and stable. Slow groundwater ingress at 2.2mbgl. After 1hr groundwater had settled within the pit to 1.9mbgl.

Trial Pit 5

0-0.5mbgl	overgrown grass onto topsoil
0.5-0.8mbgl	soft sandy clay with some topsoil intermixed.
0.8-1.2mbgl	loose to medium dense sand and gravel

Strong groundwater entry at 1.2mbgl. Groundwater level settled at 0.9mbgl. TP5 was undertaken close to the SE corner of the site where there is a permanent pool situated which is believed to be attributing to the high water table in this area. This is recorded as a well on the historical maps as shown below:



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Meeting Report	Representing C+R Bruce Clark

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium	Contract No. A/ 190889
Contract Title Burnside of Duntrune Crematorium		Distribution Aberdeen File 1 Paul Fretwell 1
Other Parties Present Digger Driver from Iain Smith Buiders		

<u>**Trial Pit 6**</u>

0-0.25mbgl	overgrown grass on topsoil
0.25-2.4mbgl	medium dense light brown silty clayey sand with occasional cobbles and boulders.

TP dry and stable.

<u>**Trial Pit 7**</u>

0-0.25mbgl	overgrown grass on topsoil
0.25-2.4mbgl	medium dense light brown silty clayey sand with occasional cobbles and boulders.

TP dry and stable.

<u>**Trial Pit 8**</u>

0-0.30mbgl	overgrown grass on topsoil
0.30-2.3mbgl	medium dense light brown silty clayey sand with occasional cobbles and boulders.

TP dry and stable. After being left open groundwater level had risen to 1.9mbgl

<u>**Trial Pit 9**</u>

0-0.30mbgl	overgrown grass on topsoil
0.30-2.0mbgl	loose to medium dense light brown silty clayey sand with occasional cobbles.

TP dry and stable.

<u>**Trial Pit 10**</u>

0-0.90mbgl	overgrown grass on topsoil
0.90-1.5mbgl	soft to firm grey silty sandy clay
1.5-2.5mbgl	loose to medium dense light brown silty clayey sand with occasional cobbles and boulders. Trial pit ended on potential weathered rock.

TP dry and stable.

Meeting Report	Representing C+R Bruce Clark

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium	Contract No. A/ 190889
Contract Title Burnside of Duntrune Crematorium		Distribution Aberdeen File 1 Paul Fretwell 1
Other Parties Present Digger Driver from Iain Smith Buiders		

Trial Pit 11

0-0.30mbgl	overgrown grass on topsoil
0.30-2.0mbgl	medium dense silty clayey sand with occasional cobbles. TP ended on potential weathered rock

TP dry and stable.

Trial Pit 12

0-0.30mbgl	overgrown grass on topsoil
0.30-2.0mbgl	medium dense silty clayey sand with occasional cobbles. TP ended on potential weathered rock

TP dry and stable.

Recommendations for Building Foundations

At the time of the investigation there is no proposed site plan available and any foundation recommendations should be reviewed once a site plan is provided.

It is recommended that foundations are situated at a minimum depth of 0.7m below the original ground level on either the firm clay or medium dense gravels. This should ensure foundations are situated below the softer clays and sand and gravels that were typically encountered in the upper substrata horizons immediately below the topsoil layer. These substrata are considered suitable for an allowable bearing pressure of 100kN/m^2

The average topsoil depth encountered across the site is 0.35m with a max depth of 0.9m encountered in TP10.

There was no made ground encountered within the trial pits.

Review of Geological Maps

A review of the British Geological Maps (see extract below) shows that the lower portion of the site drift deposits are recorded as "*Till compact sandy clay containing clasts of local rocks and far-travelled erratics."*. This is in line with the generally mix of clays and sand encountered in the substrata within the trial pits.

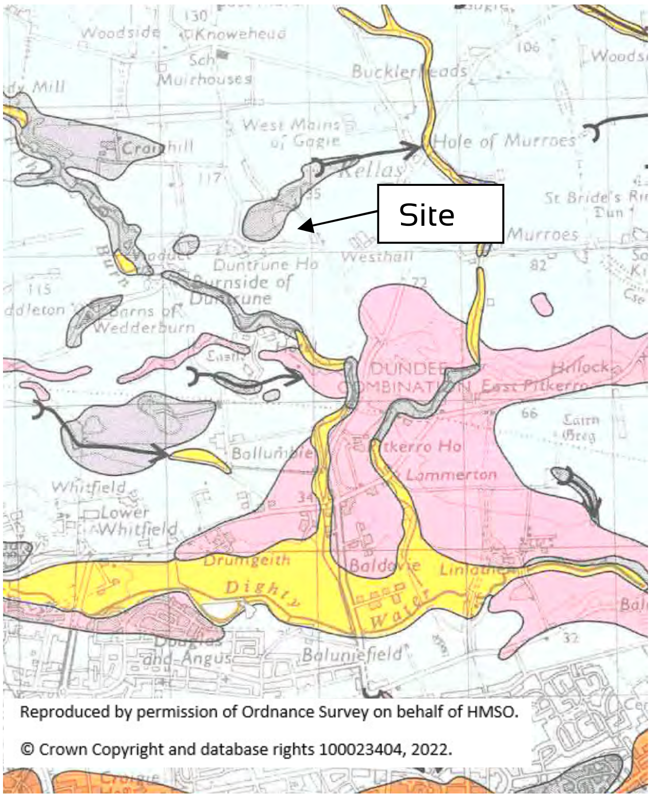
The upper part of the site is recorded as "Bedrock at or near surface". This area is out with the anticipated area for development.

Meeting Report	Representing C+R Bruce Clark

CAMERON+ROSS CONSULTING CIVIL & STRUCTURAL ENGINEERS

Date of Meeting 09.10.2019	Place of Meeting SITE – Burnside of Duntrune Crematorium
Contract Title Burnside of Duntrune Crematorium	
Other Parties Present Digger Driver from Iain Smith Buiders	

Contract No. A/ 190889	
Distribution	
Aberdeen File	1
Paul Fretwell	1



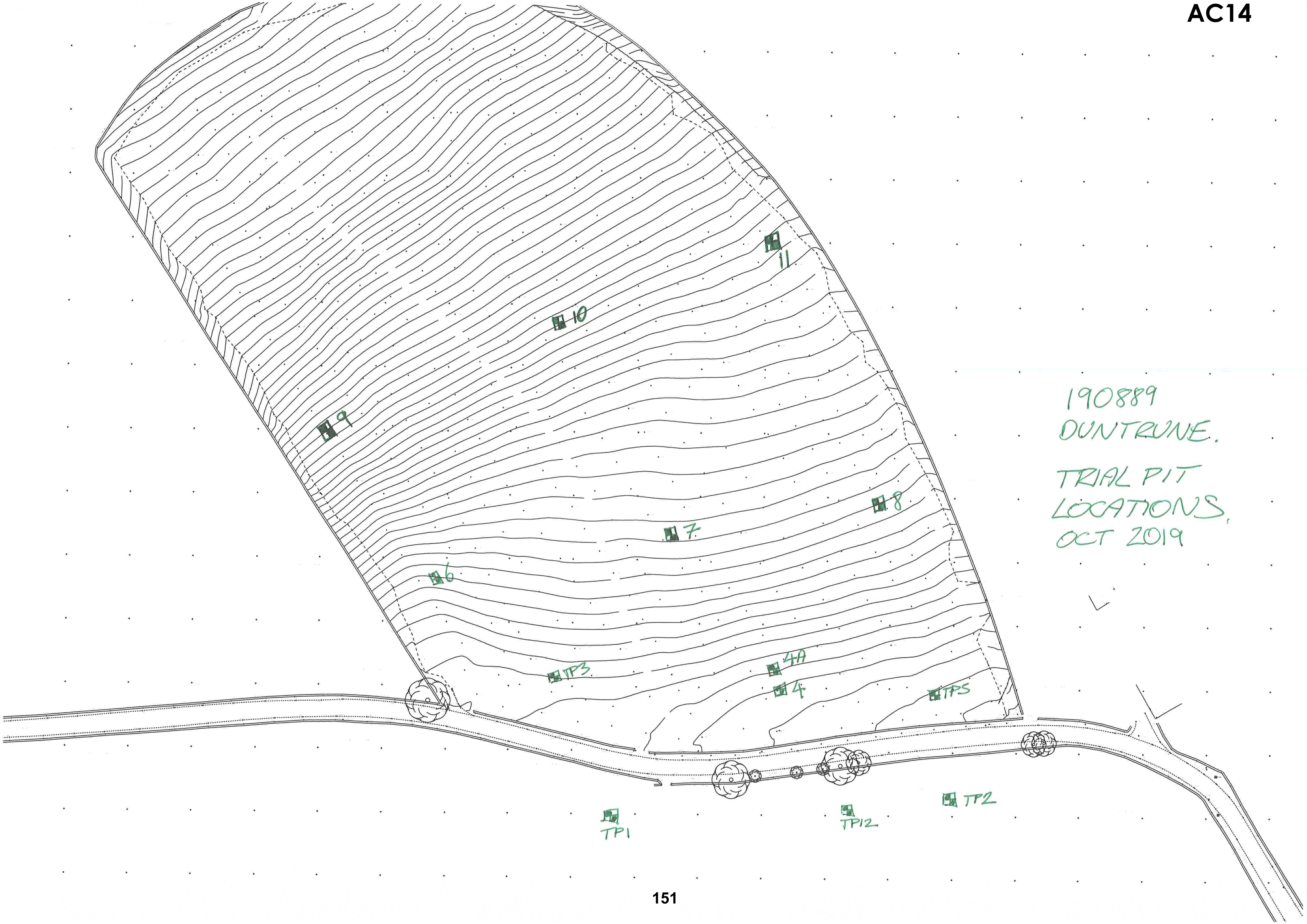
Infiltration Test Results

As a result of groundwater presence within trial pits 1,2 & 3 the infiltration tests undertaken in these pits failed.

The infiltration test undertaken in TP4 provided a moderate infiltration value which suggests infiltration systems maybe viable for surface water discharge. This is subject to site level design and provided that good land drainage is provided to take groundwater around the proposed car parking and building areas. Soakaways would only be considered suitable where they are shallow in nature.

For foulwater design will require to comply with Buillding Regs and SEPA requirements. Any infiltration bed would require to be sited in areas where the proposed ground level is raised to ensure the invert level of any distribution pipes is at least 1m above the existing ground water level which can generally be considered over the likely developed part of the site to be around1.2m below original ground level.

END OF REPORT
BAC 31.10.2019


11
10
9
8
7
6
4A
4
TP3
TP5
TP1
TP12
TP2
190889
DUNTRUNE.
TRIAL PIT
LOCATIONS,
OCT 2019


Glack Hill
133m
125m
120m
115m
110m
Path
130m
Duntrune Hill
104m
100m
Track
99m
125m
100m
120m
115m
100m
100m
W
Westhall
Cottage
Westhall House
105m
100m
Duntrune House
Sluices
95m
90m
85m
Saw Mill
80m
90m
85m
80m

Greg

From:	Gavin Elrick <Gavin.Elrick@sac.co.uk>
Sent:	23 August 2019 11:49
To:	Paul Fretwell
Subject:	RE: Report for Crematorium Site
Attachments:	Burnside of Duntrune LCA extract.pdf
Importance:	High
Follow Up Flag:	Follow up
Flag Status:	Completed

Paul

Just had a look on the LCA and soils map and the site is mapped as 3.2 in the Soils of Scotland Website you shouldn't need an investigation carried out.

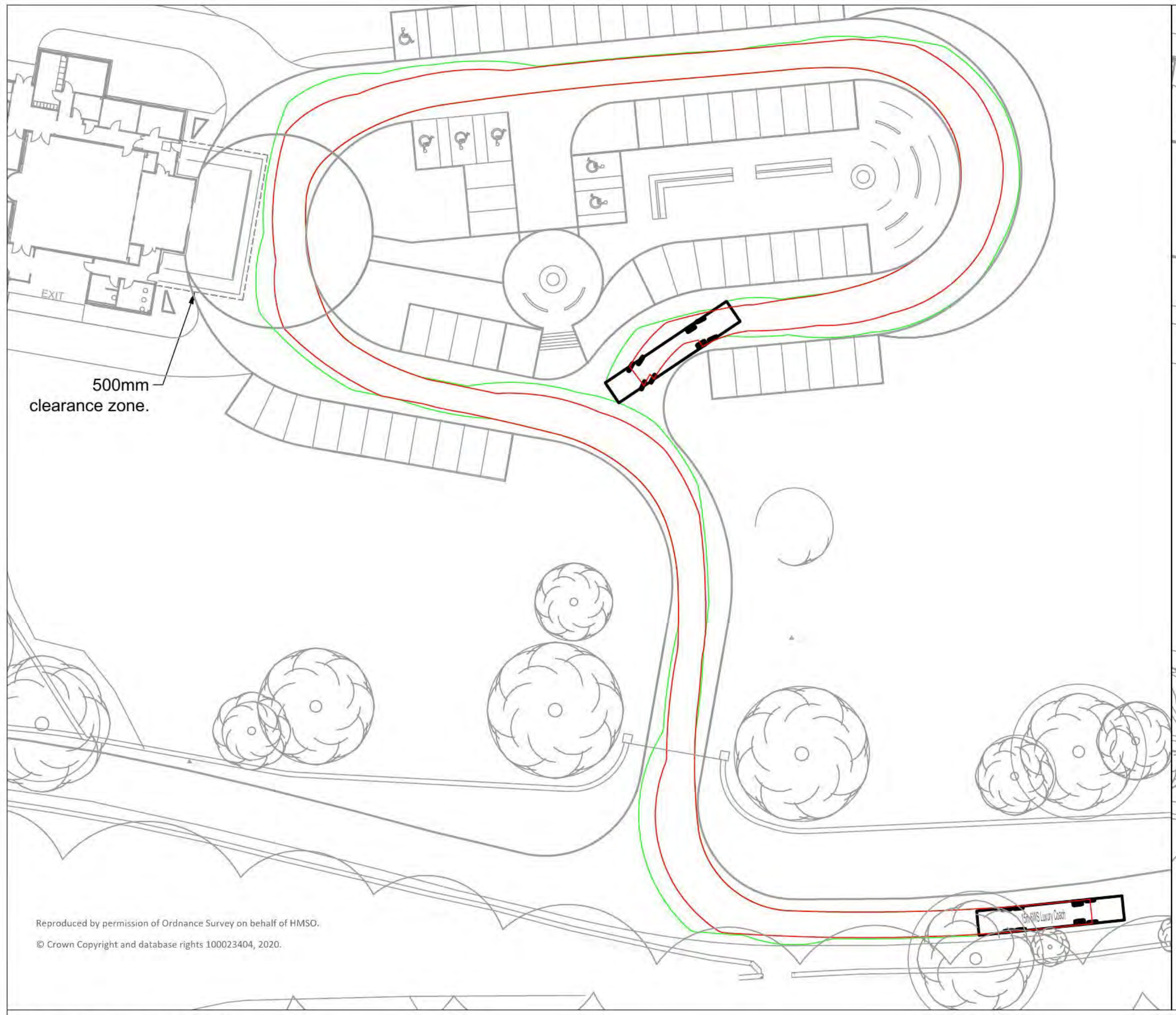
Kind regards

Gavin

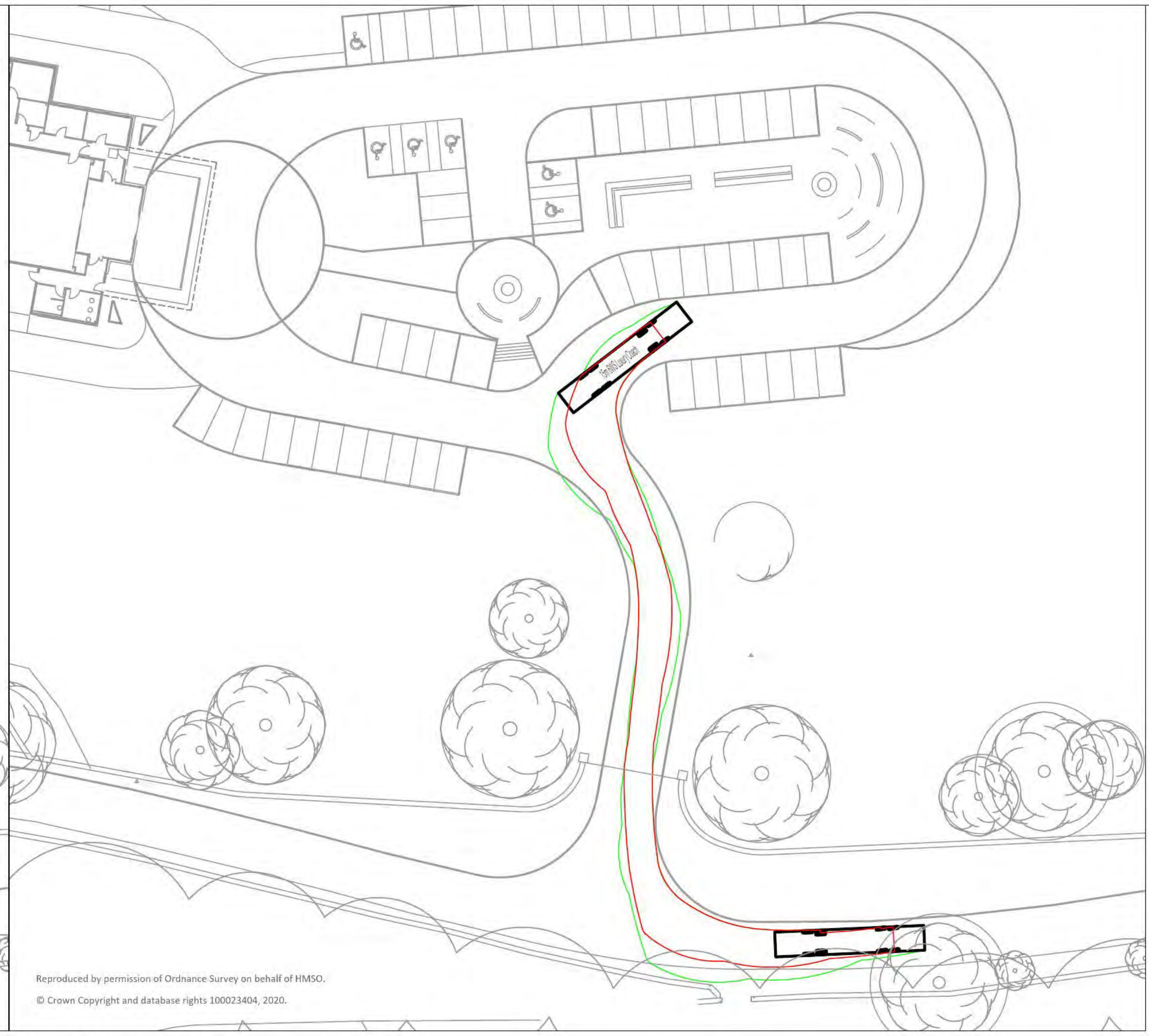
Gavin Elrick
Senior Consultant, *CEnv, MIAgrE*

Scotland's Rural College
SAC Consulting
Environment Team
Clifton Road
Turriff
AB53 4DY
Main Tel: 0131 603 7500
Local Tel: 01888 563333
Mob: [redacted]
www.sruc.ac.uk

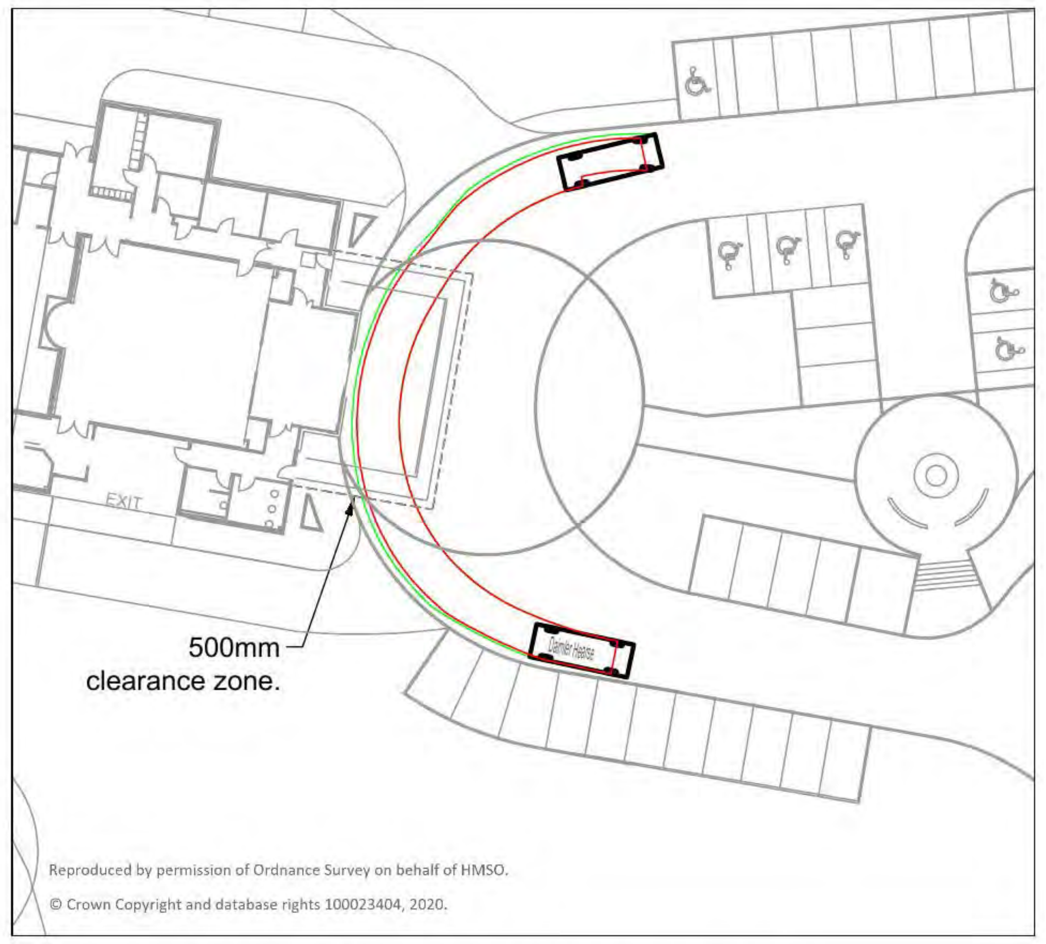
FIGURED DIMENSIONS ONLY TO BE USED



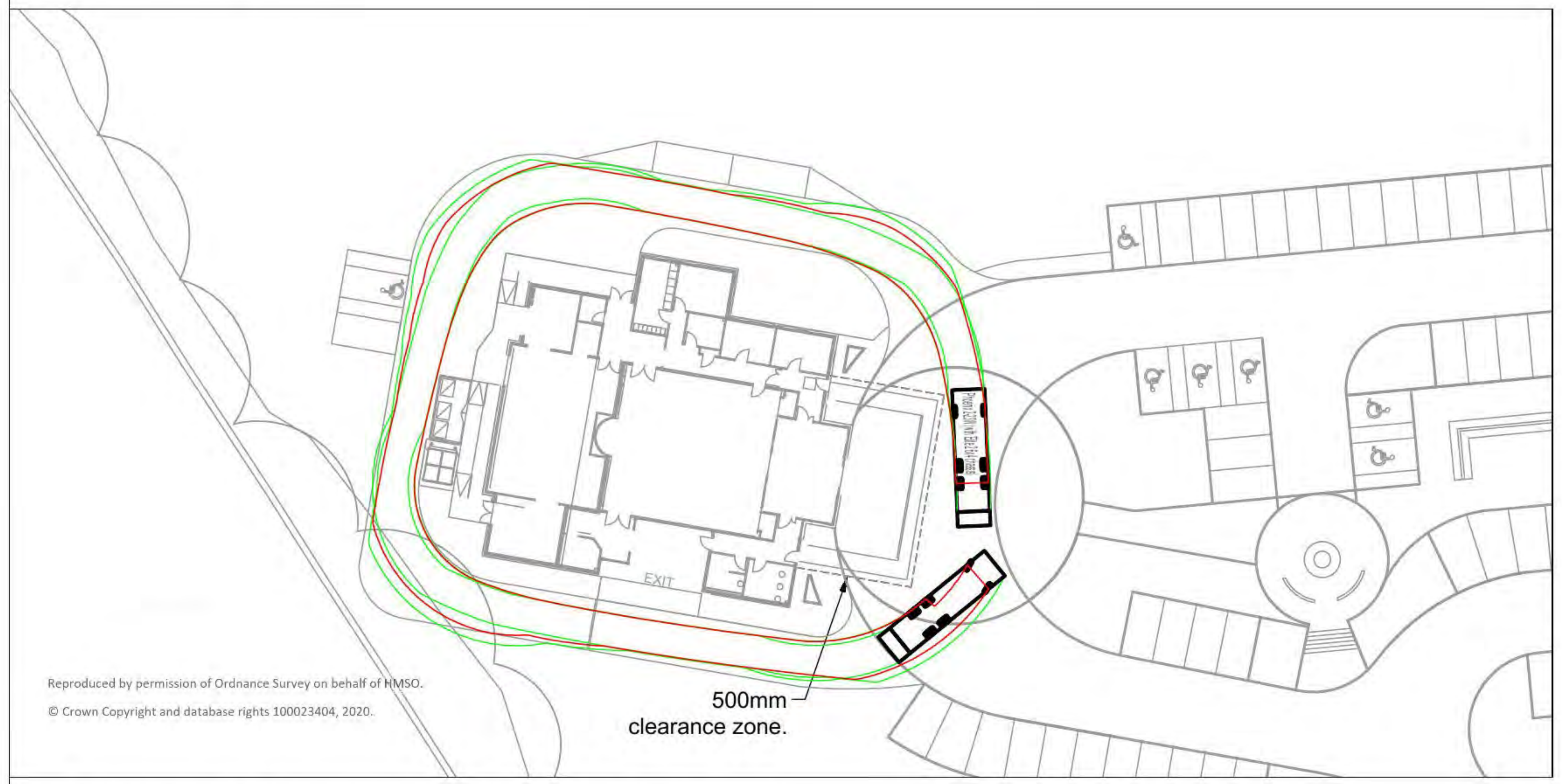
Coach entering site



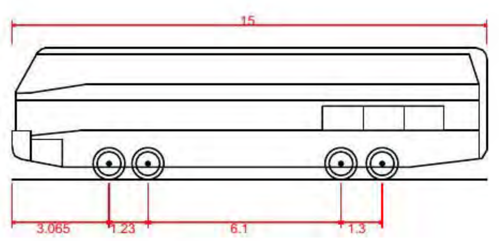
Coach leaving site



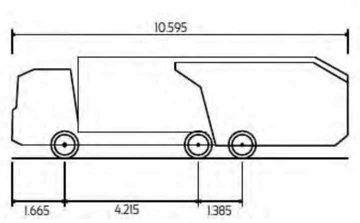
Hearse driving through entrance canopy



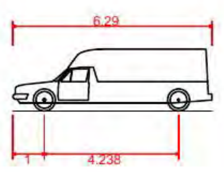
Refuse vehicle entering and leaving service area



15m 6WS Luxury Coach	
Overall Length	15.000m
Overall Width	2.500m
Overall Body Height	4.157m
Min Body Ground Clearance	0.397m
Track Width	2.500m
Lock to lock time	5.00s
Wall to Wall Turning Radius	12.490m



Phoenix 2-23W (with Elite 2 6x4 chassis)	10.595m
Overall Length	
Overall Width	2.530m
Overall Body Height	3.205m
Min Body Ground Clearance	0.410m
Track Width	2.500m
Lock to Lock Time	4.00s
Kerb to Kerb Turning Radius	9.250m



Daimler Hearse	
Overall Length	6.290m
Overall Width	2.108m
Overall Body Height	1.950m
Min Body Ground Clearance	0.251m
Track Width	2.100m
Lock to lock time	6.00s
Wall to Wall Turning Radius	7.450m

LEGEND

LINE OF BODY OVERHANG

LINE OF WHEELS

Issue	Revision	Initial	Date
2	Updated to suit amendment to service area	SAD/BAC	19/11/2020
1	Updated to suit new layout	SAD/BAC	31/08/2020

Cameron + Ross
CIVIL + STRUCTURAL ENGINEERING
Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB
t 01224 642 400 | w cameronross.co.uk
Mulberry House | 39–41 Harbour Road | Inverness | IV1 1UF
t 01463 570 100 | w cameronross.co.uk

Client: FM & G Batchelor

Project: Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title: Swept Paths Analysis

North

Status: Planning

Scale: 1:200 @ A1		Date: 25/06/2020	
By: SAD	Checked: BAC	Approved: RAG	
Dwg. No. A/190889 – 907			Rev. 2

TRAFFIC SURVEY REPORT

KELLAS ROAD, DUNDEE

TRANSURVEYS LIMITED

BLUE SQUARE OFFICES, 272 BATH STREET, GLASGOW, G2 4JR

TRAFFIC SURVEY REPORT

QUALITY MANAGEMENT

CLIENT	Cameron + Ross
PROJECT	Kellas Road, Dundee
REFERENCE	TS-19-058
REVISION	001

Revision	Date	Prepared by	Signed	Checked by	Signed
001	22/10/2018	Neil Dempsey	[redacted]	Neil Dempsey	[redacted]

DISCLAIMER

SURVEYED NETWORK

Junction Turning Counts & Queue Surveys:-

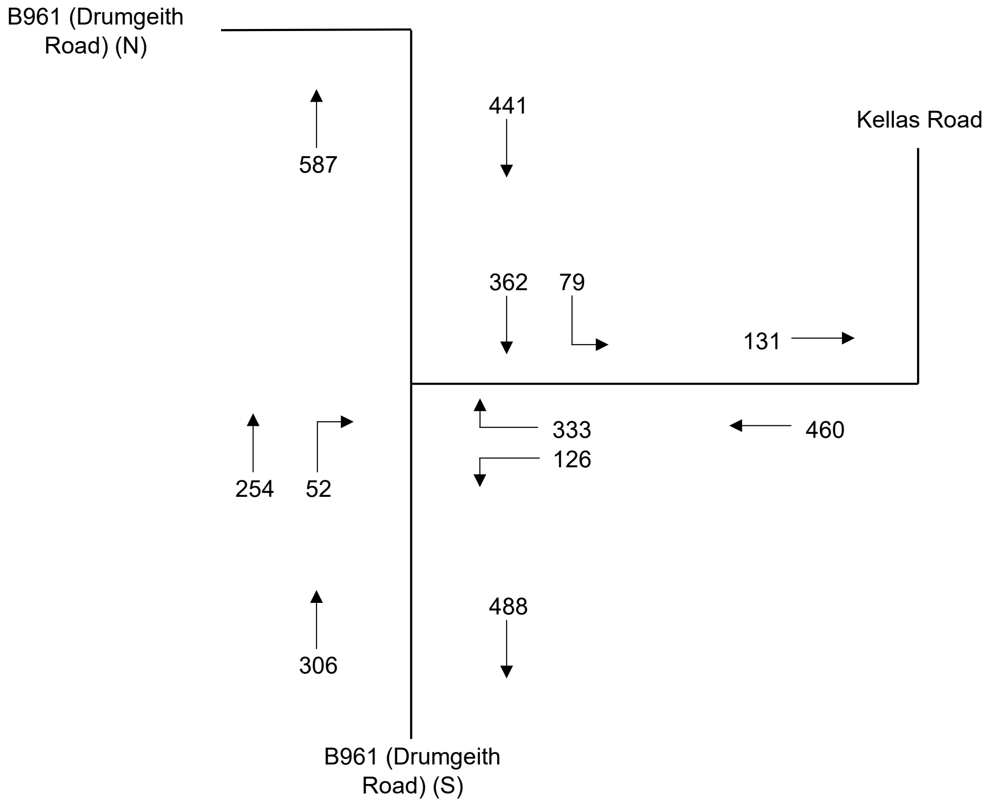
1. B961 (Drumgeith Road) / Kellas Road Priority Junction

Automatic Traffic Counts:-

2. Unnamed Road, east of Duntrune House; and
3. Kellas Road - approximately 30m south of Unnamed Road.

CLASSIFIED VEHICLE JUNCTION TURNING COUNTS

SURVEY NETWORK TRAFFIC FLOW DIAGRAMS

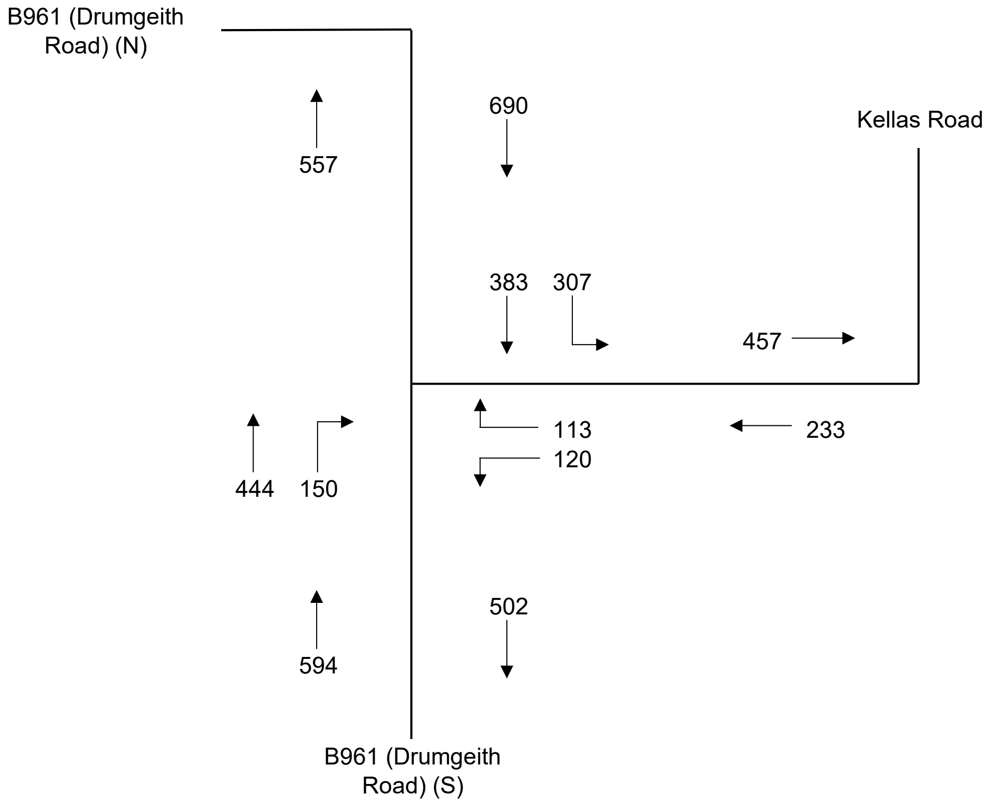


	Peak Hour
Weekday AM Hour	07:30-08:30
Veh.Classification	TOTAL PCUs

Date: 8th October 2019

For illustrative purposes only, please refer to data sheets for individual traffic movements

SURVEY NETWORK TRAFFIC FLOW DIAGRAMS



	Peak Hour
Weekday PM Hour	16:15-17:15
Veh.Classification	TOTAL PCUs

Date: 8th October 2019

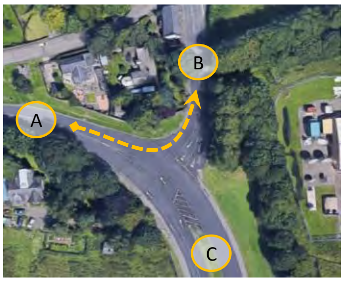
For illustrative purposes only, please refer to data sheets for individual traffic movements

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058

Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast

Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.1: B961 (Drumgeith Road) (North) to Kellas Road Left Turn (A-B)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	7	0	0	0	0	7	0	7.00
07:15	07:30	0	0	9	2	1	0	0	12	1	12.50
07:30	07:45	0	0	10	3	0	0	1	14	1	15.00
07:45	08:00	0	0	12	6	2	0	0	20	2	21.00
08:00	08:15	0	0	13	3	2	0	0	18	2	19.00
08:15	08:30	0	0	18	6	0	0	0	24	0	24.00
08:30	08:45	0	0	11	3	1	1	0	16	2	17.80
08:45	09:00	0	1	18	3	0	0	0	22	0	21.40
09:00	09:15	0	0	16	7	1	2	0	26	3	29.10
09:15	09:30	0	0	12	3	2	0	0	17	2	18.00
09:30	09:45	0	0	7	6	0	0	0	13	0	13.00
09:45	10:00	0	0	21	7	2	0	0	30	2	31.00
TOTAL		0	1	154	49	11	3	1	219	15	228.80

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	53	18	4	0	1	76	5	79.00
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	53	18	4	0	1	76	5	79.00

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	0	39	6	1	1	0	47	2	48.80
15:45	16:00	0	0	55	6	4	1	0	66	5	69.30
16:00	16:15	0	1	53	5	1	0	0	60	1	59.90
16:15	16:30	1	0	53	15	4	0	0	73	4	74.20
16:30	16:45	0	0	55	10	1	0	1	67	2	68.50
16:45	17:00	1	0	61	7	1	0	0	70	1	69.70
17:00	17:15	0	0	84	9	1	0	0	94	1	94.50
17:15	17:30	0	1	68	4	1	0	0	74	1	73.90
17:30	17:45	0	0	49	6	1	0	0	56	1	56.50
17:45	18:00	0	0	56	9	0	1	0	66	1	67.30
18:00	18:15	0	0	56	3	0	1	0	60	1	61.30
18:15	18:30	0	0	43	2	0	0	0	45	0	45.00
TOTAL		2	2	672	82	15	4	1	778	20	788.90

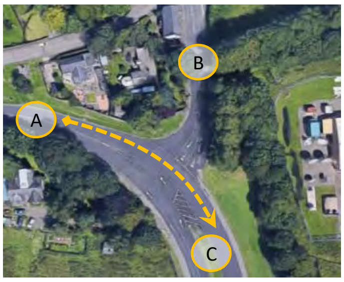
PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	2	0	253	41	7	0	1	304	8	306.90
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	2	0	253	41	7	0	1	304	8	306.90

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058

Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast

Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.2: B961 (Drumgeith Road) (North) to B961 (Drumgeith Road) (South) Ahead (A-C)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	37	2	1	1	0	41	2	42.80
07:15	07:30	1	0	61	12	4	1	0	79	5	81.50
07:30	07:45	0	1	60	13	4	0	0	78	4	79.40
07:45	08:00	1	0	82	20	5	4	0	112	9	118.90
08:00	08:15	0	0	44	15	6	3	0	68	9	74.90
08:15	08:30	2	1	62	13	4	3	0	85	7	88.70
08:30	08:45	0	0	51	11	3	2	0	67	5	71.10
08:45	09:00	0	0	58	11	0	0	0	69	0	69.00
09:00	09:15	0	0	39	10	4	0	0	53	4	55.00
09:15	09:30	0	0	32	7	2	3	0	44	5	48.90
09:30	09:45	0	0	44	8	8	3	0	63	11	70.90
09:45	10:00	0	0	48	10	3	0	0	61	3	62.50
TOTAL		4	2	618	132	44	20	0	820	64	863.60

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	3	2	248	61	19	10	0	343	29	361.90
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	3	2	248	61	19	10	0	343	29	361.90

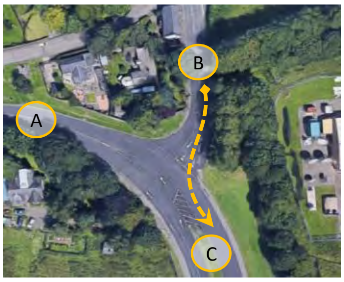
TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	1	55	8	4	1	0	69	5	71.70
15:45	16:00	0	0	60	8	3	5	0	76	8	84.00
16:00	16:15	0	0	70	6	2	0	0	78	2	79.00
16:15	16:30	0	0	69	12	5	2	0	88	7	93.10
16:30	16:45	0	0	81	16	2	2	0	101	4	104.60
16:45	17:00	0	0	69	11	1	2	0	83	3	86.10
17:00	17:15	0	0	76	11	2	3	1	93	6	98.90
17:15	17:30	0	0	83	10	3	1	0	97	4	99.80
17:30	17:45	0	0	62	7	2	1	0	72	3	74.30
17:45	18:00	0	1	68	7	1	2	0	79	3	81.50
18:00	18:15	0	0	48	8	0	0	0	56	0	56.00
18:15	18:30	0	0	68	5	0	2	0	75	2	77.60
TOTAL		0	2	809	109	25	21	1	967	47	1006.60

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	295	50	10	9	1	365	20	382.70
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	295	50	10	9	1	365	20	382.70

AC18

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.3: Kellas Road to B961 (Drumgeith Road) (South) Left Turn (B-C)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	13	1	0	1	0	15	1	16.30
07:15	07:30	1	1	18	4	0	0	0	24	0	22.60
07:30	07:45	0	1	15	3	2	0	0	21	2	21.40
07:45	08:00	0	0	27	9	0	2	0	38	2	40.60
08:00	08:15	0	0	20	2	2	0	1	25	3	27.00
08:15	08:30	1	0	25	12	0	0	0	38	0	37.20
08:30	08:45	0	0	26	2	0	1	0	29	1	30.30
08:45	09:00	0	0	31	5	1	1	0	38	2	39.80
09:00	09:15	1	0	18	5	0	0	0	24	0	23.20
09:15	09:30	1	0	21	6	0	0	0	28	0	27.20
09:30	09:45	0	0	21	4	2	1	0	28	3	30.30
09:45	10:00	0	0	21	5	0	0	0	26	0	26.00
TOTAL		4	2	256	58	7	6	1	334	14	341.90

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	1	1	87	26	4	2	1	122	7	126.20
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	1	1	87	26	4	2	1	122	7	126.20

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	1	0	17	2	0	0	0	20	0	19.20
15:45	16:00	0	0	28	2	2	0	0	32	2	33.00
16:00	16:15	0	0	21	6	0	0	0	27	0	27.00
16:15	16:30	0	0	33	7	0	0	0	40	0	40.00
16:30	16:45	0	0	18	2	0	1	0	21	1	22.30
16:45	17:00	1	0	28	2	0	0	0	31	0	30.20
17:00	17:15	0	0	23	1	2	0	0	26	2	27.00
17:15	17:30	0	0	17	5	0	0	0	22	0	22.00
17:30	17:45	0	0	32	4	1	0	0	37	1	37.50
17:45	18:00	0	0	25	1	1	1	0	28	2	29.80
18:00	18:15	0	0	31	2	1	0	0	34	1	34.50
18:15	18:30	0	0	18	2	1	0	0	21	1	21.50
TOTAL		2	0	291	36	8	2	0	339	10	344.00

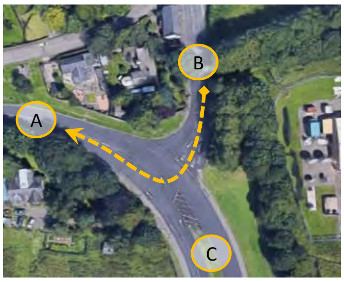
PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	102	12	2	1	0	118	3	119.50
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	102	12	2	1	0	118	3	119.50

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058

Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast

Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.3: Kellas Road to B961 (Drumgeith Road) (North) Right Turn (B-A)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	32	8	0	0	0	40	0	40.00
07:15	07:30	0	0	40	7	0	2	0	49	2	51.60
07:30	07:45	1	0	63	13	4	0	0	81	4	82.20
07:45	08:00	1	0	63	6	1	3	0	74	4	77.60
08:00	08:15	0	0	70	9	0	0	0	79	0	79.00
08:15	08:30	0	0	87	6	1	0	0	94	1	94.50
08:30	08:45	0	0	62	13	4	0	0	79	4	81.00
08:45	09:00	0	1	36	8	0	2	1	48	3	51.00
09:00	09:15	0	0	33	4	3	1	0	41	4	43.80
09:15	09:30	0	0	36	4	4	1	0	45	5	48.30
09:30	09:45	0	0	23	2	2	1	0	28	3	30.30
09:45	10:00	0	0	47	2	0	0	0	49	0	49.00
TOTAL		2	1	592	82	19	10	1	707	30	728.30

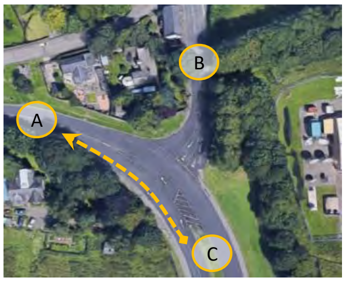
PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	2	0	283	34	6	3	0	328	9	333.30
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	2	0	283	34	6	3	0	328	9	333.30

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	0	27	6	1	1	0	35	2	36.80
15:45	16:00	0	0	21	7	1	0	0	29	1	29.50
16:00	16:15	1	0	17	5	0	0	0	23	0	22.20
16:15	16:30	0	1	15	8	0	0	0	24	0	23.40
16:30	16:45	0	0	27	5	0	0	1	33	1	34.00
16:45	17:00	0	0	21	4	1	1	0	27	2	28.80
17:00	17:15	0	0	23	4	0	0	0	27	0	27.00
17:15	17:30	0	0	32	2	0	0	0	34	0	34.00
17:30	17:45	0	0	24	1	0	0	0	25	0	25.00
17:45	18:00	0	0	21	3	0	0	0	24	0	24.00
18:00	18:15	0	0	27	4	0	0	0	31	0	31.00
18:15	18:30	0	0	24	3	0	0	0	27	0	27.00
TOTAL		1	1	279	52	3	2	1	339	6	342.70

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	1	86	21	1	1	1	111	3	113.20
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	1	86	21	1	1	1	111	3	113.20

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.4: B961 (Drumgeith Road) (South) to B961 (Drumgeith Road) (North) Ahead (C-A)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	39	9	1	0	0	49	1	49.50
07:15	07:30	0	0	31	7	1	0	0	39	1	39.50
07:30	07:45	0	0	49	6	1	6	1	63	8	72.30
07:45	08:00	0	0	41	13	1	3	0	58	4	62.40
08:00	08:15	0	0	48	8	2	0	0	58	2	59.00
08:15	08:30	0	0	40	8	8	0	0	56	8	60.00
08:30	08:45	0	0	31	13	4	1	0	49	5	52.30
08:45	09:00	0	0	37	9	2	1	0	49	3	51.30
09:00	09:15	0	0	40	12	4	5	0	61	9	69.50
09:15	09:30	0	0	31	16	3	0	0	50	3	51.50
09:30	09:45	0	0	37	13	4	0	0	54	4	56.00
09:45	10:00	0	0	49	12	3	0	0	64	3	65.50
TOTAL		0	0	473	126	34	16	1	650	51	688.80

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	178	35	12	9	1	235	22	253.70
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	178	35	12	9	1	235	22	253.70

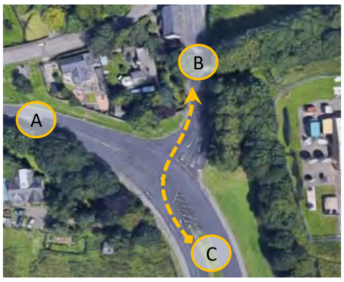
TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	1	0	123	6	0	4	0	134	4	138.40
15:45	16:00	0	0	56	10	0	2	0	68	2	70.60
16:00	16:15	1	0	63	11	4	1	0	80	5	82.50
16:15	16:30	0	0	78	19	6	2	0	105	8	110.60
16:30	16:45	0	0	97	16	2	3	0	118	5	122.90
16:45	17:00	0	0	74	9	2	2	0	87	4	90.60
17:00	17:15	1	0	105	8	3	1	0	118	4	120.00
17:15	17:30	0	0	83	10	0	0	1	94	1	95.00
17:30	17:45	0	0	77	7	0	1	0	85	1	86.30
17:45	18:00	0	0	41	3	0	0	0	44	0	44.00
18:00	18:15	0	0	47	6	0	0	0	53	0	53.00
18:15	18:30	0	0	53	6	0	0	0	59	0	59.00
TOTAL		3	0	897	111	17	16	1	1045	34	1072.90

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	354	52	13	8	0	428	21	444.10
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	354	52	13	8	0	428	21	444.10

AC18

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.5: B961 (Drumgeith Road) (South) to Kellas Road Right Turn (C-B)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	7	1	0	1	0	9	1	10.30
07:15	07:30	0	0	7	2	1	0	0	10	1	10.50
07:30	07:45	0	0	7	2	1	0	0	10	1	10.50
07:45	08:00	0	0	7	1	0	0	0	8	0	8.00
08:00	08:15	0	0	10	2	0	1	0	13	1	14.30
08:15	08:30	0	0	14	4	1	0	0	19	1	19.50
08:30	08:45	0	0	12	2	0	0	0	14	0	14.00
08:45	09:00	0	0	10	2	1	0	0	13	1	13.50
09:00	09:15	0	0	15	6	0	0	0	21	0	21.00
09:15	09:30	0	0	13	3	0	0	1	17	1	18.00
09:30	09:45	0	0	13	5	0	0	0	18	0	18.00
09:45	10:00	0	0	18	4	3	0	0	25	3	26.50
TOTAL		0	0	133	34	7	2	1	177	10	184.10

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	38	9	2	1	0	50	3	52.30
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	38	9	2	1	0	50	3	52.30

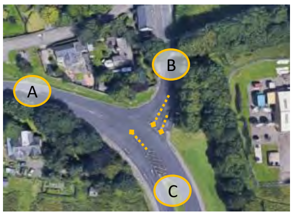
TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	1	33	5	0	1	0	40	1	40.70
15:45	16:00	1	0	32	4	1	0	0	38	1	37.70
16:00	16:15	0	0	35	2	0	1	0	38	1	39.30
16:15	16:30	0	0	36	2	0	1	1	40	2	42.30
16:30	16:45	0	0	35	4	0	0	0	39	0	39.00
16:45	17:00	0	0	23	4	0	0	0	27	0	27.00
17:00	17:15	0	0	34	5	0	1	0	40	1	41.30
17:15	17:30	1	0	31	2	0	0	0	34	0	33.20
17:30	17:45	0	0	31	1	0	2	0	34	2	36.60
17:45	18:00	0	0	24	1	0	0	0	25	0	25.00
18:00	18:15	0	0	35	2	1	0	1	39	2	40.50
18:15	18:30	0	0	19	1	1	0	0	21	1	21.50
TOTAL		2	1	368	33	3	6	2	415	11	424.10

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	128	15	0	2	1	146	3	149.60
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	128	15	0	2	1	146	3	149.60

VEHICLE QUEUE SURVEYS

STUDY NETWORK MAXIMUM QUEUE COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction



TIME		VEHICLE MOVEMENT(S) / QUEUE - PCUs / LANE			
		B961 (Drumgeith Road) (North) (A-BC)	Kellas Road		B961 (Drumgeith Road) (South) (C-B)
			Near. (B-C)	Off. (B-A)	
07:15	07:20	-	0	1	0
07:20	07:25	-	0	4	0
07:25	07:30	-	0	4	1
07:30	07:35	-	0	3	0
07:35	07:40	-	0	11	0
07:40	07:45	-	0	3	1
07:45	07:50	-	1	7	1
07:50	07:55	-	1	16	0
07:55	08:00	-	1	9	1
08:00	08:05	-	1	2	0
08:05	08:10	-	1	4	0
08:10	08:15	-	1	2	1
08:15	08:20	-	1	5	2
08:20	08:25	-	1	4	1
08:25	08:30	-	2	11	2
08:30	08:35	-	2	2	0
08:35	08:40	-	1	4	1
08:40	08:45	-	2	10	1

QUEUE	NETWORK PEAK (07:30-08:30)			
MINIMUM	-	0	2	0
MAXIMUM	-	2	16	2
AVERAGE	-	1	6	1
85th%ILE	-	1	11	1

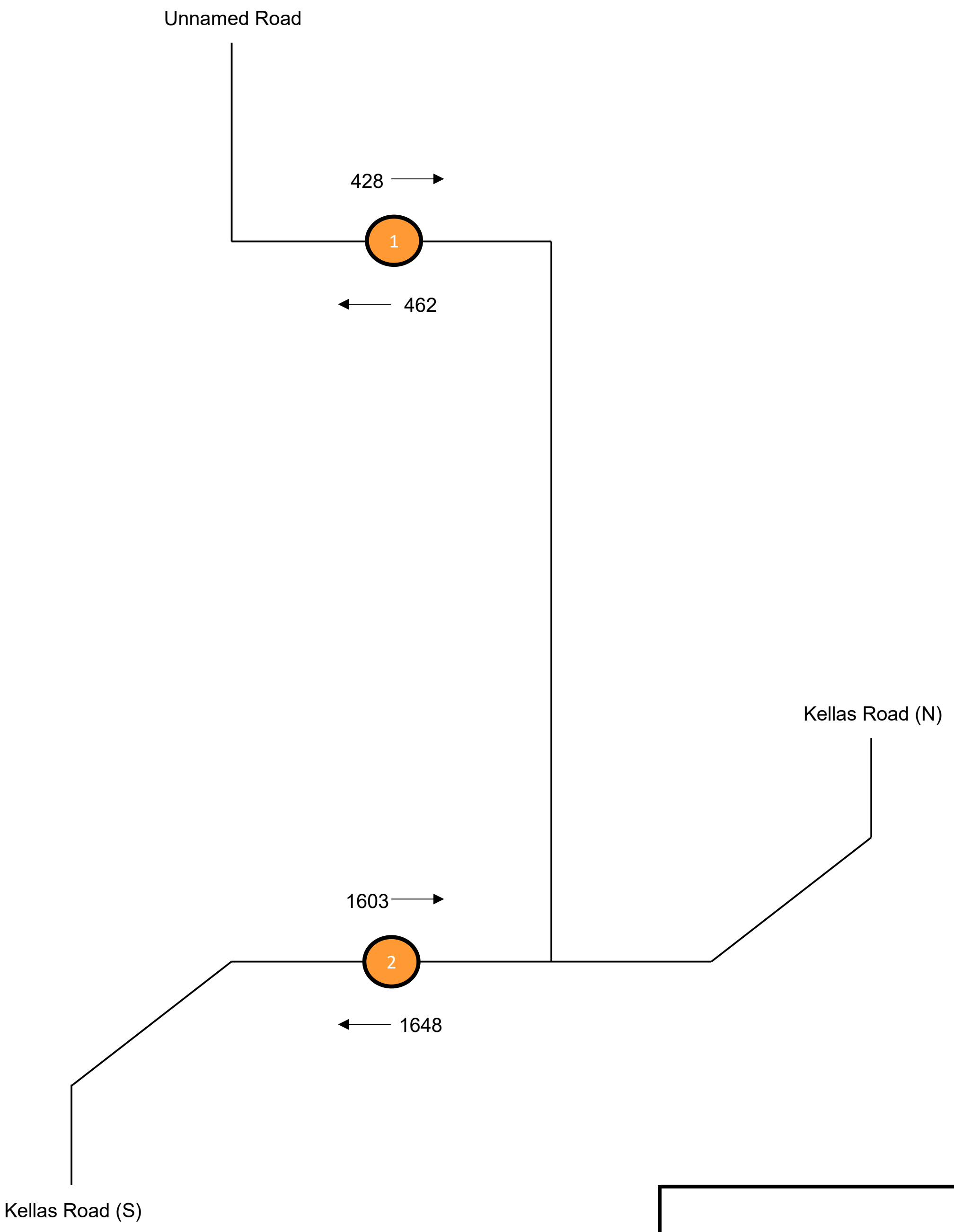
TIME		VEHICLE MOVEMENT(S) / QUEUE - PCUs / LANE			
		B961 (Drumgeith Road) (North) (A-BC)	Kellas Road		B961 (Drumgeith Road) (South) (C-B)
			Near. (B-C)	Off. (B-A)	
16:00	16:05	-	1	2	2
16:05	16:10	-	2	2	3
16:10	16:15	-	1	2	1
16:15	16:20	-	2	6	1
16:20	16:25	-	3	2	3
16:25	16:30	-	1	1	2
16:30	16:35	-	1	4	2
16:35	16:40	-	0	4	3
16:40	16:45	-	2	2	1
16:45	16:50	-	1	3	1
16:50	16:55	-	1	3	2
16:55	17:00	-	1	2	1
17:00	17:05	-	1	2	2
17:05	17:10	-	2	2	1
17:10	17:15	-	1	5	5
17:15	17:20	-	2	5	2
17:20	17:25	-	1	4	4
17:25	17:30	-	2	2	2

QUEUE	NETWORK PEAK (16:15-17:15)			
MINIMUM	-	0	1	1
MAXIMUM	-	3	6	5
AVERAGE	-	1	3	2
85th%ILE	-	2	4	3

CLASSIFIED AUTOMATIC TRAFFIC COUNTS (LINK FLOW & SPEED SURVEYS)

SITE LOCATION	
Project:	Kellas Road, Dundee
Client:	Cameron + Ross
Project.Ref.	TS-19-058
Location 1:	Unamed Road, east of Duntrune House
Location 2:	Kellas Road - Approx. 30m south of Unnamed Road

SURVEY NETWORK TRAFFIC FLOW DIAGRAM



Time	**24hr (00:00-00:00)**
Date	**7 day (Weekly) Average**

CLASS	AXLES	AXLE GROUPS	DESCRIPTION	DOMINATE VEHICLE	AGGREGATE
1	2	1 or 2	Very Short - Bicycle or Motorcycle		
2	2	1 or 2	Short - Car, 4WD or Light Van		**LIGHT**
3	3 / 4 / 5	3	Short Towing - Trailer, Caravan etc.		
4	2	2	2-Axle Truck or Bus		
5	3	2	3-Axle Truck or Bus		**MEDIUM**
6	>3	2	4-Axle Truck		
7	3	3	3-Axle Articulated Vehicle or Rigid Vehicle & Trailer		
8	4	>2	4-Axle Articulated Vehicle or Rigid Vehicle & Trailer		
9	5	>2	5-Axle Articulated Vehicle or Rigid Vehicle & Trailer		**HEAVY**
10	>=6	>2	6 (or more) Axle Articulated Vehicle or Rigid Vehicle & Trailer		
11	>6	4	B-Double or Heavy Truck & Trailer		
12	>6	>=5	Double or Triple Heavy Truck & 2 (or more) Trailers		

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 1: Unnamed Road, east of Duntrune House
Movement: Eastbound

TIME		TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
			LIGHT			MEDIUM			HEAVY						0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
			1	2	3	4	5	6	7	8	9	10	11	12																								
Date: 10 October 2019																																						
00:00	01:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	36.8	36.8	36.8	-
01:00	02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
02:00	03:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26.4	26.4	26.4	-
03:00	04:00	5	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	0	0	0	0	0	0	0	0	0	0	0	36.6	31.3	42.1	-
04:00	05:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	37.0	37.0	37.0	-
05:00	06:00	4	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	36.7	30.9	40.8	-
06:00	07:00	14	0	13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	4	0	0	0	0	0	0	0	0	0	0	0	37.9	31.4	44.4	42.1
07:00	08:00	60	0	56	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	2	14	26	16	2	0	0	0	0	0	0	0	0	0	0	37.5	26.2	47.7	42.2
08:00	09:00	71	0	63	0	6	0	1	0	0	1	0	0	0	0	0	0	1	2	3	22	34	8	1	0	0	0	0	0	0	0	0	0	0	35.6	18.7	49.6	39.9
09:00	10:00	30	0	27	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	6	8	13	2	0	0	0	0	0	0	0	0	0	0	0	33.8	21.5	41.8	38.8
10:00	11:00	25	1	15	0	8	1	0	0	0	0	0	0	0	0	0	1	0	0	1	13	7	3	0	0	0	0	0	0	0	0	0	0	0	33.5	10.1	43.3	38.7
11:00	12:00	32	0	29	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	4	11	9	5	1	0	0	0	0	0	0	0	0	0	0	34.0	12.0	47.5	40.5
12:00	13:00	32	0	28	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1	5	13	12	1	0	0	0	0	0	0	0	0	0	0	0	33.6	23.3	41.4	37.9
13:00	14:00	19	0	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	6	0	1	0	0	0	0	0	0	0	0	0	0	34.2	29.2	45.8	39.4
14:00	15:00	17	0	14	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	7	3	1	0	0	0	0	0	0	0	0	0	0	36.7	28.3	46.2	41.5
15:00	16:00	29	1	21	0	6	0	0	0	1	0	0	0	0	0	1	0	1	1	9	6	9	2	0	0	0	0	0	0	0	0	0	0	0	31.5	8.2	41.5	39.1
16:00	17:00	30	0	29	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	12	9	3	0	0	0	0	0	1	0	0	0	0	0	35.3	26.3	74.0	39.6
17:00	18:00	30	0	26	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	14	12	2	1	0	0	0	0	0	0	0	0	0	0	35.5	25.1	45.4	39.3
18:00	19:00	22	0	19	0	2	0	0	0	1	0	0	0	0	0	0	0	0	1	2	11	7	1	0	0	0	0	0	0	0	0	0	0	0	33.3	23.8	40.7	36.7
19:00	20:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	2	2	0	1	0	0	0	0	0	0	0	0	0	0	31.5	22.6	45.8	39.5
20:00	21:00	13	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	2	0	0	0	0	0	0	0	0	0	0	0	0	32.5	27.0	39.4	37.2
21:00	22:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3	1	0	0	0	0	0	0	0	0	0	0	0	31.6	9.4	40.2	-
22:00	23:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	33.8	30.9	35.3	-
23:00	00:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	32.7	28.8	38.9	-
07:00-19:00		397	2	345	1	42	1	2	0	2	2	0	0	0	0	1	3	2	6	40	140	151	46	7	0	0	0	0	1	0	0	0	0	0	34.8	8.2	74.0	39.9
06:00-22:00		443	2	390	1	43	1	2	0	2	2	0	0	0	0	2	3	2	7	49	154	166	51	8	0	0	0	0	1	0	0	0	0	0	34.7	8.2	74.0	39.8
06:00-00:00		451	2	398	1	43	1	2	0	2	2	0	0	0	0	2	3	2	7	51	157	169	51	8	0	0	0	0	1	0	0	0	0	0	34.7	8.2	74.0	39.7
00:00-00:00		463	2	404	1	49	1	2	0	2	2	0	0	0	0	2	3	2	7	52	159	176	53	8	0	0	0	0	1	0	0	0	0	0	34.7	8.2	74.0	39.7
Date: 11 October 2019																																						
00:00	01:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	31.5	31.5	31.5	-
01:00	02:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29.0	29.0	29.0	-
02:00	03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00	04:00	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	35.4	26.6	42.7	-
04:00	05:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	35.3	32.1	38.6	-
05:00	06:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	0	0	0	0	0	0	0	0	0	0	0	38.5	31.1	44.4	-
06:00	07:00	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	5	1	0	0	0	0	0	0	0	0	0	0	0	34.9	26.4	42.9	-
07:00	08:00	35	0	32	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	1	6	15	11	1	0	0	0	0	0	0	0	0	0	0	37.8	23.5	46.4	42.9
08:00	09:00	66	0	58	2	5	0	0	0	0	0	1	0	0	0	0	0	2	3	11	21	18	8	3	0	0	0	0	0	0	0	0	0	0	34.2	18.7	47.0	41.1
09:00	10:00	28	0	25	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	7	4	1	0	0	0	0	0	0	0	0	0	0	34.4	25.3	48.4	40.5
10:00	11:00	28	0	27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	8	3	0	0	0	0	0	0	0	0	0	0	0	34.3	26.8	42.9	39.3
11:00	12:00	29	1	25	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	4	14	7	3	0	0	0	0	0	0	0	0	0	0	0	33.6	20.2	44.0	38.9
12:00	13:00	23	0	19	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	10	3	0	0	0	0	0	0	0	0	0	0	0	35.5	26.0	44.3	39.8
13:00	14:00	25	0	21	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	5	9	3	6	0	0	0	0	0	0	0	0	0	0	0	34.0	22.8	43.1	41.2
14:00	15:00	20	0	14	1	4	0	1	0	0	0	0	0	0	0	0	0	0	0	4	11	2	2	1	0	0	0	0	0	0	0	0	0	0	33.6	25.5	48.4	40.2
15:00	16:00	37	1	33	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5	11	13	5	2	0	0	0	0	0	0	0	0	0	0	35.4	20.1	47.8	41.0
16:00	17:00	33	0	28	2	3	0	0	0	0	0	0	0	0	0	0	0	0	1	10	10	10	2	0	0	0	0	0	0	0	0	0	0	0	32.9	25.0	41.8	38.6
17:00	18:00	31	1	28	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	9	6	0	0	0	0	0	0	0	0	0	0	0	35.1	26.5	44.7	41.7
18:00	19:00	21	0	20	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	2	0	0	0	0	0	0	0	0	0	0	0	35.4	28.2	42.9	38.7
19:00	20:00	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	5	3	0	0	0	0	0	0	0	0	0	0	0	35.2	27.5	43.3	41.4
20:00	21:00	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	0	0	0	0	0	0	0	0	0	0	0	36.1	28.3	42.1	-
21:00	22:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	5	2	1	1	0	0	0	0	0	0	0	0	0	38.6	26.9	52.5	45.6
22:00	23:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	32.5	28.8	34.7	-
23:00	00:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	32.4	28.2	36.6	-
07:00-19:00		376	3	330	11	29	1	1	0	0	0	1	0	0	0	0	0	2	9	59	130	113	55	8	0	0	0	0	0	0	0	0	0	0	34.7	18.7	48.4	40.7
06:00-22:00		423	3	377	11	29	1	1	0	0	0	1	0	0	0	0	0	2	9	67	141	130	64	9	1	0	0	0	0	0	0	0	0	0	34.8	18.7	52.5	40.8
06:00-00:00		428	3	382	11	29	1	1	0	0	0	1	0	0	0	0	0	2	9	69	143	131	64	9	1	0	0	0	0	0	0	0	0	0	34.8	18.7	52.5	40.8
00:00-00:00		445	3	393	11	35	1	1	0	0	0	1	0	0	0	0	0	2	9	71	149	136	68	9	1	0	0	0	0	0	0	0	0	0	34.9	18.7	52.5	40.8
Date: 12 October 2019																																						
00:00	01:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	32.4	29.9	34.8	-
01:00	02:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	38.8	37.8	39.8	-
02:00	03:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	39.3	39.3	39.3	-
03:00	04:00	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	34.8	26.5	40.0	-
04:00	05:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	34.4	34.4	34.4	-
05:00	06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
06:00	07:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	34.2	26.4	39.7	-
07:00	08:00	12	0	10	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	2	1	0	0	0	0	0	0	0	0	0	0	37.0	30.7	46.6	42.9
08:00	09:00	24	0	19	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	9	7	0	2	0	0	0	0	0	0	0	0	0	0	33.8	25.3	48.2	38.7
09:00	10:00	22	0	20	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	11	6	1	1	0	0	0	0	0	0	0	0	0	0	34.4	28.6	45.2	38.9
10:00	11:00	32	1	30	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	14	11	2	0	0	0	0	0	0	0	0	0	0	0	33.2	12.2	43.6	37.7
11:00	12:00	31	0	28	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	8	12	8	3	0	0	0	0	0	0	0	0	0	0	0	33.9	26.1	44.0	39.5
12:00	13:00	36	1	32	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6	15	9	3	1	0	2	0	0	0	0	0	0	0	0	35.8	25.1	59.2	42.5
13:00	14:00	22	0	21	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	7	3	0	0	0	0	0	0	0	0	0	0	0	35.3	29.8	44.5	39.7
14:00	15:00	31	1	29	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	8	11	5	3	2	0	0	0	0	0	0	0	0	0	0	33.3	11.8	49.0	42.2
15:00	16:00	27	0	26	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	12	6	3	1	0	0	0	0	0	0	0	0	0	0	34.0	26.5	47.2	40.7
16:00	17:00	25	0	23	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	20	3	1	0	0	0	0	0	0	0	0	0	0	0	33.7	29.9	43.4	35.3
17:00	18:00	19	0	18	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	2	2	0	0	0	0	0	0	0	0	0	0	0	32.8	26.5	43.1	37.0
18:00	19:00	14	0	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	3	0	1	0	0	0	0	0	0	0	0	0	0	33.9	23.1	48.3	39.2
19:00	20:00	13	0	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3	1	1	0	0	0	0	0	0	0	0	0	0	0	30.4	25.8	42.5	37.3
20:00	21:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	3	0	0	0	0	0	0	0	0	0	0	0	0	31.6	25.3	37.1	36.1
21:00	22:00	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	1	0	0	0	0	0	0	0	0	0	0	0	34.5	27.6	40.2	-
22:00	23:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	33.8	27.4	37.0	-
23:00	00:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	35.4	27.3	47.7	-
07:00-19:00		295	3	269	10	13	0	0	0	0	0	0	0	0	0	0	2	0	2	49	137	71	23	9	0	2	0	0	0	0	0	0	0	0	34.2	11.8	59.2	38.9
06:00-22:00		333	3	306	11	13	0	0	0	0	0	0	0	0	0	0	2	0	2	65	147	81	25	9	0	2	0	0	0	0	0	0	0	0	33.9	11.8	59.2	38.7
06:00-00:00		344	3	317	11	13	0	0	0	0	0	0	0	0	0	0	2	0	2	67	152	84	25	10	0	2	0	0	0	0	0	0	0	0	34.0	11.8	59.2	38.7
00:00-00:00		356	3	323	11	19	0	0	0	0	0	0	0	0	0	0	2	0	2	69	156	89	26	10	0	2	0	0	0	0	0	0	0	0	34.0	11.8	59.2	38.9
Date: 13 October 2019																																						
00:00	01:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	32.9	31.1	36.0	-
01:00	02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
02:00	03:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	36.0	36.0	36.0	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00	06:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	39.1	39.1	39.1	-
06:00	07:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29.8	29.8	29.8	-
07:00	08:00	7	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	1	0	1	0	0	0	0	0	0	0	0	0	0	32.9	21.8	47.2	-
08:00	09:00	12	0	10	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	3	2	0	0	0	0	0	0	0	0	0	0	0	33.3	25.4	42.0	41.8
09:00	10:00	23	1	20	0	0	0	0	0	0	2	0	0	0	0	1	0	1	2	3	10	5	1	0	0	0	0	0	0	0	0	0	0	0	30.7	9.7	41.3	38.5
10:00	11:00	11	0	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	3	2	0	0	0	0	0	0	0	0	0	0	0	34.7	25.7	44.0	41.5
11:00	12:00	24	0	21	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	11	5	0	0	1	0	0	0	0	0	0	0	0	0	33.1	21.4	52.1	38.3
12:00	13:00	30	0	24	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	11	13	4	2	0	0	0	0	0	0	0	0	0	0	0	32.7	26.6	43.7	37.1
13:00	14:00	33	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	13	9	2	2	0	0	0	0	0	0	0	0	0	0	34.1	16.7	50.0	39.6
14:00	15:00	20	0	18	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	5	4	0	0	0	0	0	0	0	0	0	0	0	35.0	24.2	43.3	41.1
15:00	16:00	24	1	22	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	7	7	5	0	1	0	0	0	0	0	0	0	0	0	35.2	11.2	50.9	42.3

TIME	TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
		LIGHT			MEDIUM			HEAVY																													
		1	2	3	4	5	6	7	8	9	10	11	12	0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
Date: 13 October 2019																																					
16:00 17:00	22	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	10	1	0	0	0	0	0	0	0	0	0	0	0	35.2	29.5	40.4	38.9
17:00 18:00	25	0	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	8	7	1	0	0	0	0	0	0	0	0	0	0	36.0	25.2	46.1	41.4
18:00 19:00	17	0	16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	5	3	0	0	0	0	0	0	0	0	0	0	0	35.2	29.1	44.5	40.9
19:00 20:00	9	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	1	0	0	0	0	0	0	0	0	0	0	35.1	30.1	49.1	-
20:00 21:00	13	0	13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	7	2	1	0	0	0	0	0	0	0	0	0	0	0	31.3	13.4	43.1	37.0
21:00 22:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	33.0	30.8	34.7	-
22:00 23:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	33.6	30.7	38.3	-
23:00 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
07:00-19:00	248	2	226	11	7	0	0	0	0	2	0	0	0	0	1	1	2	7	44	93	65	29	4	2	0	0	0	0	0	0	0	0	0	34.0	9.7	52.1	39.9
06:00-22:00	275	2	252	12	7	0	0	0	0	2	0	0	0	0	1	2	2	7	47	110	69	30	5	2	0	0	0	0	0	0	0	0	0	33.9	9.7	52.1	39.6
06:00-00:00	280	2	257	12	7	0	0	0	0	2	0	0	0	0	1	2	2	7	47	114	70	30	5	2	0	0	0	0	0	0	0	0	0	33.9	9.7	52.1	39.6
00:00-00:00	286	2	262	12	8	0	0	0	0	2	0	0	0	0	1	2	2	7	47	117	73	30	5	2	0	0	0	0	0	0	0	0	0	33.9	9.7	52.1	39.4
Date: 14 October 2019																																					
00:00 01:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27.3	27.3	27.3	-
01:00 02:00	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25.7	24.0	27.3	-
02:00 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00 04:00	6	0	1	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	30.3	20.6	36.4	-
04:00 05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00 06:00	7	0	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	1	0	0	0	0	0	0	0	0	0	0	0	38.0	34.4	43.3	-
06:00 07:00	14	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	6	1	0	0	0	0	0	0	0	0	0	0	0	34.7	28.8	42.7	38.2
07:00 08:00	50	0	47	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0	22	14	8	2	0	0	0	0	0	0	0	0	0	0	35.5	20.2	48.2	41.1
08:00 09:00	53	0	49	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	17	23	7	1	1	0	0	0	0	0	0	0	0	0	36.4	26.7	50.0	40.2
09:00 10:00	32	0	31	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	5	16	9	1	0	0	0	0	0	0	0	0	0	0	0	33.3	17.3	41.6	37.2
10:00 11:00	26	0	24	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	14	6	1	1	0	0	0	0	0	0	0	0	0	0	33.9	23.5	46.5	39.2
11:00 12:00	27	0	16	1	9	0	1	0	0	0	0	0	0	0	0	0	0	0	4	14	9	0	0	0	0	0	0	0	0	0	0	0	0	33.5	26.7	38.9	37.7
12:00 13:00	27	0	21	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	11	2	2	0	0	0	0	0	0	0	0	0	0	35.9	27.0	47.1	41.2
13:00 14:00	27	0	24	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	4	15	5	3	0	0	0	0	0	0	0	0	0	0	0	33.8	26.9	42.2	39.8
14:00 15:00	27	0	23	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	2	14	10	1	0	0	0	0	0	0	0	0	0	0	0	34.4	25.9	42.2	37.1
15:00 16:00	16	0	12	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	2	9	5	0	0	0	0	0	0	0	0	0	0	0	0	34.0	25.1	39.9	37.7
16:00 17:00	45	0	39	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	4	19	19	3	0	0	0	0	0	0	0	0	0	0	0	34.8	26.1	44.3	38.8
17:00 18:00	41	0	38	0	3	0	0	0	0	0	0	0	0	0	0	0	3	1	2	14	15	5	1	0	0	0	0	0	0	0	0	0	0	34.2	17.5	45.5	40.6
18:00 19:00	20	1	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	9	4	0	0	0	0	0	0	0	0	0	0	0	36.8	27.4	44.9	43.8
19:00 20:00	13	0	10	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	2	1	0	0	0	0	0	0	0	0	0	0	36.9	30.7	49.1	42.3
20:00 21:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	1	0	0	0	0	0	0	0	0	0	34.9	25.9	53.5	-
21:00 22:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	33.5	26.4	38.2	-
22:00 23:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	36.1	29.7	40.3	-
23:00 00:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	34.0	31.0	37.0	-
07:00-19:00	391	1	342	4	40	1	2	0	1	0	0	0	0	0	0	0	4	6	33	170	135	35	7	1	0	0	0	0	0	0	0	0	0	34.8	17.3	50.0	39.4
06:00-22:00	427	1	375	4	43	1	2	0	1	0	0	0	0	0	0	0	4	6	37	184	148	38	8	2	0	0	0	0	0	0	0	0	0	34.9	17.3	53.5	39.4
06:00-00:00	432	1	380	4	43	1	2	0	1	0	0	0	0	0	0	0	4	6	38	185	150	39	8	2	0	0	0	0	0	0	0	0	0	34.9	17.3	53.5	39.4
00:00-00:00	448	1	388	4	51	1	2	0	1	0	0	0	0	0	0	0	4	8	42	188	156	40	8	2	0	0	0	0	0	0	0	0	0	34.8	17.3	53.5	39.4
Date: 15 October 2019																																					
00:00 01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
01:00 02:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25.4	25.4	25.4	-
02:00 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00 04:00	6	0	1	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	0	0	0	0	0	0	0	0	0	0	0	35.0	25.2	42.0	-
04:00 05:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	38.8	38.8	38.8	-
05:00 06:00	6	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	39.6	35.3	43.7	-
06:00 07:00	12	0	11	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	9	2	0	0	0	0	0	0	0	0	0	0	0	36.5	18.8	43.7	42.2
07:00 08:00	59	1	51	2	5	0	0	0	0	0	0	0	0	0	0	1	0	4	5	16	19	12	1	1	0	0	0	0	0	0	0	0	0	35.4	10.2	50.2	42.1
08:00 09:00	66	0	58	1	6	0	0	0	1	0	0	0	0	0	0	0	0	2	9	17	30	8	0	0	0	0	0	0	0	0	0	0	0	35.0	22.5	44.3	39.7
09:00 10:00	34	1	31	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	11	6	0	0	0	0	0	0	0	0	0	0	0	35.3	26.0	42.2	40.2
10:00 11:00	21	0	16	1	3	0	0	1	0	0	0	0	0	0	0	0	1	1	3	6	5	3	1	1	0	0	0	0	0	0	0	0	0	34.8	19.6	50.9	41.5
11:00 12:00	29	0	24	0	4	0	0	0	0	1	0	0	0	0	0	0	0	1	4	9	10	5	0	0	0	0	0	0	0	0	0	0	0	35.0	22.9	44.3	41.5
12:00 13:00	42	0	32	0	8	0	2	0	0	0	0	0	0	0	0	0	0	0	3	13	15	8	2	0	0	0	1	0	0	0	0	0	0	37.2	26.8	66.3	41.6
13:00 14:00	30	1	24	1	3	0	1	0	0	0	0	0	0	0	0	0	1	1	3	9	9	5	1	1	0	0	0	0	0	0	0	0	0	35.5	18.8	52.6	42.9
14:00 15:00	30	0	25	1	3	0	0	0	1	0	0	0	0	0	0	0	0	1	6	10	11	2	0	0	0	0	0	0	0	0	0	0	0	33.9	24.9	41.5	39.7
15:00 16:00	24	0	22	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	7	5	0	0	0	0	0	0	0	0	0	0	0	35.3	25.8	42.5	40.6
16:00 17:00	51	1	42	1	6	0	0	1	0	0	0	0	0	0	0	1	0	1	6	21	18	3	1	0	0	0	0	0	0	0	0	0	0	34.1	13.0	45.2	38.6
17:00 18:00	34	0	30	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	1	11	14	7	0	0	1	0	0	0	0	0	0	0	0	36.9	27.3	55.0	41.7
18:00 19:00	25	0	24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	9	10	2	0	0	0	0	0	0	0	0	1	0	0	36.9	27.9	85.7	39.5
19:00 20:00	18	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	5	6	0	0	0	0	0	0	0	0	0	0	0	36.5	26.9	43.5	41.6
20:00 21:00	9	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	1	1	1	0	0	0	0	0	0	0	0	0	38.7	31.8	54.5	-
21:00 22:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	31.5	25.3	37.2	-
22:00 23:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	43.7	41.3	45.5	-
23:00 00:00	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	40.4	36.1	44.8	-
07:00-19:00	445	4	379	8	44	0	5	2	2	1	0	0	0	0	0	2	2	11	48	145	159	66	6	3	1	0	1	0	0	0	1	0	0	35.4	10.2	85.7	40.4
06:00-22:00	488	4	420	8	45	0	6	2	2	1	0	0	0	0	0	2	3	11	50	156	177	75	7	4	1	0	1	0	0	0	1	0	0	35.5	10.2	85.7	40.7
06:00-00:00	494	4	425	8	46	0	6	2	2	1	0	0	0	0	0	2	3	11	50	156	178	79	8	4	1	0	1	0	0	0	1	0	0	35.6	10.2	85.7	40.8
00:00-00:00	508	4	432	8	53	0	6	2	2	1	0	0	0	0	0	2	3	11	52	158	183	84	8	4	1	0	1	0	0	0	1	0	0	35.6	10.2	85.7	41.0
Date: 16 October 2019																																					
00:00 01:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	45.8	45.8	45.8	-
01:00 02:00	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	30.0	24.5	35.4	-
02:00 03:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	33.6	33.6	33.6	-
03:00 04:00	3	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	31.7	27.3	38.7	-
04:00 05:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	42.6	42.6	42.6	-
05:00 06:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	41.2	31.5	43.9	-
06:00 07:00	17	0	14	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	5	1	0	0	0	0	0	0	0	0	0	0	39.0	32.0	47.7	43.0
07:00 08:00	57	0	51	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	4	13	21	12	5	1	1	0	0	0	0	0	0	0	0	38.4	25.3	57.4	44.8
08:00 09:00	75	0	71	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	19	29	22	3	1	0	0	0	0	0	0	0	0	0	38.3	27.6	50.0	43.1
09:00 10:00	29	1	25	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	16	3	1	0	0	0	0	0	0	0	0	0	0	36.0	28.0	45.5	39.8
10:00 11:00	28	0	22	0	5	0	1	0	0	0	0	0	0	0	0	0	0	1	3	12	8	3	1	0	0	0	0	0	0	0	0	0	0	34.6	24.7	46.4	41.4
11:00 12:00	28	0	26	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	10	10	3	1	0	0	0	0	0	0	0	0	0	0	35.2	27.0	46.3	39.8
12:00 13:00	27	0	22	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	11	4	1	0	0	0	0	0	0	0	0	0	0	35.7	26.0	45.0	41.6
13:00 14:00	22	0	21	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	9	2	0	0	0	0	0	0	0	0	0	0	0	35.1	26.2	42.9	39.7
14:00 15:00	17	0	15	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	10	1	0	0	0	0	0	0	0	0	0	0	0	36.2	31.6	41.5	38.9
15:00 16:00	27	0	24	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	11	12	4	0	0	0	0	0	0	0	0	0	0	0	36.6	33.0	44.5	41.8
16:00 17:00	37	0	33	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	8	13	13	2	1	0	0	0	0	0	0	0	0	0	0	34.3	25.8	46.0	38.7
17:00 18:00	39	0	33	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	4	23	8	4	0	0	0	0	0	0	0	0	0	0	0	34.4	29.0	42.1	39.3
18:00 19:00	32	0	31	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	12	9	7	1	1	0	0	0	0	0	0	0	0	0	36.5	27.2	50.7	41.1
19:00 20:00	11	2	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	6	0	0	0	0	0	0	0	0	0	0	0	0	33.7	23.3	39.2	37.6
20:00 21:00	15	0	13	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	4	4	1	0	0	0	0	0	0	0	0	0	0	37.6	27.1	48.7	43.8
21:00 22:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	2	0	0	1	0	0	0	0	0	0	0	0	39.0	19.4	59.4	-
22:00 23:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0	0	0	0	0	0	0	42.1	38.2	47.8	-
23:00 00:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	37.9	32.0	41.9	-
07:00-19:00	418	1	374	1	38	0	2	0	1	1	0	0	0	0	0	0	0	1	38	138	156	67	14	3	1	0	0	0	0	0	0	0	0	36.3	24.7	57.4	41.0
06:00-22:00	468	3	417	1	43	0	2	0	1	1	0	0	0	0	0	0	1	2	40	150	176	78	16	3	2	0	0	0	0	0	0	0	0	36.4	19.4	59.4	41.5
06:00-00:00	477	3	426	1	43	0	2	0	1	1	0	0	0	0	0	0	1	2	40	151	180	81	17	3	2	0	0	0	0	0	0	0	0	36.5	19.4	59.4	41.8
00:00-00:00	492	3	437	1	47	0	2	0	1	1	0	0	0	0	0	0	1	3	42	153	182	88	18	3	2	0	0	0	0	0	0	0	0	36.5	19.4	59.4	41.9
5 day (Weekday) Average																																					
07:00-19:00	405	2	354	5	39	1	2	0	1	1	0	0	0	0	0	1	2	7	44	145	143	54	8	1	0	0	0	0	0	0	0	0	0	35.2	15.8	63.1	40.3
06:00-22:00	450	3	396	5	41	1	3	0	1	1	0	0	0	0	0	1	2	7	49	157	159	61	10	2	1	0	0	0	0	0	0	0	0	35.3	14.8	65.0	40.4
06:00-00:00	456	3	402	5	41	1	3	0	1	1	0	0	0	0	0	1	2	7	50	158	162	63	10	2	1	0	0	0	0	0	0	0	0	35.3	14.8	65.0	40.5
00:00-00:00	471	3	411	5	47	1	3	0	1	1	0	0	0	0	0	1	2	8	52	161	167	67	10	2	1	0	0	0	0	0	0	0	0	35.3	14.8	65.0	40.6
7 day (Weekly) Average																																					
07:00-19:00	367	2	324	7	30	0	2	0	1	1	0	0	0	0	0	1	2	6	44	136	121	46	8	1	1	0	0	0	0	0	0	0	0	34.9	14.4	61.0	40.0
06:00-22:00	408	3	362	7	32	0	2	0	1	1	0	0	0	0	0	1	2	6	51	149	135	52	9	2	1	0	0	0	0	0	0	0	0	34.9	13.6	62.3	40.1
06:00-00:00	415	3	369	7	32	0	2	0	1	1	0	0	0	0	0	1	2	6	52	151	137	53	9	2	1	0	0	0	0	0	0	0	0	34.9	13.6	62.3	40.1
00:00-00:00	428	3	377	7	37	0	2	0	1	1	0	0	0	0	0	1	2	7	54	154	142	56	9	2	1	0	0	0	0	0	0	0	0	34.9	13.6	62.3	40.2

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 1: Unnamed Road, east of Duntrune House
Movement: Westbound

TIME		TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
			LIGHT			MEDIUM			HEAVY						0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
			1	2	3	4	5	6	7	8	9	10	11	12																								
Date: 10 October 2019																																						
00:00	01:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	47.9	47.9	47.9	-
01:00	02:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	41.0	41.0	41.0	-
02:00	03:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24.9	24.9	24.9	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00	06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
06:00	07:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	1	0	0	0	0	0	0	0	0	0	42.5	36.2	50.4	-
07:00	08:00	27	1	22	0	3	0	1	0	0	0	0	0	0	0	0	0	1	0	2	12	10	2	0	0	0	0	0	0	0	0	0	0	0	34.7	19.3	43.9	38.5
08:00	09:00	22	0	19	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	4	8	5	5	0	0	0	0	0	0	0	0	0	0	0	35.7	28.2	44.8	43.7
09:00	10:00	34	0	22	0	10	1	1	0	0	0	0	0	0	0	0	0	0	0	3	16	11	2	2	0	0	0	0	0	0	0	0	0	0	35.5	25.0	47.6	39.5
10:00	11:00	22	0	14	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	9	2	3	0	0	0	0	0	0	0	0	0	0	36.9	27.5	46.1	44.5
11:00	12:00	19	0	14	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	6	4	0	0	0	0	0	0	0	0	0	0	0	35.0	27.1	44.8	41.4
12:00	13:00	29	1	25	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	6	10	6	5	1	0	0	0	0	0	0	0	0	0	0	34.3	16.9	45.1	40.8
13:00	14:00	36	0	34	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	16	13	3	3	0	0	0	0	0	0	0	0	0	0	35.7	24.5	47.9	41.5
14:00	15:00	50	0	44	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	3	16	15	9	5	1	0	0	0	0	0	0	0	0	0	37.0	17.1	50.2	44.0
15:00	16:00	35	0	30	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	2	10	16	4	2	0	0	0	0	0	0	0	0	0	0	35.9	24.3	46.4	40.9
16:00	17:00	73	0	68	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	4	14	33	20	0	0	0	0	0	1	0	0	0	0	0	37.9	25.0	74.0	41.4
17:00	18:00	78	0	73	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	3	25	30	14	6	0	0	0	0	0	0	0	0	0	0	37.1	28.1	49.9	41.8
18:00	19:00	42	0	40	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	14	13	0	0	0	0	0	0	0	0	0	0	0	36.4	22.3	44.6	42.1
19:00	20:00	16	0	14	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1	3	3	6	2	0	0	0	0	0	0	0	0	0	0	0	33.0	19.6	43.4	39.9
20:00	21:00	11	0	11	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	4	2	0	1	0	0	0	0	0	0	0	0	0	0	31.6	11.3	48.1	40.6
21:00	22:00	11	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	3	1	1	0	0	0	0	0	0	0	0	0	0	35.6	26.5	49.1	42.4
22:00	23:00	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	33.3	28.0	37.9	-
23:00	00:00	6	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	32.2	27.2	36.1	-
07:00-19:00		467	2	405	0	55	1	4	0	0	0	0	0	0	0	0	0	3	4	37	148	168	83	22	1	0	0	0	1	0	0	0	0	0	36.4	16.9	74.0	41.5
06:00-22:00		512	2	448	0	57	1	4	0	0	0	0	0	0	0	0	1	4	5	44	160	182	87	26	2	0	0	0	1	0	0	0	0	0	36.2	11.3	74.0	41.5
06:00-00:00		521	2	455	1	58	1	4	0	0	0	0	0	0	0	0	1	4	5	47	163	185	87	26	2	0	0	0	1	0	0	0	0	0	36.2	11.3	74.0	41.5
00:00-00:00		524	2	458	1	58	1	4	0	0	0	0	0	0	0	0	1	4	6	47	163	185	88	27	2	0	0	0	1	0	0	0	0	0	36.2	11.3	74.0	41.5
Date: 11 October 2019																																						
00:00	01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
01:00	02:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	31.9	28.2	35.3	-
02:00	03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00	06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
06:00	07:00	10	0	9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2	5	1	0	0	0	0	0	0	0	0	0	0	40.6	31.5	49.1	-
07:00	08:00	19	0	15	0	3	1	0	0	0	0	0	0	0	0	0	0	1	0	4	4	7	2	1	0	0	0	0	0	0	0	0	0	0	34.2	17.6	47.7	40.0
08:00	09:00	21	0	18	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	10	2	2	0	0	0	0	0	0	0	0	0	0	36.8	29.8	46.7	44.3
09:00	10:00	33	0	29	1	2	1	0	0	0	0	0	0	0	0	0	0	0	4	4	12	8	4	1	0	0	0	0	0	0	0	0	0	0	33.6	22.2	46.1	40.3
10:00	11:00	19	0	13	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	1	6	10	0	2	0	0	0	0	0	0	0	0	0	0	36.2	29.6	48.8	38.7
11:00	12:00	22	0	19	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	4	7	6	3	0	1	0	0	0	0	0	0	0	0	0	34.4	21.0	51.1	41.6
12:00	13:00	28	0	26	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	9	11	4	2	0	0	0	0	0	0	0	0	0	0	36.3	24.3	47.7	41.0
13:00	14:00	40	1	35	1	1	0	2	0	0	0	0	0	0	0	0	0	1	1	3	8	19	8	0	0	0	0	0	0	0	0	0	0	0	36.0	19.4	44.8	41.6
14:00	15:00	32	0	26	1	4	0	0	0	0	1	0	0	0	0	0	0	0	0	1	18	11	0	2	0	0	0	0	0	0	0	0	0	0	35.0	29.7	49.4	38.7
15:00	16:00	62	0	53	1	8	0	0	0	0	0	0	0	0	0	0	0	0	1	3	18	21	17	2	0	0	0	0	0	0	0	0	0	0	36.9	24.6	47.0	42.6
16:00	17:00	68	0	63	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	18	22	17	7	0	0	0	0	0	0	0	0	0	0	37.8	26.8	49.2	44.0
17:00	18:00	70	0	65	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	13	36	14	2	1	0	0	0	0	0	0	0	0	0	37.7	25.3	54.9	43.5
18:00	19:00	43	0	39	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	18	9	7	0	1	0	0	0	0	0	0	0	0	39.4	27.9	59.0	46.2
19:00	20:00	26	0	20	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	7	6	5	0	0	0	1	0	0	0	0	0	0	39.9	28.4	66.6	47.2
20:00	21:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	31.3	24.6	38.1	-
21:00	22:00	9	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	3	1	1	0	0	0	0	0	0	0	0	0	0	34.8	17.5	45.6	-
22:00	23:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	37.3	19.8	52.9	-
23:00	00:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	1	0	0	0	0	0	0	0	0	0	41.6	33.7	50.4	-
07:00-19:00		457	1	401	10	39	2	2	0	0	2	0	0	0	0	0	0	2	8	32	125	179	80	28	2	1	0	0	0	0	0	0	0	0	36.6	17.6	59.0	42.1
06:00-22:00		507	1	444	11	44	2	2	0	0	3	0	0	0	0	0	0	3	9	36	135	193	92	35	2	1	0	1	0	0	0	0	0	0	36.8	17.5	66.6	42.5
06:00-00:00		517	1	454	11	44	2	2	0	0	3	0	0	0	0	0	0	4	9	36	137	193	97	35	4	1	0	1	0	0	0	0	0	0	36.8	17.5	66.6	42.5
00:00-00:00		520	1	457	11	44	2	2	0	0	3	0	0	0	0	0	0	4	9	37	138	194	97	35	4	1	0	1	0	0	0	0	0	0	36.8	17.5	66.6	42.5
Date: 12 October 2019																																						
00:00	01:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	32.9	25.4	40.3	-
01:00	02:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	39.4	37.7	41.2	-
02:00	03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00	06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
06:00	07:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	38.2	32.4	41.7	-
07:00	08:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	34.8	30.2	37.9	-
08:00	09:00	15	0	14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	3	3	1	0	0	0	0	0	0	0	0	0	0	36.4	26.9	46.9	43.3
09:00	10:00	19	0	15	0	3	0	0	0	0	0	1	0	0	0	0	0	0	1	4	5	7	2	0	0	0	0	0	0	0	0	0	0	0	33.8	24.1	45.0	38.4
10:00	11:00	32	0	28	0	2	0	0	0	0	0	2	0	0	0	0	0	0	1	4	14	8	5	0	0	0	0	0	0	0	0	0	0	0	34.2	24.5	43.1	40.6
11:00	12:00	30	1	27	0	2	0	0	0	0	0	0	0	0	0	0	3	1	0	0	13	9	4	0	0	0	0	0	0	0	0	0	0	0	32.8	13.0	44.3	39.9
12:00	13:00	44	1	39	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	3	10	15	10	3	0	1	0	0	0	0	0	0	0	0	37.2	23.0	58.6	43.7
13:00	14:00	27	0	25	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	12	3	3	0	0	0	0	0	0	0	0	0	0	37.6	29.1	47.8	44.3
14:00	15:00	38	3	33	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	12	15	5	1	0	2	0	0	0	0	0	0	0	0	36.0	11.8	57.2	41.6
15:00	16:00	34	0	30	2	1	0	0	0	0	0	0	0	1	0	0	0	1	0	3	9	11	4	3	3	0	0	0	0	0	0	0	0	0	37.6	19.9	52.7	48.4
16:00	17:00	35	0	34	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	15	8	4	0	0	0	0	0	0	0	0	0	0	38.3	27.0	48.1	42.8
17:00	18:00	18	0	15	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	4	2	0	0	0	0	0	0	0	0	0	0	38.5	29.5	48.4	44.4
18:00	19:00	30	0	29	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6	11	6	5	2	0	0	0	0	0	0	0	0	0	0	35.2	25.2	49.1	43.7
19:00	20:00	13	0	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	6	0	0	0	0	0	0	0	0	0	0	0	0	32.9	24.8	39.4	37.5
20:00	21:00	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	2	0	0	0	0	0	0	0	0	0	0	0	0	29.6	22.3	39.2	-
21:00	22:00	7	0	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	1	0	0	0	0	0	0	0	0	0	0	0	33.6	28.7	43.3	-
22:00	23:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	29.1	22.8	36.9	-
23:00	00:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	35.8	31.5	39.3	-
07:00-19:00		327	5	294	10	14	0	0	0	0	0	3	0	1	0	0	4	3	5	27	99	111	53	19	3	3	0	0	0	0	0	0	0	0	36.2	11.8	58.6	42.4
06:00-22:00		361	5	326	11	15	0	0	0	0	0	3	0	1	0	0	4	3	8	34	111	120	56	19	3	3	0	0	0	0	0	0	0	0	35.8	11.8	58.6	42.0
06:00-00:00		373	5	338	11	15	0	0	0	0	0	3	0	1	0	0	4	3	9	37	115	124	56	19	3	3	0	0	0	0	0	0	0	0	35.7	11.8	58.6	41.7
00:00-00:00		377	5	342	11	15	0	0	0	0	0	3	0	1	0	0	4	3	9	38	115	125	58	19	3	3	0	0	0	0	0	0	0	0	35.7	11.8	58.6	41.7
Date: 13 October 2019																																						
00:00	01:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	35.7	35.4	36.2	-
01:00	02:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	34.0	34.0	34.0	-
02:00	03:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	40.0	40.0	40.0	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00	06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
06:00	07:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	32.7	31.7	33.7	-
07:00	08:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	0	0	0	36.9	32.4	43.3	-
08:00	09:00	7	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2	0	0	0	0	0	0	0	0	0	0	0	37.5	31.5	41.0	-
09:00	10:00	13	0	11	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	4	5	1	1	0	0	0	0	0	0	0	0	0	0	35.7	25.3	47.7	40.3
10:00	11:00	15	0	12	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	5	4	0	0	0	0	0	0	0	0	0	0	0	36.8	29.8	43.4	43.0
11:00	12:00	33	1	31	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	6	8	12	5	0	0	0	0	0	0	0	0	0	0	0	34.7	22.2	43.2	40.1
12:00	13:00	22	0	21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	7	5	0	0	0	0	0	0	0	0	0	0	0	35.0	24.6	43.9	40.6
13:00	14:00	25	0	23	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	2	13	3	0	0	0	0	0	0	0	0	0	0	0	34.8	26.1	43.3	39.7
14:00	15:00	35	2	32	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	10	10	5	2	0	0	0	0	0	0	0	0	0	0	34.8	20.4	46.9	42.3
15:00	16:00	31	0	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	16	4	0	0	0	0	0	0	0	0	0	0	0	36.0	27.0	44.4	40.1

TIME	TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
		LIGHT			MEDIUM			HEAVY						0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
		1	2	3	4	5	6	7	8	9	10	11	12																								
Date: 13 October 2019																																					
16:00 17:00	20	0	19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	7	4	1	0	0	0	0	0	0	0	0	0	0	36.2	28.9	48.4	42.2
17:00 18:00	35	0	32	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	3	10	13	7	0	0	0	0	1	0	0	0	0	0	0	36.8	23.5	67.9	41.6
18:00 19:00	15	0	14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	3	2	1	1	0	0	0	0	0	0	0	0	0	35.8	26.4	52.5	44.3
19:00 20:00	13	0	12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	3	1	1	0	0	0	0	0	0	0	0	0	39.3	32.6	51.1	45.4
20:00 21:00	11	0	10	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	2	1	0	0	0	0	0	0	0	0	0	0	0	29.5	19.7	40.1	36.6
21:00 22:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	35.1	35.1	35.1	-
22:00 23:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	28.5	21.1	35.7	-
23:00 00:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	30.2	22.8	34.5	-
07:00-19:00	258	3	238	8	7	0	0	0	0	0	2	0	0	0	0	0	0	7	34	69	97	44	5	1	0	0	1	0	0	0	0	0	0	35.7	20.4	67.9	40.9
06:00-22:00	285	3	263	8	9	0	0	0	0	0	2	0	0	0	0	0	1	9	37	76	105	48	6	2	0	0	1	0	0	0	0	0	0	35.6	19.7	67.9	40.9
06:00-00:00	292	3	270	8	9	0	0	0	0	0	2	0	0	0	0	0	1	11	38	79	106	48	6	2	0	0	1	0	0	0	0	0	0	35.4	19.7	67.9	40.8
00:00-00:00	297	3	275	8	9	0	0	0	0	0	2	0	0	0	0	0	1	11	38	80	110	48	6	2	0	0	1	0	0	0	0	0	0	35.4	19.7	67.9	40.8
Date: 14 October 2019																																					
00:00 01:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	31.4	31.4	31.4	-
01:00 02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
02:00 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00 04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00 05:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	39.2	39.2	39.2	-
05:00 06:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	33.2	33.2	33.2	-
06:00 07:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	30.9	15.4	38.9	-
07:00 08:00	21	0	16	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	1	11	4	2	2	0	0	0	0	0	0	0	0	0	0	34.7	23.4	45.7	42.6
08:00 09:00	21	0	18	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	11	3	1	0	0	0	0	0	0	0	0	0	0	37.4	31.9	45.4	41.3
09:00 10:00	23	0	17	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9	9	1	0	0	0	0	0	0	0	0	0	0	0	34.6	27.5	41.9	39.0
10:00 11:00	19	0	17	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	8	6	1	0	0	0	0	0	0	0	0	0	0	0	33.4	26.1	40.3	38.3
11:00 12:00	25	0	20	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	1	12	5	5	2	0	0	0	0	0	0	0	0	0	0	36.4	26.1	49.7	42.1
12:00 13:00	27	0	24	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	5	4	8	8	1	0	0	0	0	0	0	0	0	0	0	35.8	22.3	45.3	41.9
13:00 14:00	28	0	26	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	13	4	0	1	0	0	0	0	0	0	0	0	0	36.8	28.9	50.3	41.4
14:00 15:00	27	0	24	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	3	6	10	7	1	0	0	0	0	0	0	0	0	0	0	36.9	25.5	49.2	42.3
15:00 16:00	34	0	27	1	6	0	0	0	0	0	0	0	0	0	0	0	0	1	2	12	8	10	1	0	0	0	0	0	0	0	0	0	0	36.4	20.3	47.6	43.0
16:00 17:00	74	0	70	1	3	0	0	0	0	0	0	0	0	0	0	0	1	0	2	20	31	17	3	0	0	0	0	0	0	0	0	0	0	37.3	16.4	48.5	42.5
17:00 18:00	94	2	79	0	12	0	0	0	0	1	0	0	0	0	0	0	2	2	11	19	30	21	8	1	0	0	0	0	0	0	0	0	0	36.7	19.6	54.1	43.0
18:00 19:00	32	0	31	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	8	9	7	5	0	0	0	0	0	0	0	0	0	0	37.6	22.9	48.1	45.8
19:00 20:00	19	0	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	8	2	2	0	0	0	0	0	0	0	0	0	0	36.3	29.0	47.8	43.3
20:00 21:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	3	0	0	0	0	0	0	0	0	0	0	0	36.9	27.4	43.7	41.7
21:00 22:00	9	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0	31.5	20.3	37.2	-
22:00 23:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	37.0	28.9	43.7	-
23:00 00:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	35.4	32.6	39.2	-
07:00-19:00	425	2	369	4	47	0	1	0	0	2	0	0	0	0	0	0	3	7	35	124	144	86	24	2	0	0	0	0	0	0	0	0	0	36.5	16.4	54.1	42.2
06:00-22:00	469	2	411	4	49	0	1	0	0	2	0	0	0	0	0	0	4	9	42	133	162	91	26	2	0	0	0	0	0	0	0	0	0	36.3	15.4	54.1	42.1
06:00-00:00	476	2	418	4	49	0	1	0	0	2	0	0	0	0	0	0	4	9	43	135	165	92	26	2	0	0	0	0	0	0	0	0	0	36.3	15.4	54.1	42.1
00:00-00:00	479	2	420	4	50	0	1	0	0	2	0	0	0	0	0	0	4	9	43	137	166	92	26	2	0	0	0	0	0	0	0	0	0	36.3	15.4	54.1	42.1
Date: 15 October 2019																																					
00:00 01:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	39.7	38.0	41.3	-
01:00 02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
02:00 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00 04:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	34.1	34.1	34.1	-
04:00 05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00 06:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27.0	27.0	27.0	-
06:00 07:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	38.3	34.7	40.6	-
07:00 08:00	19	0	15	1	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	7	2	1	0	0	0	0	0	0	0	0	0	0	35.9	19.5	46.0	40.8
08:00 09:00	22	0	18	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	7	11	1	1	0	0	0	0	0	0	0	0	0	0	35.2	22.4	45.7	39.7
09:00 10:00	30	0	20	0	9	0	0	0	0	1	0	0	0	0	0	0	1	0	3	11	8	6	1	0	0	0	0	0	0	0	0	0	0	35.2	18.4	45.1	42.5
10:00 11:00	27	0	20	2	5	0	0	0	0	0	0	0	0	0	0	0	0	2	2	7	11	4	1	0	0	0	0	0	0	0	0	0	0	35.6	21.2	49.3	41.9
11:00 12:00	28	0	23	1	4	0	0	0	0	0	0	0	0	0	0	0	0	2	2	11	6	5	1	1	0	0	0	0	0	0	0	0	0	35.6	20.5	50.7	43.0
12:00 13:00	29	0	25	1	3	0	0	0	0	0	0	0	0	0	0	0	0	3	2	8	10	4	2	0	0	0	0	0	0	0	0	0	0	35.5	20.8	45.7	43.3
13:00 14:00	31	0	23	1	5	0	1	0	0	1	0	0	0	0	0	0	0	1	3	9	14	3	1	0	0	0	0	0	0	0	0	0	0	35.1	23.7	45.0	39.1
14:00 15:00	34	0	28	1	4	1	0	0	0	0	0	0	0	0	0	0	0	1	3	10	15	4	1	0	0	0	0	0	0	0	0	0	0	35.8	20.8	48.5	39.9
15:00 16:00	37	0	29	1	6	0	0	0	1	0	0	0	0	0	0	0	1	0	2	6	12	11	5	0	0	0	0	0	0	0	0	0	0	38.2	18.1	49.9	44.5
16:00 17:00	86	0	80	1	5	0	0	0	0	0	0	0	0	0	0	4	0	4	7	19	29	21	2	0	0	0	0	0	0	0	0	0	0	35.0	10.5	45.5	42.6
17:00 18:00	95	1	89	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	1	13	49	22	8	1	0	0	0	0	0	0	0	0	0	38.9	18.2	52.5	43.8
18:00 19:00	42	0	39	0	2	0	0	0	1	0	0	0	0	0	0	0	0	1	2	5	18	13	2	0	1	0	0	0	0	0	0	0	0	38.2	24.6	57.9	42.9
19:00 20:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4	4	0	0	0	0	0	0	0	0	0	0	0	37.7	27.9	44.0	43.6
20:00 21:00	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	1	2	0	0	0	0	0	0	0	0	0	0	35.6	21.0	48.5	-
21:00 22:00	12	0	9	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	1	0	0	0	0	0	0	0	0	0	0	39.4	35.4	45.6	44.8
22:00 23:00	4	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	36.3	27.9	42.8	-
23:00 00:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	41.8	37.6	48.8	-
07:00-19:00	480	1	409	10	54	1	1	0	2	2	0	0	0	0	0	4	4	16	27	114	190	96	26	2	1	0	0	0	0	0	0	0	0	36.5	10.5	57.9	42.6
06:00-22:00	516	1	442	10	57	1	1	0	2	2	0	0	0	0	0	4	4	17	29	120	203	107	29	2	1	0	0	0	0	0	0	0	0	36.6	10.5	57.9	42.6
06:00-00:00	525	1	450	10	58	1	1	0	2	2	0	0	0	0	0	4	4	17	30	120	207	110	30	2	1	0	0	0	0	0	0	0	0	36.7	10.5	57.9	42.7
00:00-00:00	529	1	453	10	59	1	1	0	2	2	0	0	0	0	0	4	4	17	31	121	208	111	30	2	1	0	0	0	0	0	0	0	0	36.6	10.5	57.9	42.7
Date: 16 October 2019																																					
00:00 01:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	33.4	33.4	33.4	-
01:00 02:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	42.5	37.4	47.7	-
02:00 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00 04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00 05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00 06:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	43.1	43.1	43.1	-
06:00 07:00	5	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	38.7	33.6	41.8	-
07:00 08:00	26	0	23	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	11	8	1	0	0	0	0	0	0	0	0	0	0	37.4	16.4	47.2	42.8
08:00 09:00	27	0	24	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	8	13	4	1	0	0	0	0	0	0	0	0	0	0	36.6	26.9	46.5	40.8
09:00 10:00	39	0	35	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	15	4	1	0	0	0	0	0	0	0	0	0	0	34.7	24.7	45.1	39.8
10:00 11:00	24	0	18	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	8	2	2	0	0	0	0	0	0	0	0	0	0	35.7	28.7	46.0	41.6
11:00 12:00	29	0	23	0	6	0	0	0	0	0	0	0	0	0	0	0	0	1	3	9	10	4	2	0	0	0	0	0	0	0	0	0	0	36.1	23.2	48.0	40.7
12:00 13:00	15	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	5	5	1	0	0	0	0	0	0	0	0	0	0	37.9	28.7	45.1	43.2
13:00 14:00	28	0	24	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	11	7	2	0	0	0	0	0	0	0	0	0	0	37.6	28.5	46.9	43.5
14:00 15:00	26	0	22	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	2	13	7	4	0	0	0	0	0	0	0	0	0	0	0	34.9	27.6	42.7	40.0
15:00 16:00	35	1	29	0	5	0	0	0	0	0	0	0	0	0	0	1	0	0	1	12	13	3	5	0	0	0	0	0	0	0	0	0	0	36.6	14.4	45.5	44.3
16:00 17:00	70	0	65	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	5	7	29	21	7	0	0	0	0	0	0	0	0	0	0	38.8	22.7	49.2	43.6
17:00 18:00	92	1	86	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	43	22	7	1	0	0	0	0	0	0	0	0	0	38.6	28.1	52.7	43.3
18:00 19:00	42	1	37	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	1	8	16	13	3	0	0	0	0	0	0	0	0	0	0	37.9	19.8	47.9	43.1
19:00 20:00	19	2	16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	6	3	0	0	0	0	0	0	0	0	0	0	0	34.9	25.7	44.5	41.5
20:00 21:00	9	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	4	0	0	0	0	0	0	0	0	0	0	0	36.4	28.5	42.0	-
21:00 22:00	9	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	1	1	1	0	0	0	0	0	0	0	0	0	39.0	29.0	51.7	-
22:00 23:00	10	0	8	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	0	1	0	0	0	0	0	0	0	0	0	37.1	20.2	52.5	-
23:00 00:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	36.5	34.9	38.0	-
07:00-19:00	453	3	401	3	44	1	0	0	1	0	0	0	0	0	0	1	2	4	28	107	181	97	32	1	0	0	0	0	0	0	0	0	0	37.3	14.4	52.7	42.1
06:00-22:00	495	5	437	3	48	1	0	0	1	0	0	0	0	0	0	1	2	4	32	121	192	108	33	2	0	0	0	0	0	0	0	0	0	37.2	14.4	52.7	42.1
06:00-00:00	507	5	447	3	50	1	0	0	1	0	0	0	0	0	0	1	2	5	33	124	195	111	33	3	0	0	0	0	0	0	0	0	0	37.2	14.4	52.7	42.1
00:00-00:00	511	5	451	3	50	1	0	0	1	0	0	0	0	0	0	1	2	5	33	125	196	112	34	3	0	0	0	0	0	0	0	0	0	37.2	14.4	52.7	42.1
5 day (Weekday) Average																																					
07:00-19:00	456	2	397	5	48	1	2	0	1	1	0	0	0	0	0	1	3	8	32	124	172	88	26	2	0	0	0	0	0	0	0	0	0	36.7	15.2	59.5	42.1
06:00-22:00	500	2	436	6	51	1	2	0	1	1	0	0	0	0	0	1	3	9	37	134	186	97	30	2	0	0	0	0	0	0	0	0	0	36.6	13.8	61.1	42.2
06:00-00:00	509	2	445	6	52	1	2	0	1	1	0	0	0	0	0	1	4	9	38	136	189	99	30	3	0	0	0	0	0	0	0	0	0	36.6	13.8	61.1	42.2
00:00-00:00	513	2	448	6	52	1	2	0	1	1	0	0	0	0	0	1	4	9	38	137	190	100	30	3	0	0	0	0	0	0	0	0	0	36.6	13.8	61.1	42.2
7 day (Weekly) Average																																					
07:00-19:00	410	2	360	6	37	1	1	0	0	1	1	0	0	0	0	1	2	7	31	112	153	77	22	2	1	0	0	0	0	0	0	0	0	36.5	15.4	60.6	42.0
06:00-22:00	449	3	396	7	40	1	1	0	0	1	1	0	0	0	0	1	3	9	36	122	165	84	25	2	1	0	0	0	0	0	0	0	0	36.4	14.4	61.7	42.0
06:00-00:00	459	3	405	7	40	1	1	0	0	1	1	0	0	0	0	1	3	9	38	125	168	86	25	3	1	0	0	0	0	0	0	0	0	36.3	14.4	61.7	41.9
00:00-00:00	462	3	408	7	41	1	1	0	0	1	1	0	0	0	0	1	3	9	38	126	169	87	25	3	1	0	0	0	0	0	0	0	0	36.3	14.4	61.7	41.9

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 2: Kellas Road - Approx. 30m south of Unnamed Road
Movement: Northbound

TIME		TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
			LIGHT			MEDIUM			HEAVY						0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
			1	2	3	4	5	6	7	8	9	10	11	12																								
Date:	10 October 2019																																					
00:00	01:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	1	3	0	2	0	0	0	0	0	0	0	47.1	26.7	62.5	60.8
01:00	02:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	1	0	0	0	0	0	0	0	0	44.4	38.9	55.1	-
02:00	03:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	37.2	33.4	41.1	-
03:00	04:00	6	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	28.6	25.9	37.7	-
04:00	05:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	32.4	24.3	41.1	-
05:00	06:00	8	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	1	1	1	0	0	0	0	0	0	0	0	0	35.3	21.7	51.9	-
06:00	07:00	30	0	24	0	5	1	0	0	0	0	0	0	0	0	0	0	0	1	6	4	6	3	5	3	0	1	1	0	0	0	0	0	0	40.0	25.0	67.2	50.5
07:00	08:00	51	0	42	0	8	0	1	0	0	0	0	0	0	0	0	0	1	1	9	8	5	10	9	4	4	0	0	0	0	0	0	0	0	39.9	18.6	57.8	51.6
08:00	09:00	75	0	69	0	4	2	0	0	0	0	0	0	0	0	0	0	1	5	20	8	14	16	6	3	1	1	0	0	0	0	0	0	0	36.1	18.5	64.2	45.1
09:00	10:00	75	0	66	1	7	0	0	0	1	0	0	0	0	0	0	0	0	13	8	8	14	21	8	3	0	0	0	0	0	0	0	0	0	36.5	20.4	52.2	45.0
10:00	11:00	59	0	51	0	8	0	0	0	0	0	0	0	0	0	0	0	0	3	8	5	19	13	8	1	2	0	0	0	0	0	0	0	0	38.7	23.1	58.1	46.0
11:00	12:00	111	0	106	0	4	0	0	0	1	0	0	0	0	0	0	0	1	6	16	7	29	29	18	5	0	0	0	0	0	0	0	0	0	38.4	19.4	54.4	46.3
12:00	13:00	110	0	95	3	8	1	0	0	1	1	1	0	0	0	0	0	1	8	14	18	19	31	13	4	1	0	0	1	0	0	0	0	0	37.7	15.8	73.7	46.6
13:00	14:00	101	0	87	0	13	1	0	0	0	0	0	0	0	0	0	0	0	6	6	10	22	33	18	6	0	0	0	0	0	0	0	0	0	39.7	21.7	54.4	46.9
14:00	15:00	108	2	97	0	8	0	0	0	1	0	0	0	0	0	0	0	0	3	6	14	31	28	15	8	2	1	0	0	0	0	0	0	0	40.2	22.1	60.3	47.4
15:00	16:00	135	2	116	1	12	2	1	0	1	0	0	0	0	0	0	1	2	12	9	12	29	34	21	11	3	1	0	0	0	0	0	0	0	39.2	11.3	63.4	47.9
16:00	17:00	190	1	179	1	9	0	0	0	0	0	0	0	0	0	0	0	1	12	12	29	60	51	20	5	0	0	0	0	0	0	0	0	0	37.8	19.2	51.2	44.6
17:00	18:00	181	0	169	2	9	0	1	0	0	0	0	0	0	0	0	0	2	5	14	11	64	53	23	8	1	0	0	0	0	0	0	0	0	39.1	17.2	58.7	45.6
18:00	19:00	133	0	124	0	8	0	0	0	1	0	0	0	0	0	0	0	1	3	13	14	47	30	17	7	1	0	0	0	0	0	0	0	0	38.9	19.7	56.0	46.1
19:00	20:00	88	0	84	0	4	0	0	0	0	0	0	0	0	0	0	0	3	3	6	5	25	26	18	1	1	0	0	0	0	0	0	0	0	39.2	15.9	60.0	46.0
20:00	21:00	52	0	51	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5	5	23	11	4	2	0	0	1	0	0	0	0	0	0	38.7	23.4	67.6	43.8
21:00	22:00	50	0	49	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	4	3	16	16	7	2	0	0	0	0	0	0	0	0	0	39.4	19.7	52.7	45.9
22:00	23:00	29	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	5	7	6	6	0	0	1	0	0	0	0	0	0	43.3	23.6	65.0	51.1
23:00	00:00	13	0	12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	4	1	0	0	0	0	0	0	0	0	0	41.6	29.7	51.4	48.6
07:00-19:00		1329	5	1201	8	98	6	3	0	6	1	1	0	0	0	0	1	10	77	135	144	353	349	176	65	15	3	0	1	0	0	0	0	0	38.6	11.3	73.7	46.3
06:00-22:00		1549	5	1409	8	108	7	4	0	6	1	1	0	0	0	0	1	14	83	156	161	423	405	210	73	16	4	2	1	0	0	0	0	0	38.7	11.3	73.7	46.3
06:00-00:00		1591	5	1450	8	109	7	4	0	6	1	1	0	0	0	0	1	14	84	158	165	430	415	220	80	16	4	3	1	0	0	0	0	0	38.8	11.3	73.7	46.5
00:00-00:00		1627	5	1481	8	114	7	4	0	6	1	1	0	0	0	0	1	14	86	167	167	435	423	223	84	17	6	3	1	0	0	0	0	0	38.8	11.3	73.7	46.5
Date:	11 October 2019																																					
00:00	01:00	9	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	1	1	0	0	0	0	0	0	0	0	45.2	34.7	58.0	-
01:00	02:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	35.4	22.4	48.3	-
02:00	03:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	44.4	32.6	60.8	-
03:00	04:00	9	0	5	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	28.3	23.8	40.6	-
04:00	05:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	28.7	24.7	35.4	-
05:00	06:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	1	0	0	0	0	0	0	0	0	0	0	0	31.9	24.6	42.3	-
06:00	07:00	20	0	18	0	1	0	1	0	0	0	0	0	0	0	0	0	0	3	5	1	2	1	4	2	2	0	0	0	0	0	0	0	0	38.1	23.2	59.6	52.2
07:00	08:00	59	0	47	1	6	2	1	0	1	0	1	0	0	0	0	0	0	1	8	4	13	21	10	0	2	0	0	0	0	0	0	0	0	39.7	23.7	58.1	46.2
08:00	09:00	86	0	77	0	5	2	0	1	0	1	0	0	0	0	0	0	2	12	10	6	11	20	16	6	3	0	0	0	0	0	0	0	0	38.4	18.3	58.6	48.7
09:00	10:00	61	0	49	3	9	0	0	0	0	0	0	0	0	0	0	0	0	5	9	6	10	12	14	2	3	0	0	0	0	0	0	0	0	39.1	21.1	57.4	48.7
10:00	11:00	94	1	81	2	9	0	0	0	1	0	0	0	0	0	0	1	0	2	11	6	14	35	13	10	2	0	0	0	0	0	0	0	0	40.6	11.8	57.9	48.1
11:00	12:00	84	0	80	0	3	0	0	0	0	0	1	0	0	0	0	0	0	5	6	3	21	30	15	1	2	1	0	0	0	0	0	0	0	40.3	22.8	62.0	46.8
12:00	13:00	112	1	98	0	12	0	0	0	1	0	0	0	0	0	0	0	0	3	13	10	25	38	18	4	1	0	0	0	0	0	0	0	0	39.7	23.4	58.5	46.2
13:00	14:00	131	0	113	2	13	0	1	0	1	0	1	0	0	0	0	0	0	7	9	11	36	39	21	6	2	0	0	0	0	0	0	0	0	39.8	20.5	56.8	47.0
14:00	15:00	130	4	118	1	6	1	0	0	0	0	0	0	0	0	0	0	0	3	8	8	37	42	22	8	2	0	0	0	0	0	0	0	0	40.7	21.8	56.2	47.1
15:00	16:00	171	1	159	1	8	1	1	0	0	0	0	0	0	0	0	0	0	3	19	23	39	42	35	9	1	0	0	0	0	0	0	0	0	39.7	20.0	55.3	46.9
16:00	17:00	153	1	142	0	8	1	0	0	0	0	1	0	0	0	0	0	0	9	13	5	38	41	37	9	1	0	0	0	0	0	0	0	0	40.4	20.2	58.7	47.1
17:00	18:00	186	0	182	0	3	0	1	0	0	0	0	0	0	0	0	0	0	11	16	12	34	54	40	18	0	0	1	0	0	0	0	0	0	40.7	21.8	65.2	48.7
18:00	19:00	115	0	110	0	5	0	0	0	0	0	0	0	0	0	0	0	0	5	3	10	26	29	33	3	4	2	0	0	0	0	0	0	0	42.1	21.8	63.3	48.5
19:00	20:00	87	1	79	0	6	0	0	1	0	0	0	0	0	0	0	0	1	4	7	16	21	15	15	5	2	0	1	0	0	0	0	0	0	39.1	18.0	65.9	47.8
20:00	21:00	50	0	49	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	10	20	6	4	3	0	0	0	0	0	0	0	0	41.7	21.0	58.7	50.2
21:00	22:00	62	1	60	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	20	17	11	7	0	0	0	0	0	0	0	0	0	41.0	20.3	52.8	49.3
22:00	23:00	29	1	27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	6	10	6	2	1	0	0	0	0	0	0	0	0	42.1	22.3	59.1	48.0
23:00	00:00	16	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	5	3	3	0	1	0	0	0	0	0	0	0	43.1	21.0	61.7	52.8
07:00-19:00		1382	8	1256	10	87	7	4	1	4	1	4	0	0	0	0	1	2	66	125	104	304	403	274	76	23	3	1	0	0	0	0	0	0	40.2	11.8	65.2	47.5
06:00-22:00		1601	10	1462	10	96	7	5	2	4	1	4	0	0	0	0	1	3	79	142	124	357	456	310	94	30	3	2	0	0	0	0	0	0	40.2	11.8	65.9	47.6
06:00-00:00		1646	11	1505	10	97	7	5	2	4	1	4	0	0	0	0	1	3	81	144	126	365	471	319	99	31	4	2	0	0	0	0	0	0	40.3	11.8	65.9	47.6
00:00-00:00		1680	11	1534	10	102	7	5	2	4	1	4	0	0	0	0	1	3	88	150	133	368	474	324	100	32	5	2	0	0	0	0	0	0	40.2	11.8	65.9	47.8
Date:	12 October 2019																																					
00:00	01:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	3	1	0	1	0	0	0	0	0	0	0	44.0	25.3	63.5	53.6
01:00	02:00	12	0	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	3	0	1	0	0	0	0	0	0	0	0	42.4	28.9	55.6	50.1
02:00	03:00	13	0	12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	1	2	2	3	0	0	0	0	0	0	0	0	0	40.3	24.7	54.0	51.7
03:00	04:00	8	0	3	0	5	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	1	2	0	0	0	0	0	0	0	0	0	0	33.0	23.9	48.6	-
04:00	05:00	5	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1	1	0	0	0	0	0	0	0	0	0	38.6	27.3	52.0	-
05:00	06:00	7	0	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	1	0	0	0	0	0	0	0	0	0	37.8	25.5	52.8	-
06:00	07:00	10	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	4	1	0	0	0	0	0	0	0	0	0	43.4	33.1	51.9	-
07:00	08:00	30	0	25	0	5	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	5	9	6	3	0	0	0	0	0	0	0	0	0	39.8	18.9	52.5	47.2
08:00	09:00	54	2	45	1	5	0	0	0	0	1	0	0	0	0	0	1	1	0	3	9	0	13	15	7	5	0	0	0	0	0	0	0	0	37.7	8.5	52.9	47.5
09:00	10:00	79	5	65	0	8	0	1	0	0	0	0	0	0	0	0	0	2	8	6	8	15	28	6	3	2	1	0	0	0	0	0	0	0	38.2	17.6	60.7	45.9
10:00	11:00	97	1	86	2	7	0	0	1	0	0	0	0	0	0	0	1	1	6	11	7	20	24	18	8	1	0	0	0	0	0	0	0	0	39.1	12.3	57.6	47.6
11:00	12:00	112	1	107	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	14	11	23	29	21	11	1	0	0	0	0	0	0	0	0	40.5	22.4	55.1	48.3
12:00	13:00	134	4	120	0	10	0	0	0	0	0	0	0	0	0	0	0	2	1	11	10	25	48	21	12	2	1	1	0	0	0	0	0	0	41.3	17.7	68.9	49.3
13:00	14:00	142	2	130	0	9	1	0	0	0	0	0	0	0	0	0	0	1	9	8	11	28	36	32	10	5	2	0	0	0	0	0	0	0	40.8	18.5	62.9	48.3
14:00	15:00	131	3	123	3	2	0	0	0	0	0	0	0	0	0	0	0	0	4	15	8	23	43	25	8	1	3	1	0	0	0	0	0	0	41.0	20.9	66.6	48.9
15:00	16:00	119	1	116	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	17	35	32	7	4	4	0	0	1	0	0	0	0	43.0	21.5	78.9	49.7
16:00	17:00	140	2	133	0	5	0	0	0	0	0	0	0	0	0	0	0	0	3	12	16	26	50	22	7	2	2	0	0	0	0	0	0	0	40.6	23.3	63.0	47.4
17:00	18:00	104	0	103	0	1	0	0	0	0	0	0	0	0	0	0	0	1	6	6	1	20	38	25	4	2	1	0	0	0	0	0	0	0	41.3	18.9	60.5	47.5
18:00	19:00	98	0	94	0	3	0	1	0	0	0	0	0	0	0	0	0	0	2	8	3	22	32	22	7	2	0	0	0	0	0	0	0	0	41.4	23.9	57.3	48.6
19:00	20:00	78	0	75	0	2	0	0	0	1	0	0	0	0	0	0	0	0	5	4	9	18	20	13	5	4	0	0	0	0	0	0	0	0	40.1	21.4	58.5	48.7
20:00	21:00	46	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	2	15	12	7	2	1	1	0	0	0	0	0	0	0	40.3	21.4	62.8	47.5
21:00	22:00	46	0	43	1	2	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2	9	14	10	6	0	1	0	0	0	0	0	0	0	42.1	23.4	61.2	50.1
22:00	23:00	32	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	1	9	7	6	1	1	0	0	0	0	0	0	0	0	38.3	21.8	57.1	46.3
23:00	00:00	29	1	25	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	6	8	7	3	0	0	0	0	0	0	0	0	0	41.7	22.4	53.6	49.0
07:00-19:00		1240	21	1147	7	60	1	2	1	0	1	0	0	0	0	1	2	8	50	109	85	237	387	237	85	22	14	2	0	1	0	0	0	0	40.7	8.5	78.9	48.2
06:00-22:00		1420	21	1320	8	65	1	2	1	1	1	0	0	0	0	1	2	8	62	116	100	280	435	271	99	27	16	2	0	1	0	0	0	0	40.7	8.5	78.9	48.3
06:00-00:00		1481	22	1377	9	67	1	2	1	1	1	0	0	0	0	1	2	8	67	120	104	295	450	284	103	28	16	2	0	1	0	0	0	0	40.7	8.5	78.9	48.3
00:00-00:00		1538	22	1425	10	74	1	3	1	1	1	0	0	0	0	1	2	8	71	129	108	304	462	295	109	29	17	2	0	1	0	0	0	0	40.6	8.5	78.9	48.4
Date:	13 October 2019																																					
00:00	01:00	30	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	5	15	7	1	0	0	0	0	0	0	0	0	0	41.7	25.0	52.1	48.1
01:00	02:00	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	3	4	3	1	0	0	0	0	0	0	0	0	43.4	30.7	56.4	51.2
02:00	03:00	9	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	3	1	0	0	0	0	0	0	0	0	0	41.9	29.3	50.6	-
03:00	04:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	42.0	38.4	46.6	-
04:00	05:00	5	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	1	0	0	0	0	0	0	52.0	41.5	65.2	-
05:00	06:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	1	0	0	0	0	0	0	0	0	0	41.5	32.7	50.5	-
06:00	07:00	10	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	6	1	0	0	0	0	0	0	0	0	0	0	41.5	33.7	47.3	-
07:00	08:00	19	1	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	2	4	3	1	2	0	0	0	0	0	0	0	0	40.3	27.5	57.0	52.1
08:00	09:00	32	0	29	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3	7	8	5	1	0	2	0	0	0	0	0	0	0	39.7	21.3	64.4	49.0
09:00	10:00	39	1	37	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	4	2	5	12	11	2	0	1	0	0	0	0	0	0	0	41.0	16.0	64.3	48.0
10:00	11:00	53	0	49	0	4	0	0	0	0	0	0	0	0	0	0	0	0	3	6	0	6	20	14	4	0	0	0	0	0	0	0	0	0	40.7	20.0	52.1	47.2
11:00	12:00	82	0	80	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	8	3	10	26	20	6	3	1	1	0	0	0	0	0	0	42.3	20.7	68.5	48.6
12:00	13:00	96	3	88	0	4	0	0	1	0	0	0	0	0	0	0	0	1	5	13	10	21	19	20	3	3	1	0	0	0	0	0	0	0	39.2	18.9	60.7	48.9
13:00	14:00	110	0	107	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	10	8	18	35	28	6	3	0	0	0	0	0	0	0	0	41.4	22.6	59.8	48.3
14:00	15:00	129	0	125	0	4	0	0	0	0	0	0	0	0	0	0	0	1	2	6	10	18	52	28	7	3	0	1	0	1	0	0	0	0	42.2	15.3	75.6	47.6
15:00	16:00	112	1	108	1	2	0	0	0	0	0	0	0	0	0	0	0	0	7	5	6	16	38	18	16	4	2	0	0	0	0	0	0	0	42.5	21.3	64.3	51.4

TIME		TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
			LIGHT			MEDIUM			HEAVY						0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
			1	2	3	4	5	6	7	8	9	10	11	12																								
Date: 13 October 2019																																						
16:00	17:00	123	0	119	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	12	12	14	33	32	13	4	1	0	0	0	0	0	0	0	42.3	24.8	61.0	50.4
17:00	18:00	100	0	95	1	4	0	0	0	0	0	0	0	0	0	0	0	0	4	9	3	14	37	13	15	5	0	0	0	0	0	0	0	0	42.3	21.0	59.3	50.9
18:00	19:00	78	0	73	0	5	0	0	0	0	0	0	0	0	0	0	0	1	5	11	9	11	20	15	4	2	0	0	0	0	0	0	0	0	39.1	19.8	57.9	48.0
19:00	20:00	56	0	54	0	1	0	1	0	0	0	0	0	0	0	0	0	0	3	4	3	14	23	5	3	1	0	0	0	0	0	0	0	0	40.2	21.9	57.7	48.1
20:00	21:00	51	0	49	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	17	9	5	1	0	0	0	0	0	0	0	0	0	36.3	20.4	50.6	42.9
21:00	22:00	40	0	38	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	4	4	13	7	6	4	0	0	0	0	0	0	0	0	0	39.0	20.0	53.7	48.4
22:00	23:00	17	0	15	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	3	0	4	1	1	0	0	0	0	0	0	0	0	37.9	24.8	56.3	48.9
23:00	00:00	9	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	1	0	2	0	0	0	0	0	0	0	0	43.7	33.9	58.0	-
07:00-19:00		973	6	928	4	34	0	0	1	0	0	0	0	0	0	0	0	4	39	89	70	142	304	207	78	29	8	2	0	1	0	0	0	0	41.4	15.3	75.6	49.0
06:00-22:00		1130	6	1078	5	39	0	1	1	0	0	0	0	0	0	0	0	5	47	104	86	188	349	224	86	30	8	2	0	1	0	0	0	0	41.0	15.3	75.6	48.7
06:00-00:00		1156	6	1102	6	40	0	1	1	0	0	0	0	0	0	0	0	5	48	106	92	194	351	229	87	33	8	2	0	1	0	0	0	0	41.0	15.3	75.6	48.7
00:00-00:00		1226	6	1170	6	41	0	2	1	0	0	0	0	0	0	0	0	5	49	108	94	210	374	246	93	34	9	3	0	1	0	0	0	0	41.1	15.3	75.6	48.7
Date: 14 October 2019																																						
00:00	01:00	8	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	2	1	0	0	0	0	0	0	0	0	0	42.6	29.3	52.7	-
01:00	02:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	46.7	38.7	55.6	-
02:00	03:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26.5	26.5	26.5	-
03:00	04:00	6	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	25.9	19.5	45.4	-
04:00	05:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	41.8	38.6	45.1	-
05:00	06:00	9	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0	2	0	0	0	0	0	0	0	0	0	0	34.6	26.0	48.0	-
06:00	07:00	27	0	25	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	10	5	2	3	4	0	0	1	0	0	0	0	0	0	0	35.2	24.5	61.3	47.1
07:00	08:00	69	0	64	0	4	1	0	0	0	0	0	0	0	0	0	0	1	8	8	7	12	13	12	6	2	0	0	0	0	0	0	0	0	38.4	19.3	59.3	48.3
08:00	09:00	62	1	55	0	6	0	0	0	0	0	0	0	0	0	1	0	2	2	16	11	3	12	11	2	1	1	0	0	0	0	0	0	0	36.4	9.0	63.2	47.2
09:00	10:00	87	0	74	0	12	0	0	0	0	0	1	0	0	0	0	0	2	5	12	9	18	25	15	1	0	0	0	0	0	0	0	0	0	37.8	16.1	54.2	46.6
10:00	11:00	74	2	64	1	7	0	0	0	0	0	0	0	0	0	0	2	1	1	11	5	12	25	13	1	3	0	0	0	0	0	0	0	0	38.9	10.4	59.0	48.2
11:00	12:00	89	0	71	2	14	0	1	0	1	0	0	0	0	0	0	0	0	3	10	9	17	30	16	3	1	0	0	0	0	0	0	0	0	39.4	20.6	56.0	46.5
12:00	13:00	99	0	83	0	16	0	0	0	0	0	0	0	0	0	0	0	0	5	10	6	17	35	19	6	1	0	0	0	0	0	0	0	0	40.1	21.9	55.4	46.4
13:00	14:00	99	1	92	1	4	0	0	0	0	0	1	0	0	0	1	0	0	4	10	4	19	32	14	9	5	1	0	0	0	0	0	0	0	41.1	6.8	64.5	50.6
14:00	15:00	128	0	112	0	11	1	1	0	1	1	1	0	0	0	0	0	0	4	17	7	32	27	27	10	2	2	0	0	0	0	0	0	0	40.3	23.9	61.4	48.8
15:00	16:00	122	0	106	3	9	2	2	0	0	0	0	0	0	0	0	0	0	4	7	10	28	39	21	12	1	0	0	0	0	0	0	0	0	41.1	22.5	57.4	48.3
16:00	17:00	194	3	175	2	12	1	0	0	0	0	1	0	0	0	0	1	3	9	26	17	37	53	33	10	2	1	1	1	0	0	0	0	0	39.2	13.9	70.2	47.2
17:00	18:00	216	1	203	0	12	0	0	0	0	0	0	0	0	0	0	0	4	8	15	17	27	81	45	12	7	0	0	0	0	0	0	0	0	40.7	15.7	59.3	46.9
18:00	19:00	122	1	115	1	4	1	0	0	0	0	0	0	0	0	0	0	0	4	9	12	24	34	28	8	3	0	0	0	0	0	0	0	0	41.2	23.5	58.9	49.0
19:00	20:00	81	1	75	0	5	0	0	0	0	0	0	0	0	0	0	0	1	2	5	3	20	21	22	5	2	0	0	0	0	0	0	0	0	41.7	18.1	56.1	48.6
20:00	21:00	63	0	60	0	3	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	10	20	14	9	2	2	0	0	0	0	0	0	0	43.8	19.8	60.9	51.9
21:00	22:00	43	0	42	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	5	17	6	7	0	1	0	0	0	0	0	0	0	42.4	21.8	64.5	51.7
22:00	23:00	25	0	23	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	6	5	4	6	0	1	0	0	0	0	0	0	0	43.3	24.4	63.9	51.7
23:00	00:00	22	0	21	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	6	4	5	0	0	0	0	0	0	0	0	0	42.7	23.3	54.1	50.6
07:00-19:00		1361	9	1214	10	111	6	4	0	2	1	4	0	0	0	2	3	13	57	151	114	246	406	254	80	28	5	1	1	0	0	0	0	0	39.8	6.8	70.2	47.8
06:00-22:00		1575	10	1416	10	121	7	4	0	2	1	4	0	0	0	2	3	15	63	175	123	283	467	300	101	32	9	1	1	0	0	0	0	0	40.1	6.8	70.2	48.1
06:00-00:00		1622	10	1460	10	124	7	4	0	2	1	4	0	0	0	2	3	15	66	175	127	292	478	308	112	32	10	1	1	0	0	0	0	0	40.2	6.8	70.2	48.3
00:00-00:00		1652	10	1483	10	131	7	4	0	2	1	4	0	0	0	2	3	17	69	180	131	295	482	315	113	33	10	1	1	0	0	0	0	0	40.1	6.8	70.2	48.2
Date: 15 October 2019																																						
00:00	01:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	1	1	0	0	0	0	0	0	0	48.4	40.9	64.8	-
01:00	02:00	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	43.5	23.4	55.0	-
02:00	03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
03:00	04:00	8	0	3	0	5	0	0	0	0	0	0	0	0	0	0	0	1	3	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	28.4	18.9	43.7	-
04:00	05:00	5	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	0	0	0	0	0	0	0	0	40.5	30.1	51.9	-
05:00	06:00	8	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	36.0	28.3	50.0	-
06:00	07:00	26	0	20	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	7	5	3	2	1	0	0	0	0	0	0	0	0	39.4	26.7	58.3	49.5
07:00	08:00	63	0	48	0	14	0	0	0	1	0	0	0	0	0	1	0	0	4	8	12	8	15	10	5	0	0	0	0	0	0	0	0	0	37.9	8.2	54.6	46.6
08:00	09:00	83	0	69	0	14	0	0	0	0	0	0	0	0	0	0	0	2	9	17	14	6	17	10	3	5	0	0	0	0	0	0	0	0	36.4	17.0	59.9	47.3
09:00	10:00	68	0	50	0	18	0	0	0	0	0	0	0	0	0	0	0	0	6	11	9	13	19	9	1	0	0	0	0	0	0	0	0	0	37.1	22.3	50.6	45.2
10:00	11:00	96	0	84	0	9	1	0	0	1	1	0	0	0	0	0	1	3	2	6	5	19	31	18	9	1	1	0	0	0	0	0	0	0	40.7	13.8	63.8	48.5
11:00	12:00	109	0	95	1	13	0	0	0	0	0	0	0	0	0	0	0	0	6	12	11	23	31	14	10	2	0	0	0	0	0	0	0	0	39.4	21.2	56.7	48.1
12:00	13:00	131	0	116	1	14	0	0	0	0	0	0	0	0	0	0	0	0	5	20	8	20	43	21	10	4	0	0	0	0	0	0	0	0	40.0	22.9	58.3	48.3
13:00	14:00	118	4	103	1	10	0	0	0	0	0	0	0	0	0	1	0	0	2	7	11	18	45	22	10	2	0	0	0	0	0	0	0	0	41.3	9.4	55.4	48.2
14:00	15:00	114	0	104	1	7	0	0	0	1	1	0	0	0	0	0	0	2	7	13	7	18	39	18	8	2	0	0	0	0	0	0	0	0	39.6	19.1	59.6	48.0
15:00	16:00	141	0	125	3	13	0	0	0	0	0	0	0	0	0	0	0	2	5	11	8	38	34	34	7	1	1	0	0	0	0	0	0	0	40.3	16.7	60.8	47.4
16:00	17:00	195	1	175	0	14	1	2	0	0	0	2	0	0	0	0	1	1	11	18	16	39	59	35	12	3	0	0	0	0	0	0	0	0	39.6	14.8	55.8	47.6
17:00	18:00	196	1	179	1	13	0	1	0	0	1	0	0	0	0	0	0	1	10	13	12	30	71	39	10	7	2	1	0	0	0	0	0	0	41.3	19.6	68.4	47.9
18:00	19:00	136	0	123	1	11	0	0	0	0	1	0	0	0	0	0	0	0	4	15	9	30	36	30	8	2	0	1	1	0	0	0	0	0	41.0	22.3	71.4	48.8
19:00	20:00	75	0	74	0	1	0	0	0	0	0	0	0	0	0	0	0	2	3	8	4	15	19	15	9	0	0	0	0	0	0	0	0	0	40.0	17.0	54.6	49.6
20:00	21:00	69	1	64	0	4	0	0	0	0	0	0	0	0	0	0	0	1	4	1	9	8	23	17	5	1	0	0	0	0	0	0	0	0	41.1	18.2	55.2	48.9
21:00	22:00	49	0	48	0	1	0	0	0	0	0	0	0	0	0	0	1	1	2	0	5	7	13	8	5	4	1	2	0	0	0	0	0	0	43.4	15.0	67.7	54.9
22:00	23:00	28	0	27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	6	10	3	1	0	0	0	0	0	0	0	0	43.0	24.0	55.7	50.3
23:00	00:00	18	0	17	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	3	2	2	3	1	0	0	0	0	0	0	0	0	40.9	27.7	58.6	52.5
07:00-19:00		1450	6	1271	9	150	2	3	0	3	4	2	0	0	0	2	2	11	71	151	122	262	440	260	93	29	4	2	1	0	0	0	0	0	39.9	8.2	71.4	47.6
06:00-22:00		1669	7	1477	9	162	2	3	0	3	4	2	0	0	0	2	3	15	80	163	145	299	500	303	114	35	5	4	1	0	0	0	0	0	40.0	8.2	71.4	48.0
06:00-00:00		1715	7	1521	9	164	2	3	0	3	4	2	0	0	0	2	3	15	81	167	152	305	508	315	120	37	5	4	1	0	0	0	0	0	40.1	8.2	71.4	48.1
00:00-00:00		1745	7	1543	9	172	2	3	0	3	4	2	0	0	0	2	3	16	85	171	156	308	516	316	122	39	6	4	1	0	0	0	0	0	40.1	8.2	71.4	48.1
Date: 16 October 2019																																						
00:00	01:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	2	1	0	0	0	0	0	0	0	0	44.1	28.8	57.5	-
01:00	02:00	8	0	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	1	2	0	1	0	0	0	0	0	0	0	0	0	36.3	23.8	53.1	-
02:00	03:00	4	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	33.6	23.7	38.7	-
03:00	04:00	6	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	0	1	0	0	0	0	0	0	0	0	0	0	32.4	22.6	46.6	-
04:00	05:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	27.4	22.9	31.8	-
05:00	06:00	12	0	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	2	2	1	1	0	0	0	0	0	0	0	0	40.3	30.0	59.0	51.3
06:00	07:00	31	0	26	0	4	0	0	0	0	1	0	0	0	0	0	0	0	2	7	6	3	2	8	3	0	0	0	0	0	0	0	0	0	37.7	23.5	54.6	47.2
07:00	08:00	68	0	59	0	8	1	0	0	0	0	0	0	0	0	0	0	0	1	13	11	12	16	11	3	1	0	0	0	0	0	0	0	0	38.3	24.2	55.1	48.6
08:00	09:00	95	0	75	1	15	1	0	0	2	0	1	0	0	0	0	0	1	4	25	13	11	21	12	5	3	0	0	0	0	0	0	0	0	37.2	17.9	57.8	47.5
09:00	10:00	79	0	69	0	10	0	0	0	0	0	0	0	0	0	0	0	0	5	10	6	14	26	14	4	0	0	0	0	0	0	0	0	0	39.4	21.7	54.6	47.3
10:00	11:00	86	0	72	0	13	1	0	0	0	0	0	0	0	0	0	0	0	9	15	2	13	26	16	4	1	0	0	0	0	0	0	0	0	38.3	20.5	58.8	47.5
11:00	12:00	100	0	91	0	8	1	0	0	0	0	0	0	0	0	0	0	0	4	14	5	34	26	15	1	1	0	0	0	0	0	0	0	0	38.5	21.7	55.2	45.8
12:00	13:00	124	0	107	1	12	2	0	0	0	1	1	0	0	0	0	0	0	7	15	14	26	32	19	9	1	1	0	0	0	0	0	0	0	39.3	20.9	62.6	48.3
13:00	14:00	102	0	91	0	9	2	0	0	0	0	0	0	0	0	0	0	0	5	6	10	16	34	23	7	1	0	0	0	0	0	0	0	0	40.7	21.5	57.2	48.3
14:00	15:00	111	1	99	0	10	0	1	0	0	0	0	0	0	0	0	0	0	3	8	11	26	39	16	5	3	0	0	0	0	0	0	0	0	40.2	22.5	56.9	46.1
15:00	16:00	146	1	134	0	9	0	0	0	1	0	1	0	0	0	0	0	0	3	13	11	30	49	32	8	0	0	0	0	0	0	0	0	0	40.4	21.4	53.8	46.8
16:00	17:00	163	0	154	0	8	1	0	0	0	0	0	0	0	0	0	0	0	4	18	6	33	58	36	4	4	0	0	0	0	0	0	0	0	40.6	22.3	57.3	47.1
17:00	18:00	207	0	196	0	10	0	0	0	0	0	1	0	0	0	0	0	1	6	15	18	54	62	36	13	2	0	0	0	0	0	0	0	0	40.1	19.9	57.5	46.8
18:00	19:00	143	0	134	0	8	0	1	0	0	0	0	0	0	0	0	0	1	9	13	9	33	43	23	10	2	0	0	0	0	0	0	0	0	39.9	19.0	56.8	48.0
19:00	20:00	83	1	78	0	4	0	0	0	0	0	0	0	0	0	0	0	1	3	3	4	18	25	21	7	1	0	0	0	0	0	0	0	0	41.7	19.8	55.8	48.0
20:00	21:00	68	0	64	1	1	0	2	0	0	0	0	0	0	0	0	0	0	5	5	7	14	16	12	5	4	0	0	0	0	0	0	0	0	40.6	22.6	58.6	48.6
21:00	22:00	55	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	11	12	12	8	2	0	0	0	0	0	0	0	0	42.2	25.3	58.1	50.6
22:00	23:00	40	0	38	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4	11	11	5	2	3	0	0	0	0	0	0	0	0	41.0	23.8	57.2	48.9
23:00	00:00	13	0	12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	5	2	0	1	0	0	0	0	0	0	0	0	41.4	21.9	55.0	47.4
07:00-19:00		1424	2	1281	2	120	9	2	0	3	1	4	0	0	0	0	0	3	60	165	116	302	432	253	73	19	1	0	0	0	0	0	0	0	39.6	17.9	62.6	47.2
06:00-22:00		1661	3	1504	3	129	9	4	0	3	2	4	0	0	0	0	0	4	70	186	137	348	487	306	96	26	1	0	0	0	0	0	0	0	39.8	17.9	62.6	47.3
06:00-00:00		1714	3	1554	3	132	9	4	0	3	2	4	0	0	0	0	0	4	72	189	141	363	503	313	98	30	1	0	0	0	0	0	0	0	39.8	17.9	62.6	47.4
00:00-00:00		1753	3	1587	3	137	10	4	0	3	2	4	0	0	0	0	0	4	77	193	150	371	507	316	102	32	1	0	0	0	0	0	0	0	39.8	17.9	62.6	47.4
5 day (Weekday) Average																																						
07:00-19:00		1389	6	1245	8	113	6	3	0	4	2	3	0	0	0	1	1	8	66	145	120	293	406	243	77	23	3	1	1	0	0	0	0	0	39.6	11.2	68.6	47.3
06:00-22:00		1611	7	1454	8	123	6	4	0	4	2	3	0	0	0	1	2	10	75	164	138	342	463	286	96	28	4	2	1	0	0	0	0	0	39.8	11.2	68.8	47.5
06:00-00:00		1658	7	1498	8	125	6	4	0	4	2	3	0	0	0	1	2	10	77	167	142	351	475	295	102	29	5	2	1	0	0	0	0	0	39.8	11.2	68.8	47.6
00:00-00:00		1691	7	1526	8	131	7	4	0	4	2	3	0	0	0	1	2	11	81	172	147	355	480	299	104	31	6	2	1	0	0	0	0	0	39.8	11.2	68.8	47.6
7 day (Weekly) Average																																						
07:00-19:00		1308	8	1185	7	94	4	3	0	3	1	2	0	0	0	1	1	7	60	132	108	264	389	237	79	24	5	1	0	0	0	0	0	0	40.0	11.4	71.1	47.7
06:00-22:00		1515	9	1381	8	103	5	3	1	3	1	2	0	0	0	1	1	9	69	149	125	311	443	275	95	28	7	2	0	0	0	0	0	0	40.1	11.4	71.2	47.8
06:00-00:00		1561	9	1424	8	105	5	3	1	3	1	2	0	0	0	1	1	9	71	151	130	321	454	284	100	30	7	2	0	0	0	0	0	0	40.1	11.4	71.2	47.8
00:00-00:00		1603	9	1460	8	110	5	4	1	3	1	2	0	0	0	1	1	10	75	157	134	327	463	291	103	31	8	2	0	0	0	0	0	0	40.1	11.4	71.2	47.9

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 2: Kellas Road - Approx. 30m south of Unnamed Road
Movement: Southbound

TIME		TOTAL	ARX VEHICLE CLASSIFICATIONS LIGHT 1	LIGHT 2	LIGHT 3	MEDIUM 4	MEDIUM 5	MEDIUM 6	HEAVY 7	HEAVY 8	HEAVY 9	HEAVY 10	HEAVY 11	HEAVY 12	SPEED BIN TOTALS 0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	SPEED STATISTICS AVERAGE	MINIMUM	MAXIMUM	85th%ile
Date: 10 October 2019																																						
00:00	01:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	2	0	0	0	0	0	0	0	0	0	0	39.2	27.2	48.7	-
01:00	02:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21.7	21.7	21.7	-
02:00	03:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	35.3	35.3	35.3	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	39.0	35.2	42.7	-
05:00	06:00	12	0	11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	6	1	0	0	0	0	0	0	0	0	0	0	40.1	30.0	46.5	42.9
06:00	07:00	54	0	49	0	3	0	0	0	0	2	0	0	0	0	0	0	0	2	4	1	16	20	8	2	1	0	0	0	0	0	0	0	0	40.5	23.3	56.4	46.1
07:00	08:00	158	2	134	1	19	2	0	0	0	0	0	0	0	0	0	1	2	6	8	7	28	47	33	21	2	1	1	1	0	0	0	0	0	42.1	12.5	70.3	51.0
08:00	09:00	147	0	133	0	12	1	1	0	0	0	0	0	0	0	0	0	2	9	7	3	19	25	58	17	4	3	0	0	0	0	0	0	0	43.3	16.8	64.4	50.3
09:00	10:00	134	1	120	0	13	0	0	0	0	0	0	0	0	0	0	1	0	16	15	4	19	37	33	9	0	0	0	0	0	0	0	0	0	39.2	14.8	54.8	47.5
10:00	11:00	112	1	93	0	17	0	0	0	1	0	0	0	0	0	0	0	2	7	5	3	16	32	27	17	1	2	0	0	0	0	0	0	0	42.4	17.2	61.0	51.1
11:00	12:00	111	1	100	1	8	0	0	0	1	0	0	0	0	0	0	0	0	8	4	10	25	44	11	8	0	1	0	0	0	0	0	0	0	39.9	20.3	60.6	46.3
12:00	13:00	130	1	120	1	8	0	0	0	0	0	0	0	0	0	0	2	0	16	7	6	40	39	14	5	1	0	0	0	0	0	0	0	0	37.9	13.0	58.0	45.2
13:00	14:00	112	0	100	0	10	0	0	0	1	1	0	0	0	0	0	0	4	10	8	4	29	37	15	4	1	0	0	0	0	0	0	0	0	38.4	18.1	58.5	46.2
14:00	15:00	141	3	128	0	7	1	1	0	1	0	0	0	0	0	0	0	5	17	15	10	35	37	17	3	0	2	0	0	0	0	0	0	0	36.8	16.2	63.5	45.6
15:00	16:00	110	0	98	0	11	1	0	0	0	0	0	0	0	0	0	0	3	9	12	8	19	33	22	4	0	0	0	0	0	0	0	0	0	38.5	18.8	54.3	46.9
16:00	17:00	115	2	102	2	8	1	0	0	0	0	0	0	0	0	0	0	2	18	11	9	35	29	7	3	1	0	0	0	0	0	0	0	0	35.9	16.0	57.1	43.8
17:00	18:00	131	0	122	1	7	0	0	0	0	1	0	0	0	0	0	0	1	14	24	6	28	26	20	9	2	1	0	0	0	0	0	0	0	37.9	18.3	61.6	48.1
18:00	19:00	111	0	104	0	6	0	0	0	0	0	1	0	0	0	0	0	0	10	15	11	16	30	19	9	1	0	0	0	0	0	0	0	0	38.7	23.5	55.5	47.0
19:00	20:00	70	0	67	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	4	5	17	26	9	5	0	0	0	0	0	0	0	0	0	39.7	20.6	54.1	46.2
20:00	21:00	35	0	32	0	2	1	0	0	0	0	0	0	0	0	0	0	0	6	3	7	6	8	3	2	0	0	0	0	0	0	0	0	0	36.2	21.0	50.8	45.0
21:00	22:00	32	0	31	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	1	4	11	5	4	2	0	1	0	0	0	0	0	0	43.3	23.4	66.6	53.4
22:00	23:00	14	0	13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	3	1	2	2	0	0	0	0	0	0	0	0	42.0	22.1	57.5	54.9
23:00	00:00	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	5	0	0	1	0	0	0	0	0	0	0	41.9	22.3	62.1	-
07:00-19:00		1512	11	1354	6	126	6	2	0	4	2	1	0	0	0	0	4	21	140	131	81	309	416	276	109	13	10	1	1	0	0	0	0	0	39.3	12.5	70.3	48.1
06:00-22:00		1703	11	1533	6	134	8	2	0	4	4	1	0	0	0	0	4	21	156	142	95	352	481	301	122	16	10	2	1	0	0	0	0	0	39.4	12.5	70.3	47.9
06:00-00:00		1727	11	1556	6	135	8	2	0	4	4	1	0	0	0	0	4	21	159	144	96	356	484	307	124	18	11	2	1	0	0	0	0	0	39.4	12.5	70.3	48.0
00:00-00:00		1748	11	1576	6	136	8	2	0	4	4	1	0	0	0	0	4	21	160	146	96	364	491	310	124	18	11	2	1	0	0	0	0	0	39.4	12.5	70.3	48.0
Date: 11 October 2019																																						
00:00	01:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	52.5	40.4	60.6	-
01:00	02:00	4	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	27.6	23.4	39.3	-
02:00	03:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	36.2	36.2	36.2	-
03:00	04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00	05:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	35.2	35.2	35.2	-
05:00	06:00	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	4	0	0	0	0	0	0	0	0	0	0	42.6	35.7	49.2	-
06:00	07:00	52	0	42	0	8	0	0	0	0	2	0	0	0	0	0	0	0	4	5	0	10	14	14	3	2	0	0	0	0	0	0	0	0	41.0	20.7	58.3	48.2
07:00	08:00	131	0	123	0	7	1	0	0	0	0	0	0	0	0	0	0	2	6	6	5	28	43	32	7	1	1	0	0	0	0	0	0	0	40.9	17.4	60.1	47.3
08:00	09:00	144	1	132	1	9	0	0	0	0	0	1	0	0	0	0	1	0	9	5	6	30	52	33	7	1	0	0	0	0	0	0	0	0	40.6	14.3	57.2	47.7
09:00	10:00	132	0	120	1	8	3	0	0	0	0	0	0	0	0	0	0	3	17	11	6	32	36	22	4	1	0	0	0	0	0	0	0	0	37.6	17.0	56.7	46.6
10:00	11:00	111	1	101	0	9	0	0	0	0	0	0	0	0	0	0	1	0	4	4	5	20	46	21	6	3	0	1	0	0	0	0	0	0	41.4	14.3	65.9	47.2
11:00	12:00	135	0	116	1	15	1	1	0	0	0	1	0	0	0	0	2	0	8	8	5	18	42	36	9	4	3	0	0	0	0	0	0	0	41.8	13.3	62.7	49.3
12:00	13:00	120	2	111	2	3	0	1	0	0	0	1	0	0	0	0	0	1	10	8	6	34	36	18	6	0	1	0	0	0	0	0	0	0	39.1	16.7	60.4	47.3
13:00	14:00	120	2	109	0	6	1	0	0	0	1	1	0	0	0	0	2	1	15	6	12	31	35	13	3	2	0	0	0	0	0	0	0	0	37.2	11.5	59.6	45.2
14:00	15:00	118	1	103	1	13	0	0	0	0	0	0	0	0	0	0	0	1	9	5	6	29	42	17	6	3	0	0	0	0	0	0	0	0	40.1	19.9	59.0	46.9
15:00	16:00	140	2	121	0	15	1	0	0	0	1	0	0	0	0	0	0	1	18	13	6	33	39	18	11	1	0	0	0	0	0	0	0	0	38.4	19.7	59.2	47.9
16:00	17:00	139	0	129	0	9	0	1	0	0	0	0	0	0	0	0	0	2	28	11	7	14	52	18	7	0	0	0	0	0	0	0	0	0	37.2	19.1	54.6	45.6
17:00	18:00	118	0	110	0	5	0	0	0	0	3	0	0	0	0	0	0	1	17	11	5	22	29	17	12	4	0	0	0	0	0	0	0	0	38.8	19.8	57.6	49.2
18:00	19:00	104	0	99	0	5	0	0	0	0	0	0	0	0	0	0	0	1	13	13	3	19	28	21	3	3	0	0	0	0	0	0	0	0	38.5	18.5	56.5	47.5
19:00	20:00	68	0	60	0	6	2	0	0	0	0	0	0	0	0	0	0	1	6	6	7	13	16	8	6	2	3	0	0	0	0	0	0	0	39.8	19.7	63.8	50.6
20:00	21:00	39	0	37	0	1	0	0	1	0	0	0	0	0	0	0	0	1	3	1	2	8	9	9	5	1	0	0	0	0	0	0	0	0	41.0	19.0	58.4	50.4
21:00	22:00	32	0	31	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	6	11	6	3	2	0	0	0	0	0	0	0	0	42.4	20.4	59.3	50.9
22:00	23:00	14	0	13	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	3	4	2	2	0	0	0	0	0	0	0	0	0	40.3	17.7	53.8	52.5
23:00	00:00	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	32.3	24.8	39.4	-
07:00-19:00		1512	9	1374	6	104	7	3	0	0	5	4	0	0	0	0	6	13	154	101	72	310	480	266	81	23	5	1	0	0	0	0	0	0	39.3	11.5	65.9	47.2
06:00-22:00		1703	9	1544	6	120	9	3	1	0	7	4	0	0	0	0	6	15	170	113	82	347	530	303	98	30	8	1	0	0	0	0	0	0	39.5	11.5	65.9	47.5
06:00-00:00		1724	9	1564	6	121	9	3	1	0	7	4	0	0	0	0	6	16	171	116	84	353	534	305	100	30	8	1	0	0	0	0	0	0	39.5	11.5	65.9	47.5
00:00-00:00		1745	9	1584	6	121	10	3	1	0	7	4	0	0	0	0	6	16	174	116	84	358	539	310	101	31	9	1	0	0	0	0	0	0	39.5	11.5	65.9	47.5
Date: 12 October 2019																																						
00:00	01:00	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	3	1	8	0	1	1	0	0	0	0	0	0	0	42.8	17.3	62.0	52.9
01:00	02:00	4	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	31.5	23.6	39.9	-
02:00	03:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0	39.1	34.5	45.3	-
03:00	04:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	44.2	40.5	48.0	-
04:00	05:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	47.0	46.1	47.5	-
05:00	06:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	0	0	0	0	0	0	0	0	0	45.2	35.7	48.4	-
06:00	07:00	20	0	17	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	8	5	1	2	0	0	0	0	0	0	0	0	44.0	30.4	57.5	51.4
07:00	08:00	52	0	44	0	7	0	1	0	0	0	0	0	0	0	0	0	0	3	2	1	9	17	12	4	2	2	0	0	0	0	0	0	0	42.9	20.5	64.3	50.5
08:00	09:00	76	0	69	1	6	0	0	0	0	0	0	0	0	0	0	0	0	6	4	2	19	19	18	7	1	0	0	0	0	0	0	0	0	40.8	20.7	55.3	49.4
09:00	10:00	118	0	111	0	6	1	0	0	0	0	0	0	0	0	0	0	0	7	5	3	23	40	24	12	4	0	0	0	0	0	0	0	0	42.0	20.1	55.9	49.3
10:00	11:00	133	4	119	1	8	1	0	0	0	0	0	0	0	0	0	1	1	7	7	3	12	30	52	14	5	0	1	0	0	0	0	0	0	43.3	13.1	66.9	50.4
11:00	12:00	124	2	111	0	9	1	1	0	0	0	0	0	0	0	0	1	0	4	16	8	20	46	21	6	2	0	0	0	0	0	0	0	0	39.9	14.1	59.3	47.1
12:00	13:00	140	1	128	0	9	0	0	1	0	1	0	0	0	0	0	0	3	10	7	5	18	48	33	14	1	0	1	0	0	0	0	0	0	41.3	17.7	65.9	49.4
13:00	14:00	110	3	98	1	7	0	1	0	0	0	0	0	0	0	0	0	1	10	8	11	17	31	20	9	1	1	1	0	0	0	0	0	0	39.8	16.3	69.4	49.0
14:00	15:00	150	3	138	2	7	0	0	0	0	0	0	0	0	0	0	1	2	10	9	6	24	49	31	11	3	4	0	0	0	0	0	0	0	41.0	14.4	63.4	48.3
15:00	16:00	118	1	109	1	6	0	0	0	0	0	1	0	0	0	0	2	1	8	13	5	27	31	21	5	3	2	0	0	0	0	0	0	0	39.2	12.1	63.4	47.6
16:00	17:00	121	5	113	0	3	0	0	0	0	0	0	0	0	0	0	0	0	6	8	4	24	39	33	4	1	1	1	0	0	0	0	0	0	41.5	20.0	68.1	47.8
17:00	18:00	100	2	91	0	7	0	0	0	0	0	0	0	0	0	0	0	2	5	3	3	19	32	26	8	1	1	0	0	0	0	0	0	0	41.7	16.4	62.9	49.1
18:00	19:00	94	0	90	1	2	1	0	0	0	0	0	0	0	0	0	0	1	13	5	3	21	30	16	4	1	0	0	0	0	0	0	0	0	38.4	19.3	56.2	47.3
19:00	20:00	72	0	70	0	1	1	0	0	0	0	0	0	0	0	0	0	0	5	2	9	16	22	12	3	3	0	0	0	0	0	0	0	0	40.5	20.6	57.9	47.9
20:00	21:00	41	1	38	0	1	1	0	0	0	0	0	0	0	0	0	1	0	3	2	2	12	4	10	5	1	1	0	0	0	0	0	0	0	41.1	11.4	61.9	51.0
21:00	22:00	25	0	23	0	2	0	0	0	0	0	0	0	0	0	0	0	1	5	2	2	2	5	4	3	1	0	0	0	0	0	0	0	0	37.6	18.9	55.1	51.0
22:00	23:00	19	0	17	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	2	6	5	3	0	0	0	0	0	0	0	0	0	0	37.7	19.2	48.4	45.7
23:00	00:00	16	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	9	3	1	0	0	0	0	0	0	0	0	47.7	31.9	57.0	54.2
07:00-19:00		1336	21	1221	7	77	4	3	1	0	1	1	0	0	0	0	5	11	89	87	54	233	412	307	98	25	11	4	0	0	0	0	0	0	41.0	12.1	69.4	48.8
06:00-22:00		1494	22	1369	9	82	6	3	1	0	1	1	0	0	0	0	6	12	102	93	70	264	451	338	110	32	12	4	0	0	0	0	0	0	40.9	11.4	69.4	48.8
06:00-00:00		1529	22	1402	9	83	7	3	1	0	1	1	0	0	0	0	6	13	103	94	73	270	458	350	113	33	12	4	0	0	0	0	0	0	41.0	11.4	69.4	48.8
00:00-00:00		1566	22	1438	9	84	7	3	1	0	1	1	0	0	0	0	6	14	106	95	74	278	462	367	113	34	13	4	0	0	0	0	0	0	41.0	11.4	69.4	48.8
Date: 13 October 2019																																						
00:00	01:00	19	0	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	6	1	1	0	0	0	0	0	0	0	0	44.6	35.1	56.8	49.4
01:00	02:00	11	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	7	1	0	0	0	0	0	0	0	0	0	0	39.8	21.7	45.5	44.6
02:00	03:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0	0	0	0	0	0	0	0	41.8	38.5	47.1	-
03:00	04:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	48.5	40.4	67.4	-
04:00	05:00	4	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	50.8	45.3	59.4	-
05:00	06:00	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	0	43.7	38.2	52.5	-
06:00	07:00	17	0	14	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	4	9	1	1	0	0	0	0	0	0	0	0	45.3	32.0	55.8	50.9
07:00	08:00	24	0	23	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	7	9	1	1	0	1	0	0	0	0	0	0	43.1	22.4	67.8	50.2
08:00	09:00	27	0	24	0	0	3	0	0	0	0	0	0	0	0	0	0	0	4	1	1	7	7	6	1	0	0	0	0	0	0	0	0	0	39.1	21.6	50.4	46.5
09:00	10:00	67	2	60	1	2	0	0	0	1	1	0	0	0	0	0	0	1	2	1	1	11	17	20	11	3	0	0	0	0	0	0	0	0	44.1	19.6	56.1	52.3
10:00	11:00	106	1	93	0	10	1	1	0	0	0	0	0	0	0	0	0	0	5	3	9	7	28	36	14	4	0	0	0	0	0	0	0	0	43.5	21.2	59.2	50.7
11:00	12:00	96	4	87	2	3	0	0	0	0	0	0	0	0	0	0	0	2	6	10	7	14	20	14	18	3	2	0	0	0	0	0	0	0	41.0	15.9	63.1	51.4
12:00	13:00	91	0	86	0	4	1	0	0	0	0	0	0	0	0	0	1	0	5	6	1	15	33	23	6	0	1	0	0	0	0	0	0	0	41.3	13.0	60.5	48.2
13:00	14:00	114	2	109	1	2	0	0	0	0	0	0	0	0	0	0	0	0	4	11	4	10	21	30	26	6	2	0	0	0	0	0	0	0	44.2	21.5	64.8	52.8
14:00	15:00	140	2	131	0	7	0	0	0	0	0	0	0	0	0	0	0	1	7	9	5	30	38	30	11	8	0	1	0	0	0	0	0	0	41.8	19.3	65.4	49.9
15:00	16:00	133	0	129	0	4	0	0	0	0	0	0	0	0	0	0	0	2	9	6	10	19	40	36	8	2	0	1	0	0	0	0	0	0	41.1	18.3	66.1	48.2

TIME	TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																				SPEED STATISTICS			
		LIGHT			MEDIUM			HEAVY						0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	AVERAGE	MINIMUM	MAXIMUM	85th%ile
		1	2	3	4	5	6	7	8	9	10	11	12																								
16:00 17:00	86	0	81	0	4	0	0	0	0	1	0	0	0	0	0	0	0	5	5	2	7	19	21	21	5	1	0	0	0	0	0	0	0	44.5	21.3	61.4	53.3
17:00 18:00	98	0	93	0	3	0	1	0	0	1	0	0	0	0	0	0	3	11	6	1	12	25	16	14	8	2	0	0	0	0	0	0	0	41.8	16.7	62.5	53.8
18:00 19:00	57	0	53	1	1	2	0	0	0	0	0	0	0	0	0	0	1	3	3	2	9	21	9	6	2	1	0	0	0	0	0	0	0	41.8	17.0	60.9	51.0
19:00 20:00	49	0	46	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	5	1	14	9	11	7	1	1	0	0	0	0	0	0	0	42.6	25.0	63.3	51.2
20:00 21:00	42	0	39	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3	3	10	11	10	5	0	0	0	0	0	0	0	0	0	0	37.0	21.6	48.3	43.7
21:00 22:00	19	0	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	6	6	3	1	1	0	0	0	0	0	0	0	0	41.9	22.8	55.5	48.5
22:00 23:00	15	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	3	6	1	1	0	0	0	0	0	0	0	0	0	37.4	17.6	52.2	45.3
23:00 00:00	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	1	1	0	0	0	0	0	0	0	0	0	36.8	23.0	54.1	-
07:00-19:00	1039	11	969	5	41	7	2	0	1	3	0	0	0	0	0	1	10	63	63	44	141	276	250	137	42	9	3	0	0	0	0	0	0	42.4	13.0	67.8	50.8
06:00-22:00	1166	11	1086	5	48	7	2	1	2	3	1	0	0	0	0	1	10	67	71	58	172	305	278	146	45	10	3	0	0	0	0	0	0	42.2	13.0	67.8	50.7
06:00-00:00	1187	11	1107	5	48	7	2	1	2	3	1	0	0	0	0	1	11	69	75	58	175	312	280	148	45	10	3	0	0	0	0	0	0	42.1	13.0	67.8	50.7
00:00-00:00	1236	11	1154	5	50	7	2	1	2	3	1	0	0	0	0	1	11	70	75	59	182	335	292	150	47	10	4	0	0	0	0	0	0	42.2	13.0	67.8	50.7
Date: 14 October 2019																																					
00:00 01:00	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	45.9	33.4	53.3	-
01:00 02:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	44.5	43.0	46.0	-
02:00 03:00	3	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	33.8	30.0	40.4	-
03:00 04:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	48.7	48.7	48.7	-
04:00 05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
05:00 06:00	13	0	11	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	6	1	1	0	0	0	0	0	0	0	0	44.9	29.3	55.3	50.7
06:00 07:00	49	0	39	1	6	2	0	0	0	1	0	0	0	0	0	0	0	0	2	2	8	13	12	9	2	1	0	0	0	0	0	0	0	44.7	25.0	61.4	52.3
07:00 08:00	159	1	134	1	20	1	0	0	0	1	1	0	0	0	0	0	0	11	1	2	27	44	52	18	3	1	0	0	0	0	0	0	0	43.4	21.0	60.2	50.0
08:00 09:00	136	2	119	0	13	1	0	0	0	0	1	0	0	0	0	0	2	7	9	2	19	34	48	11	3	1	0	0	0	0	0	0	0	42.2	16.7	60.5	48.8
09:00 10:00	117	2	101	0	9	3	0	0	1	0	1	0	0	0	0	1	1	11	7	4	24	34	22	8	5	0	0	0	0	0	0	0	0	40.2	14.5	57.6	48.8
10:00 11:00	95	0	87	0	7	0	0	0	0	0	1	0	0	0	0	0	0	4	5	4	19	32	16	13	1	0	1	0	0	0	0	0	0	42.1	22.3	68.0	50.2
11:00 12:00	102	1	84	0	15	0	0	0	1	0	1	0	0	0	0	0	1	5	8	6	21	30	24	7	0	0	0	0	0	0	0	0	0	40.5	19.5	52.9	48.8
12:00 13:00	114	1	101	0	11	0	0	0	1	0	0	0	0	0	0	0	1	7	12	2	12	34	28	15	2	1	0	0	0	0	0	0	0	41.7	18.2	62.0	50.2
13:00 14:00	128	1	111	2	13	0	0	0	0	1	0	0	0	0	0	1	2	9	11	10	21	25	19	21	8	1	0	0	0	0	0	0	0	41.0	14.7	61.0	52.6
14:00 15:00	110	0	98	3	9	0	0	0	0	0	0	0	0	0	0	0	1	9	6	4	15	41	23	7	4	0	0	0	0	0	0	0	0	41.2	17.5	59.0	49.3
15:00 16:00	90	1	73	0	14	0	1	0	0	1	0	0	0	0	1	0	2	8	7	4	14	21	23	7	2	1	0	0	0	0	0	0	0	40.1	5.8	63.0	48.9
16:00 17:00	127	0	120	0	5	1	0	0	1	0	0	0	0	0	0	0	2	13	19	3	22	38	16	13	1	0	0	0	0	0	0	0	0	38.4	16.3	57.9	48.8
17:00 18:00	150	2	134	1	10	0	1	0	0	1	1	0	0	0	0	0	4	14	25	14	18	36	29	7	3	0	0	0	0	0	0	0	0	37.7	15.9	58.2	47.7
18:00 19:00	114	2	107	0	5	0	0	0	0	0	0	0	0	0	0	1	1	6	15	3	17	24	35	11	0	1	0	0	0	0	0	0	0	40.3	12.3	60.2	49.3
19:00 20:00	72	0	67	0	4	1	0	0	0	0	0	0	0	0	0	0	1	8	5	1	11	20	13	7	6	0	0	0	0	0	0	0	0	41.1	16.3	59.4	50.6
20:00 21:00	33	0	31	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	5	11	7	4	1	0	0	0	0	0	1	0	0	43.7	19.1	87.8	50.4
21:00 22:00	25	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0	9	6	4	1	0	0	0	0	0	0	0	0	42.2	21.4	58.1	53.2
22:00 23:00	21	0	19	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4	11	3	1	0	0	0	0	0	0	0	0	0	40.4	17.7	52.9	47.2
23:00 00:00	13	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	3	3	1	1	0	0	0	0	0	0	0	0	41.7	20.4	59.0	54.3
07:00-19:00	1442	13	1269	7	131	6	2	0	4	4	6	0	0	0	1	3	17	104	125	58	229	393	335	138	32	6	1	0	0	0	0	0	0	40.7	5.8	68.0	49.3
06:00-22:00	1621	13	1431	8	143	9	2	0	4	5	6	0	0	0	1	3	19	116	135	62	253	446	373	162	42	7	1	0	0	0	1	0	0	40.9	5.8	87.8	49.4
06:00-00:00	1655	13	1463	8	145	9	2	0	4	5	6	0	0	0	1	3	20	118	135	63	260	460	379	164	43	7	1	0	0	0	1	0	0	40.9	5.8	87.8	49.4
00:00-00:00	1678	13	1483	8	147	10	2	0	4	5	6	0	0	0	1	3	20	118	137	65	262	464	389	166	44	7	1	0	0	0	1	0	0	41.0	5.8	87.8	49.4
Date: 15 October 2019																																					
00:00 01:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	43.3	40.4	46.8	-
01:00 02:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	41.0	41.0	41.0	-
02:00 03:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	43.5	41.1	45.8	-
03:00 04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-
04:00 05:00	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	42.9	40.9	45.9	-
05:00 06:00	12	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	7	1	0	0	0	0	0	0	0	0	0	45.3	33.5	53.0	49.6
06:00 07:00	51	0	46	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	15	15	10	5	0	0	0	1	0	0	0	0	47.0	24.2	77.1	53.5
07:00 08:00	159	1	136	1	19	1	0	0	0	0	0	1	0	0	0	0	0	8	6	7	12	49	44	21	11	1	0	0	0	0	0	0	0	44.1	21.4	62.7	51.7
08:00 09:00	151	0	134	1	13	1	0	0	0	0	2	0	0	0	0	0	0	5	5	8	16	57	28	23	5	4	0	0	0	0	0	0	0	43.8	22.5	64.0	51.2
09:00 10:00	130	0	112	0	15	1	1	0	1	0	0	0	0	0	0	0	1	9	11	4	16	38	34	14	2	1	0	0	0	0	0	0	0	41.3	16.0	61.6	49.5
10:00 11:00	143	0	122	1	18	2	0	0	0	0	0	0	0	0	0	0	1	8	8	9	14	40	34	22	5	2	0	0	0	0	0	0	0	42.7	18.6	61.9	51.4
11:00 12:00	113	1	96	0	15	0	1	0	0	0	0	0	0	0	0	0	0	6	9	1	21	30	29	12	4	1	0	0	0	0	0	0	0	42.3	21.8	60.2	50.2
12:00 13:00	117	1	101	0	14	0	0	0	1	0	0	0	0	0	0	0	1	4	12	5	9	40	22	15	8	1	0	0	0	0	0	0	0	42.5	19.3	62.3	51.9
13:00 14:00	145	1	120	1	20	0	1	0	0	1	1	0	0	0	0	0	0	11	15	6	38	45	17	4	9	0	0	0	0	0	0	0	0	39.7	20.5	58.6	47.3
14:00 15:00	118	0	107	0	11	0	0	0	0	0	0	0	0	0	0	0	0	8	10	5	23	39	20	10	3	0	0	0	0	0	0	0	0	40.5	20.5	59.5	49.1
15:00 16:00	107	1	91	0	14	1	0	0	0	0	0	0	0	0	0	0	0	14	8	9	26	26	13	7	3	0	1	0	0	0	0	0	0	38.6	22.1	68.1	47.0
16:00 17:00	121	1	105	0	12	1	0	0	1	1	0	0	0	0	0	0	0	20	17	6	18	30	20	6	3	0	1	0	0	0	0	0	0	37.8	20.4	65.8	47.5
17:00 18:00	129	0	116	2	10	0	1	0	0	0	0	0	0	0	0	1	0	23	25	8	17	22	23	6	3	1	0	0	0	0	0	0	0	36.3	14.6	64.1	47.1
18:00 19:00	117	0	107	2	7	0	0	0	0	0	1	0	0	0	0	0	1	11	20	6	20	35	16	5	3	0	0	0	0	0	0	0	0	37.8	16.0	58.4	46.9
19:00 20:00	50	0	46	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	6	5	3	16	12	4	3	0	0	0	0	0	0	0	0	41.7	22.0	56.7	50.0
20:00 21:00	38	0	37	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	6	8	7	10	2	1	0	0	0	0	0	0	0	0	40.2	22.0	55.9	47.9
21:00 22:00	24	0	22	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	3	4	2	4	3	3	2	2	0	0	0	0	0	0	0	41.9	23.5	62.7	55.5
22:00 23:00	20	0	19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	1	7	2	3	1	0	0	0	0	0	0	0	0	40.7	22.3	55.5	51.3
23:00 00:00	13	0	12	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	1	2	2	3	1	0	0	0	0	0	0	0	0	0	37.1	21.0	54.9	47.3
07:00-19:00	1550	6	1347	8	168	7	4	0	3	2	4	1	0	0	0	1	4	127	146	74	230	451	300	145	59	11	2	0	0	0	0	0	0	40.8	14.6	68.1	49.6
06:00-22:00	1713	6	1498	10	175	10	4	0	3	2	4	1	0	0	0	1	4	132	158	90	245	493	340	164	70	13	2	0	1	0	0	0	0	41.0	14.6	77.1	49.8
06:00-00:00	1746	6	1529	10	176	11	4	0	3	2	4	1	0	0	0	1	4	137	159	95	248	502	345	168	71	13	2	0	1	0	0	0	0	41.0	14.6	77.1	49.8
00:00-00:00	1767	6	1549	10	177	11	4	0	3	2	4	1	0	0	0	1	4	137	159	96	248	511	355	169	71	13	2	0	1	0	0	0	0	41.0	14.6	77.1	49.8
Date: 16 October 2019																																					
00:00 01:00	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	34.6	21.1	41.9	-
01:00 02:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	32.2	32.2	32.2	-
02:00 03:00	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	35.7	28.1	44.4	-
03:00 04:00	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	37.4	37.4	37.4	-
04:00 05:00	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	40.1	36.1	44.2	-
05:00 06:00	15	0	14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	8	3	2	0	0	0	0	0	0	0	0	0	43.8	32.9	51.4	49.8
06:00 07:00	59	0	49	0	9	1	0	0	0	0	0	0	0	0	0	0	0	1	4	1	3	14	18	15	2	1	0	0	0	0	0	0	0	45.7	23.6	62.0	53.0
07:00 08:00	154	2	133	0	15	1	1	0	0	2	0	0	0	0	0	0	1	9	9	6	13	29	46	28	13	0	0	0	0	0	0	0	0	44.0	19.5	58.7	52.4
08:00 09:00	155	0	125	2	23	2	1	0	1	0	1	0	0	0	0	0	1	7	5	6	22	43	32	28	6	4	0	1	0	0	0	0	0	43.9	16.0	74.2	52.3
09:00 10:00	172	0	163	0	8	0	1	0	0	0	0	0	0	0	0	0	0	11	11	2	24	53	50	15	6	0	0	0	0	0	0	0	0	42.2	20.1	59.2	49.5
10:00 11:00	116	0	97	0	19	0	0	0	0	0	0	0	0	0	0	0	1	11	4	2	17	28	34	15	3	1	0	0	0	0	0	0	0	42.3	16.0	61.2	50.4
11:00 12:00	117	0	100	1	13	1	1	0	0	1	0	0	0	0	0	0	0	5	9	5	13	36	30	19	0	0	0	0	0	0	0	0	0	42.6	20.7	54.9	50.3
12:00 13:00	121	0	103	0	16	1	0	0	1	0	0	0	0	0	0	0	1	6	5	2	17	39	28	15	7	1	0	0	0	0	0	0	0	43.5	19.4	60.8	51.4
13:00 14:00	109	0	96	0	10	0	1	0	0	1	1	0	0	0	0	0	0	5	13	1	16	25	28	17	4	0	0	0	0	0	0	0	0	42.3	23.3	59.1	50.4
14:00 15:00	107	0	99	0	6	0	1	0	0	1	0	0	0	0	0	0	2	7	7	3	21	33	25	8	1	0	0	0	0	0	0	0	0	40.7	17.0	58.7	47.9
15:00 16:00	119	0	108	1	10	0	0	0	0	0	0	0	0	0	0	1	0	9	12	5	22	42	23	5	0	0	0	0	0	0	0	0	0	39.2	12.3	53.3	46.3
16:00 17:00	129	0	114	1	12	0	0	0	0	1	1	0	0	0	0	0	0	18	14	7	21	41	18	6	3	1	0	0	0	0	0	0	0	38.4	20.5	61.2	46.2
17:00 18:00	147	0	138	1	8	0	0	0	0	0	0	0	0	0	0	0	0	24	24	4	22	32	33	7	1	0	0	0	0	0	0	0	0	37.6	20.5	55.1	48.4
18:00 19:00	99	1	91	0	7	0	0	0	0	0	0	0	0	0	0	1	2	7	16	10	20	25	17	1	0	0	0	0	0	0	0	0	0	36.9	14.8	52.6	46.9
19:00 20:00	74	0	70	0	4	0	0	0	0	0	0	0	0	0	0	0	0	6	2	5	17	30	10	3	1	0	0	0	0	0	0	0	0	40.1	23.6	57.0	46.0
20:00 21:00	38	0	32	2	4	0	0	0	0	0	0	0	0	0	0	0	1	1	2	4	6	14	8	2	0	0	0	0	0	0	0	0	0	40.5	19.1	52.4	47.1
21:00 22:00	25	0	21	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	7	12	2	1	1	0	0	0	0	0	0	0	0	40.6	23.7	55.9	46.5
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00:00-00:00	1793	3	1588	8	169	7	6	0	2	7	3	0	0	0	0	2	9	132	141	69	269	514	409	190	48	8	1	1	0	0	0	0	0	41.3	12.3	74.2	49.7
5 day (Weekday) Average																																					
07:00-19:00	1512	8	1342	7	135	6	3	0	3	4	4	0	0	0	0	3	13	129	126	68	261	433	308	127	34	8	1	0	0	0	0	0	0	40.3	11.3	69.3	48.8
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7 day (Weekly) Average																																					
07:00-19:00	1419	11	1272	6	113	6	3	0	2	3	3	0	0	0	0	3	12	114	112	62	240	408	300	125	34	8	2	0	0	0	0	0	0	40.7	11.7	69.1	49.1
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06:00-00:00	1619	11	1455	7	125	8	3	0	2	4	3	0	0	0	0	3	13	127	123	76	275	465	339	144	41	10	2	0	0	0	0	0	0	40.7	11.6	73.2	49.1
00:00-00:00	1648	11	1482	7	126	9	3	0	2	4	3	0	0	0	0	3	14	128	124	78	280	474	347	145	42	10	2	0	0	0	0	0	0	40.8	11.6	73.2	49.1

Cameron+Ross

A/190889

PROPOSED CREMATORIUM
BURNSIDE OF DUNTRUNE
ANGUS

TRANSPORTATION ASSESSMENT
REV – 02
(Amendments in Red Text)

MARCH 2020

FM & G BATCHELOR
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CONTENTS

REVISION SCHEDULE

Rev No.	Description of Amendment	Prepared By	Approved By	Date
-	Draft Issue	B. Clark	R. Gibb	Jan 2020
01	Issue to Angus Council for Comment	B.Clark	R.Gibb	Feb 2020
02	Response to Angus Council Traffic Team Comments	B.Clark	R.Gibb	March 2020

A/190889 – PROPOSED CREMATORIUM, BURNSIDE OF DUNTRUNE

1.0 INTRODUCTION

1.1 Cameron + Ross have been appointed by FM & G Batchelor to prepare a Transportation Assessment (TA) to support a planning application for a proposed crematorium development at Burnside of Duntrune.

1.2 A Scoping meeting was held with Angus Council Traffic Team in November 2019.

1.3 The purpose of this Transportation Assessment is to assess the suitability of the site transport infrastructure proposals, the local road network and local transport infrastructure for the development and to respond to the Scoping Meeting items raised by the Angus Council Traffic Team.

2.0 DEVELOPMENT PROPOSALS

2.0 The site is 4.5 hectares and is proposed to be developed for a 120-seating capacity crematorium.

2.1 The site is located on the north side of the C4 and is set in a rural location around 7km to the northeast of Dundee City Centre and around 0.5km to the east of the village of Burnside of Duntrune. The Site Location Plan is contained below:

BALDOVIE ROAD

Figure 1 – Site Location Plan.

2.2 The site is surrounded by wooded areas to the north, east and west beyond which is generally agricultural land. Agricultural land also bounds the site to the to the south of the C4.

Development Layout and Access Overview

2.3 The Architects Proposed Site Layout Plan is contained below and shows that a single simple priority T-junction is proposed for the site access taken from the C4.

ARCHITECTS SITE LAYOUT PLAN TO FOLLOW

Figure 2 – Proposed Site Layout Plan

2.4 The site frontage is currently a national speed limit 60mph. The C4 along the site frontage is typically 4.75m to 5.2m in width. It is now proposed to widen the existing road to 5.5m along the full length of the site frontage.

2.5 At the scoping meeting it was agreed that the new access priority T-junction will require 4.5m x 120m visibility splays in both directions. This was agreed as a result of the weekly average of the 85%tile speed survey results taken along the site frontage being 40mph eastbound and 42mph westbound. Using a 40mph design speed which corresponds to a 70A kph design speed in accordance with the DMRB. The speed survey results are contained within **Appendix A**.

2.6 Similarly it was agreed that the desired visibility in both directions at the Unclassified Road junction with Kellas Road is 4.5m x 160m as a result of the weekly average 85%tile surveyed speeds being 48mph eastbound and 49mph westbound. This corresponds to a 50mph or 85A kph design speed.

2.7 The desired 4.5m x160m visibility is achieved on the Unclassified Road looking southbound although this requires shrubs/grass etc to be cut down to ground level to achieve this. Looking northbound around 2.4mx160m is achieved once tress/shrubs/grass are cut back and down to ground level within the visibility splay which is within the adopted road envelope.

2.8 It should be noted that the local authority is currently not adequately maintaining the stated desired visibility splays at the Unclassified Road/ Kellas Road junction as only a narrow strip of verge is being cut. The existing visibility splays for the junctions considered within this assessment are contained within **Appendix B**.

2.9 A review of the existing road widths has been undertaken. The existing road widths, signage, passing place provision and proposed improvements are shown within the drawings provided within **Appendix B**. This shows that the existing C4 along the site frontage is typically between 4.8m and 5.18m in width. Continuing southbound to the C4/unclassified road junction the C4 is typically between 5.1 and 5.7m in width. The road then continues southbound from this junction as an unclassified road where the width remains between 4.65m and 5.5m in width.

2.10 The stretch of C4 between the unclassified Road and the B978 Kellas Road is narrower with a typical width of 3.8m to 4.2m. As a result, it is anticipated that this route will see a lesser traffic generation than the unclassified road coming off Kellas Road. It is therefore suggested that the signed route is via the unclassified Road. This also takes traffic through the junction off Kellas Road with the better visibility splay provision

2.11 Also the C4 junction with the unclassified Road and the B978 Kellas Road has substandard visibility splay provision.

Parking Provision

2.12 At the scoping meeting it was agreed that for a 120 seating capacity crematorium Angus Council would be looking for 40 spaces to be provided. Based on subsequent information it is proposed that a total of 90 spaces will be provided with a significant proportion of this being overflow with a soft appearance so as not to have the majority of funerals that have a lower attendance have to deal with a large empty, baron and unattractive parking areas.

2.13 The National Parking Standard indicates that there should be a minimum of 4 No disabled spaces or 4% of the total capacity. 4% of 90 spaces provided is 4 spaces.

2.14 A separate staff car parking area will be provided. There is expected to be 4 full time staff and therefore 4 staff spaces are considered to be adequate corresponding to 1 space per permanent staff member. 1 disabled user staff space will be provided. 1 of the staff spaces will also be an electrical charge point.

Review of agreed Parking Provision for Existing Crematorium

Brewsterswells, 100 Acre Wood, (Fife) – 120 Seats

2.15 The spaces provided are 90 total, including 50 standard, 4 disabled, 32 over flow and 4 staff.

Parkgrove, 164 Seats

2.16 In 2011 conducted 750 cremations averaging 3 per week as proposed for this smaller crematorium. Parkgrove has only 24 formal spaces for cars with large overspill on loop road, totalling 100 car capacity. Parkgrove sees an average occupancy of 3 people / car.

3.0 SUSTAINABLE TRAVEL OPPORTUNITIES

Walking

3.1 Due to the rural nature of the development there are no footpath links to the crematorium site. Adequate footpath provision to link the various car park areas to the crematorium building will be provided within the Architects development layout.

Cycle Infrastructure

3.2 It is very unlikely that anyone will travel to a funeral by cycle given the rural location of the development. As a result, no public cycling facilities is proposed to be provided. Those who wish to cycle to the crematorium by cycle to visit the memorial gardens would be able to keep their cycle with them within the memorial gardens and therefore there is no requirement for a public cycle storage facility.

3.3 There is anticipated to be 4 full time staff and therefore the provision of a single Sheffield stand would suffice to comply with the National Parking Standard which requires 1 space per 4 permanent staff members. There will be locker and shower facilities available for staff to use.

3.4 There is no designated cycle routes within the vicinity of the site and cyclists would require to the carriageway.

3.5 Given the anticipated low public demand for cycling to the development and the proposed staff cycle parking, locker and shower facilities it is considered that there is adequate provision for cyclists should they wish to travel to the crematorium.

<u>Public Transport</u>

Existing Provision

3.6 There are no public transport directly within the vicinity of the site. The nearest bus stops are on Kellas Road at the junction with Fithie Bank. This is approximately 1.6km walking distance from the site.

3.7 Further buses can be accessed on Hawick Drive off the Drumgeith Road approximately 2.4km from the site. There is no footpath provision from the site until the Kellas Road junction with Poplar Drive approximately 1.4km from the proposed crematorium site.

3.8 The Table below gives a summary of the buses that can be accessed from the bus stops.

				Typical Time Interval Between Services	
Service Operator	**Service Type**	**Service No.**	**Journey**	**Peak Hours**	**Outwith Normal Hours**
Moffat & Williamson	Bus	78C	Dundee to Monikie via Kellas Rd		There is a total of 3 services per day
Moffat & Williamson	Bus	78A/79A	Monikie to Dundee via Kellas Rd		There is a total of 4 services per day
Moffat & Williamson	Bus	88 at Hawick Drive	Whitfiled – Broughty Ferry Circular via Hawick Drive	hourly	hourly

Table 1 – Summary of Existing Public Transport Provision.

3.9 Given the rural nature of the site there is little opportunity for crematorium visitors to travel by public transport to the site. It is also unlikely that staff would utilise public transport given the distance from the site to the nearest bus stops.

3.10 There will be potential for people to travel to the site by private bus and the site layout is designed to have adequate space for buses although no designated space will be provided. Buses would be expected to utilise the overspill parking area.

4.0 NETWORK ANALYSIS

Road Network Extent Considered

4.1 The initial extent of the existing road network to be included in the study was agreed with Angus Council Traffic Team at the scoping meeting and includes the following junctions:

- New Site Access junction
- C4/C6 simple priority T-junction
- Unclassified Rd/ C4 simple priority T-Junction
- C4/ Kellas Road simple priority T-Junction
- Unclassified Road/ Kellas Road simple priority T-Junction

4.2 The following junction with the Dundee City Council area is also within the extent of road network considered. The B978 Baldovie Road is dual-carriageway and changes to single carriageway at Drumgeith Road. Kellas Road is also designated as the B978.

- Kellas Road/Baldovie Road/Drumgeith Road ghost island right turn junction.

Traffic Surveys

4.3 A turning count traffic survey was undertaken by Transurveys Ltd on Tuesday the 8th of October 2019 at the B961 Drumgeith Road/B978 Kellas Road and Baldovie Road ghost island junction. A week long speed survey was also undertaken at the same period on the B978 Kellas Road approximately 30m south of the unclassified road. A speed survey was also undertaken on the C4 along the site frontage. Straight ahead flows are also provided at the speed survey locations for the peak periods. The traffic flow survey data is contained within **Appendix A**.

4.4 The AM and PM peak flows were established from the traffic counts and are displayed in the road network diagrams below:

Assessment Years/Periods

4.5 We confirm a we will assess the development for a proposed opening year of 2021 and the NRTF central growth rate has been applied to the 2019 base flows. The NRTF central growth factor is = a growth rate of 1.19% over 2 years which = 1.019*1.019= 1.038. The 2021 AM and Pm Base Flows are contained in the figures below.

Cameron + Ross AC19

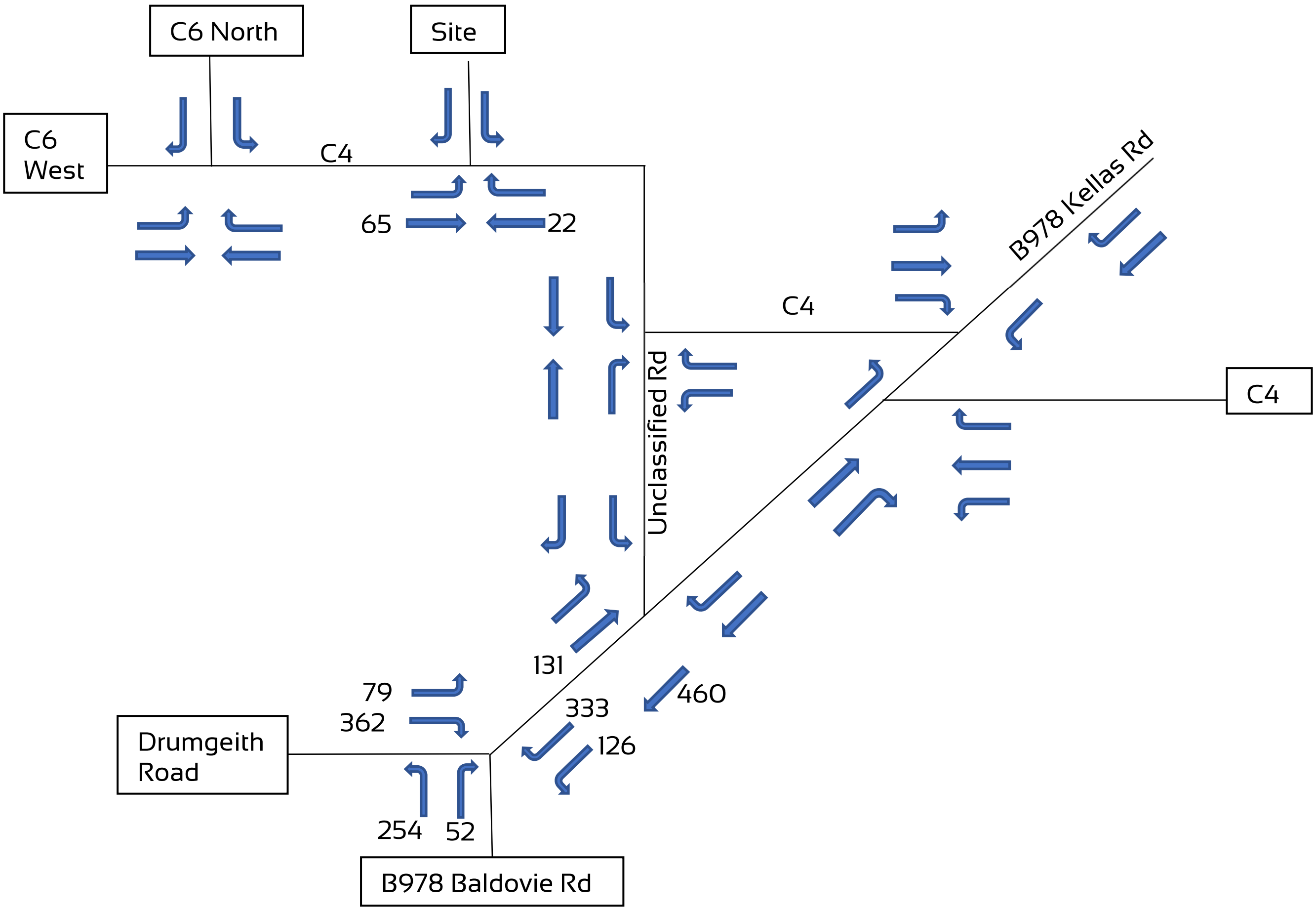

Figure 3 – 2019 Weekday AM Surveyed Base Flows 07:30 – 08:30 (PCUs)

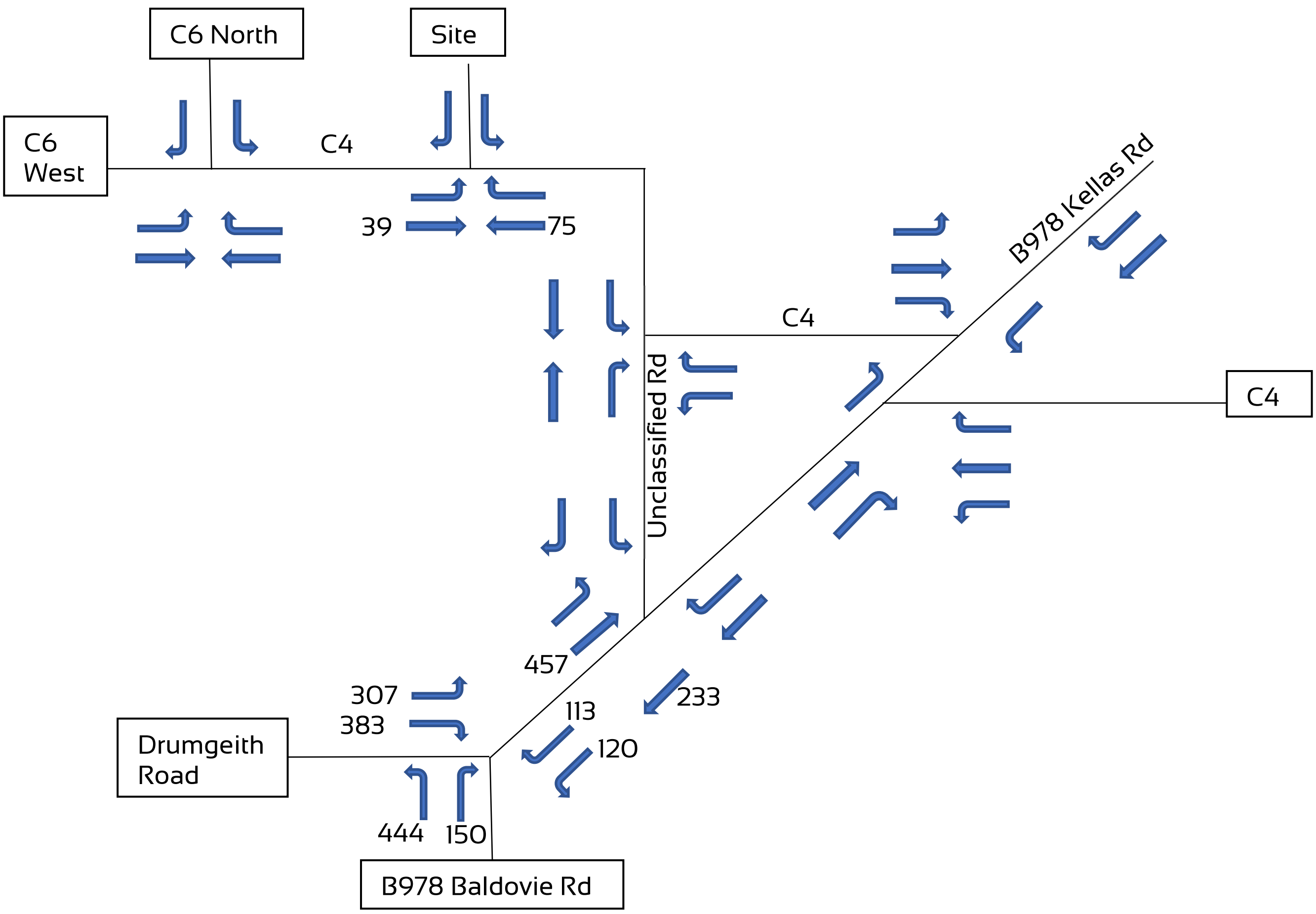

Figure 4 – 2019 Weekday PM Surveyed Base Flows 16:15 – 17:15 (PCUs)

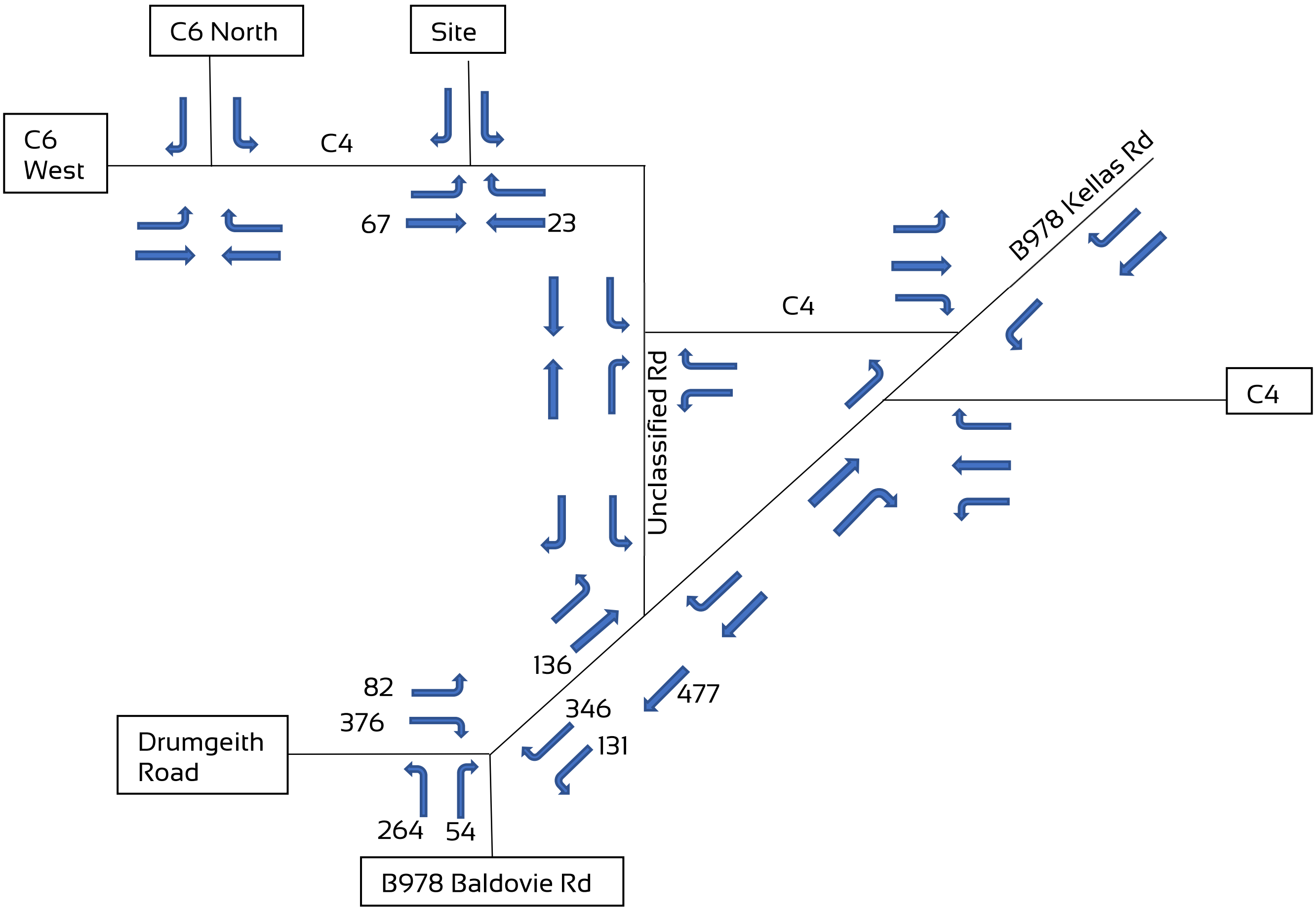

Figure 5 – 2021 Weekday AM Base Flows 07:30 – 08:30 (Vehicles)

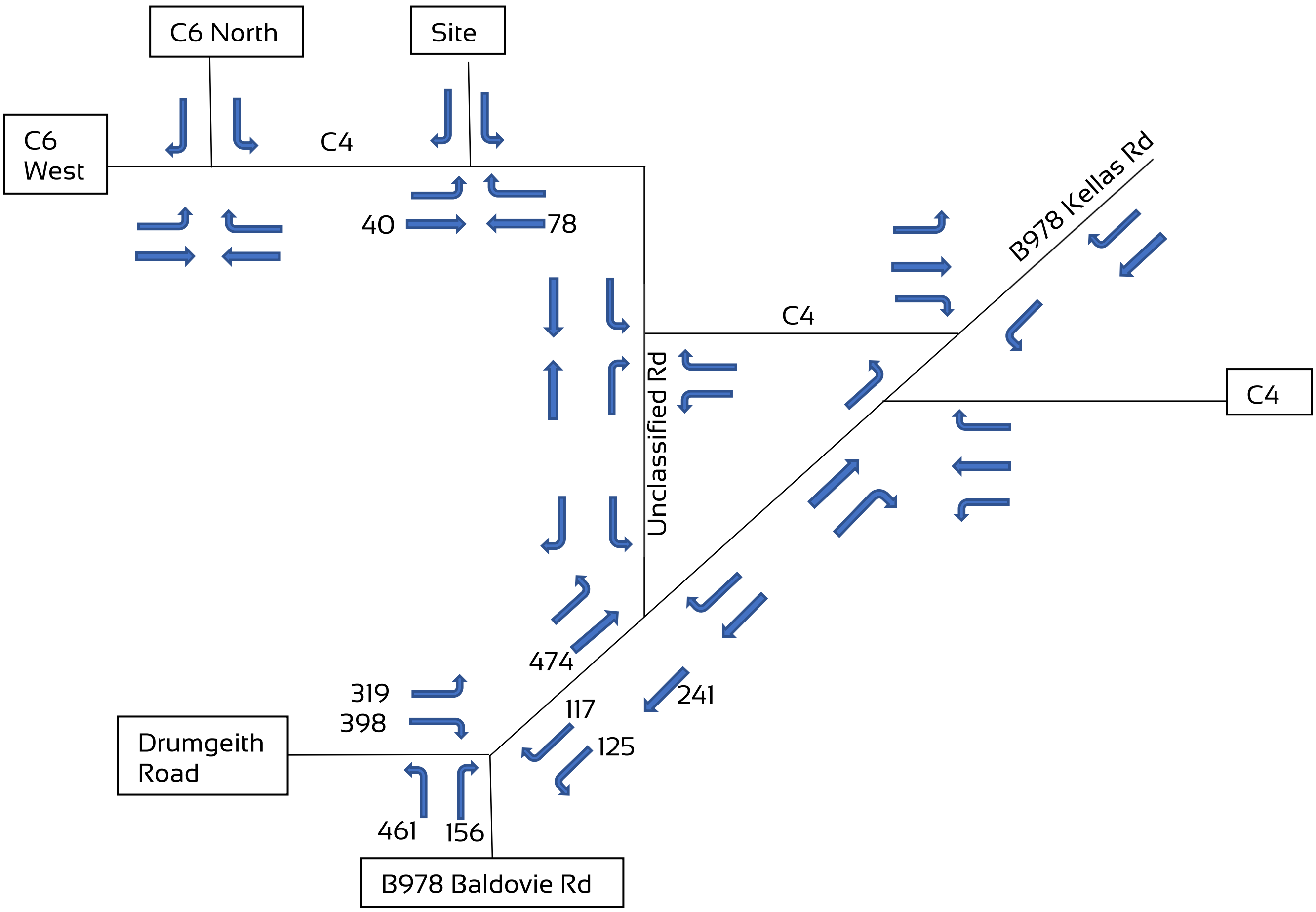

Figure 6 – 2021 Weekday PM Base Flows 16:15 – 17:15 (Vehicles)

TRIP GENERATION

4.6 As there are no sites from Crematoriums within the TRICS database the generated trips will be based on the expected usage of the Crematorium. The following information has been provided by the developer. Some of the information has been based on a previous TA undertaken for a Crematorium at 100Acre Wood in Fife which used information obtained from Parkgrove Crematorium near Friockheim.

- The Crematorium will have a seating capacity of 120.
- There is expected to be an average of 3 cremations per day.
- There will be no weekend cremations.
- A maximum of 5 cremations per day will take place.
- Cremations will be at a minimum of 1-hour intervals (i.e. There is a minimum of 1-hour gap between a service ending and the next one starting).
- Cremations start times will be between 09:00 and 16:00.
- 4 full time staff.
- Cremations will be attended by an average of 70 people arriving in 24 cars, with a very infrequent extreme maximum of 200 people arriving in 67 cars. This is based on the average occupancy of 3 people per car as experienced at Parkgrove (See section 2.16)
- There will be a memorial garden which is expected to not have a high peak demand with peak usage expected at weekends when there are no cremations planned.
- Coaches will be expected at approximately 3% of funerals.
- Visitors to the memorial gardens will generate an average of 10 vehicles per day although this will only reach this figure once the garden is fully established.

4.7 It is unlikely that two maximum capacity funerals would take place back to back and these are not expected to occur with any great frequency. Therefore, the worst case frequently experienced scenario to be considered is for an average size funeral leaving and an average size funeral arriving within the same hourly period. Therefore, it is considered that 24 cars arriving and leaving within the same hour should be assessed for impact on the local road network.

<u>Trip Distribution</u>

4.8 It was agreed at the scoping meeting that a population gravity/distribution model should be used to determine the percentage distribution of the generated trips. A population gravity model was considered however this would likely lead to a much disproportionately high proportion of trips from Dundee given the high population and short distance to the site. The crematorium is to primarily serve the Angus Council District.

4.9 The distribution is therefore based on a population distribution model which has been determined using the populations of electoral ward areas provided within the Scotland Census 2011 data. This has considered the catchment area of the crematorium to be the Angus Council electoral wards and the Dundee City Council wards. The extent of the electoral wards selected is shown below:

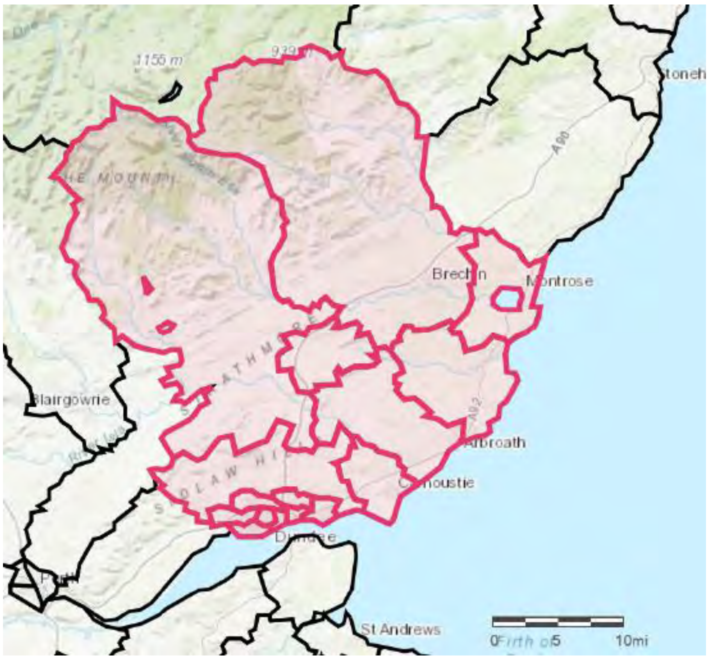

Figure 7 – Scottish Census Electoral Ward Areas – Proposed Crematorium Catchment Area

4.10 A percentage of the traffic from each electoral ward area has been apportioned to the most likely routes used from these electoral wards to access the crematorium and enter the assessed road network area.

4.11 The population distribution model is contained in **Appendix C**. The % distribution through the assessed road network is in figure 8 below:

4.12 The proposed traffic generated by the development with 24 inbound and 24 outbound trips is shown in the figure 9 below:

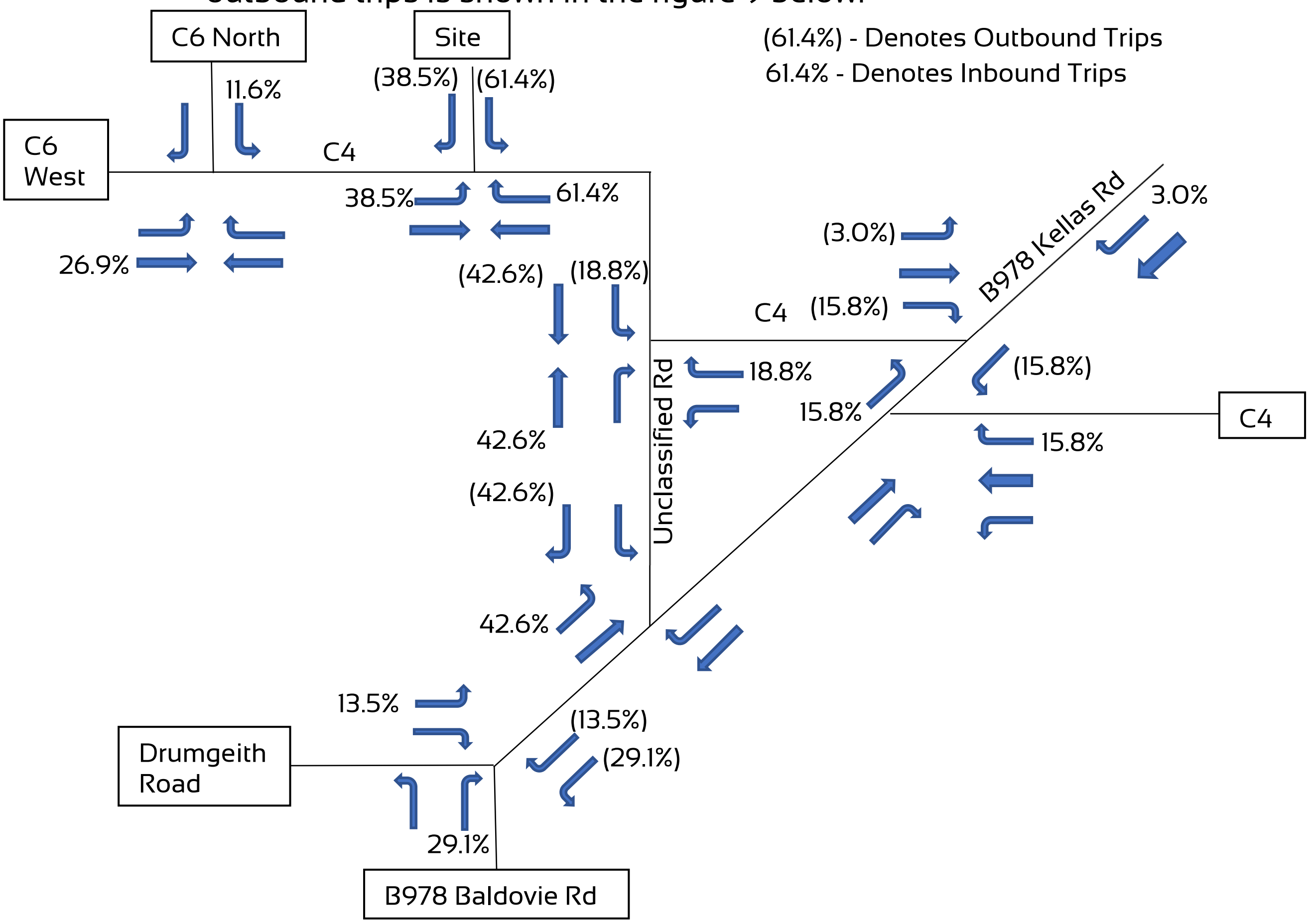

Figure 8 – Generated Trip Distribution

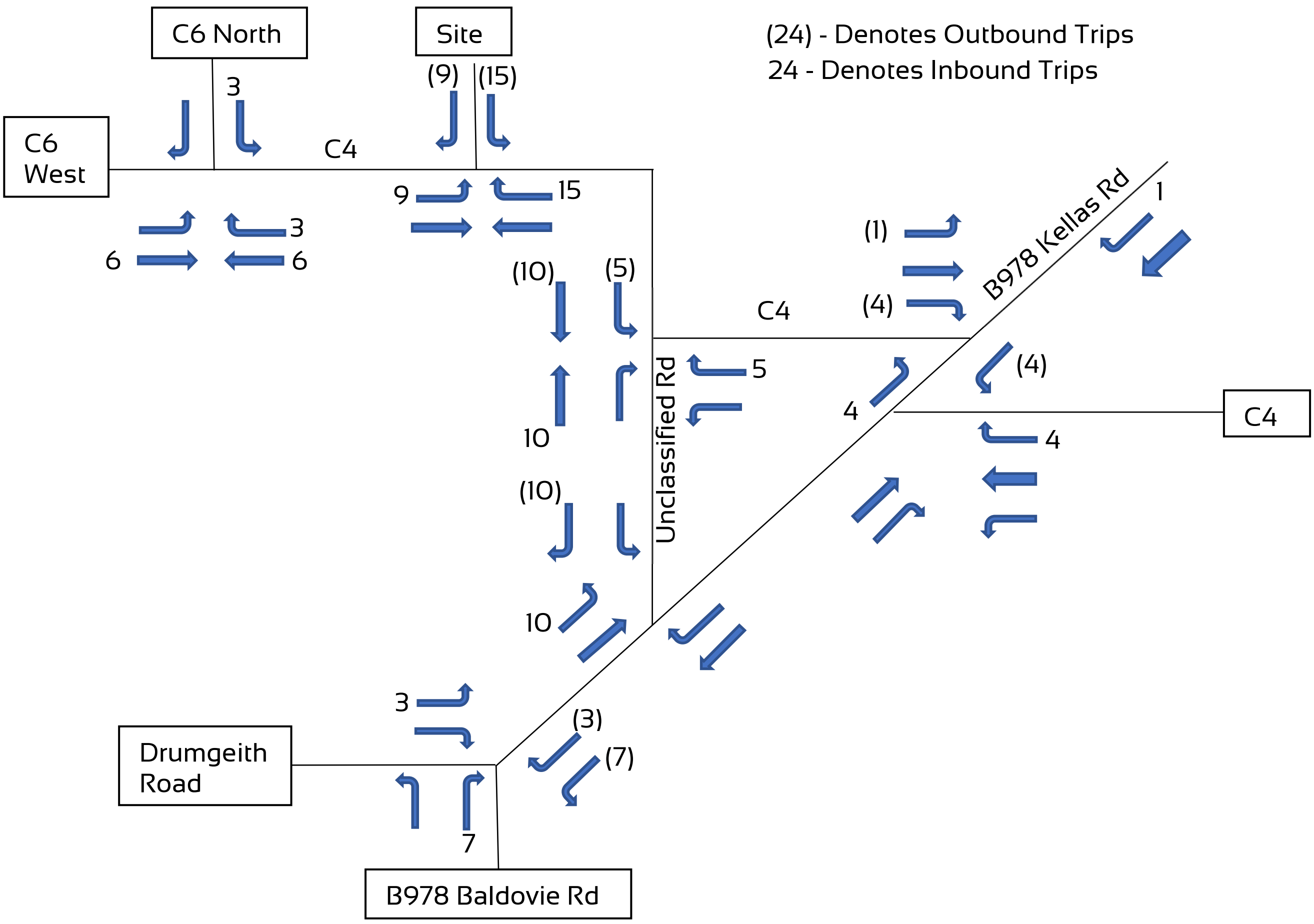

Figure 9 – Generated Trips Based on Average Funerals

Committed Developments

4.13 There are no known committed developments to consider.

Threshold Assessment

4.14 The above proposed traffic generation figures are applied to the 2021 AM and PM Base Flows to determine the 2-way flow thresholds assessment which is shown in the figures below. Where the generated traffic results in an increase of greater than 5% a junction capacity analysis is normally considered to be required to be undertaken. Although where existing plus proposed development traffic is clearly shown to be well below that expected to cause capacity and queuing issues then it is accepted that modelling is not required in these circumstances.

4.15 Based on the figures below it is shown that due to the relatively small existing traffic flows on the existing minor roads there is a large percentage increase in traffic resulting from the development with a 27% increase during the AM peak on the C4 at the site frontage. Due to the existing traffic flows and expected traffic generation it was accepted at the scoping meeting that there would be no requirement to model the proposed site access junction provided a simple priority T-junction with adequate visibility lines is provided.

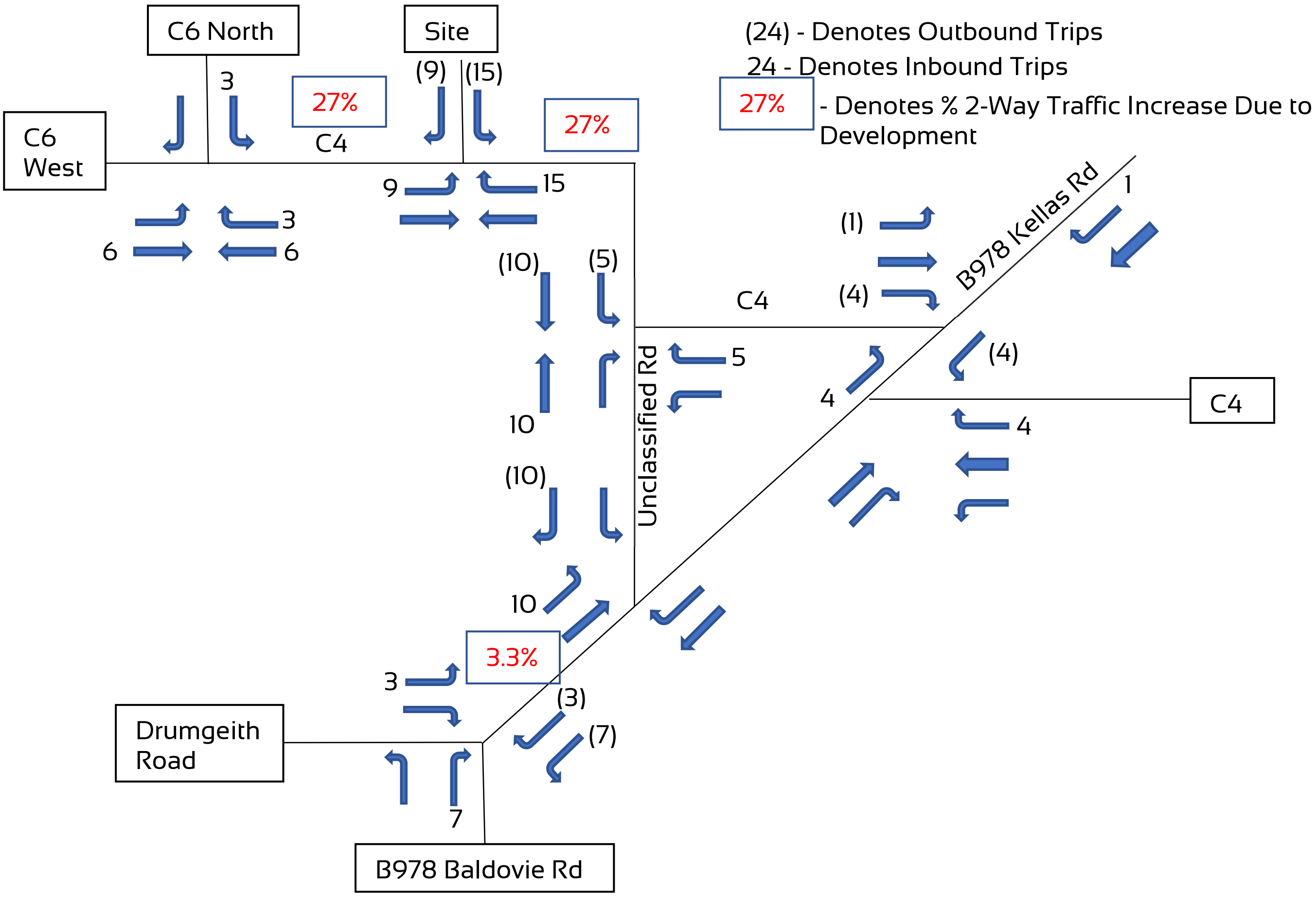

Figure 10 – 2-Way Traffic Threshold Assessment Generated Trips Based on Average Funerals Compared with 2021 AM Base Flow

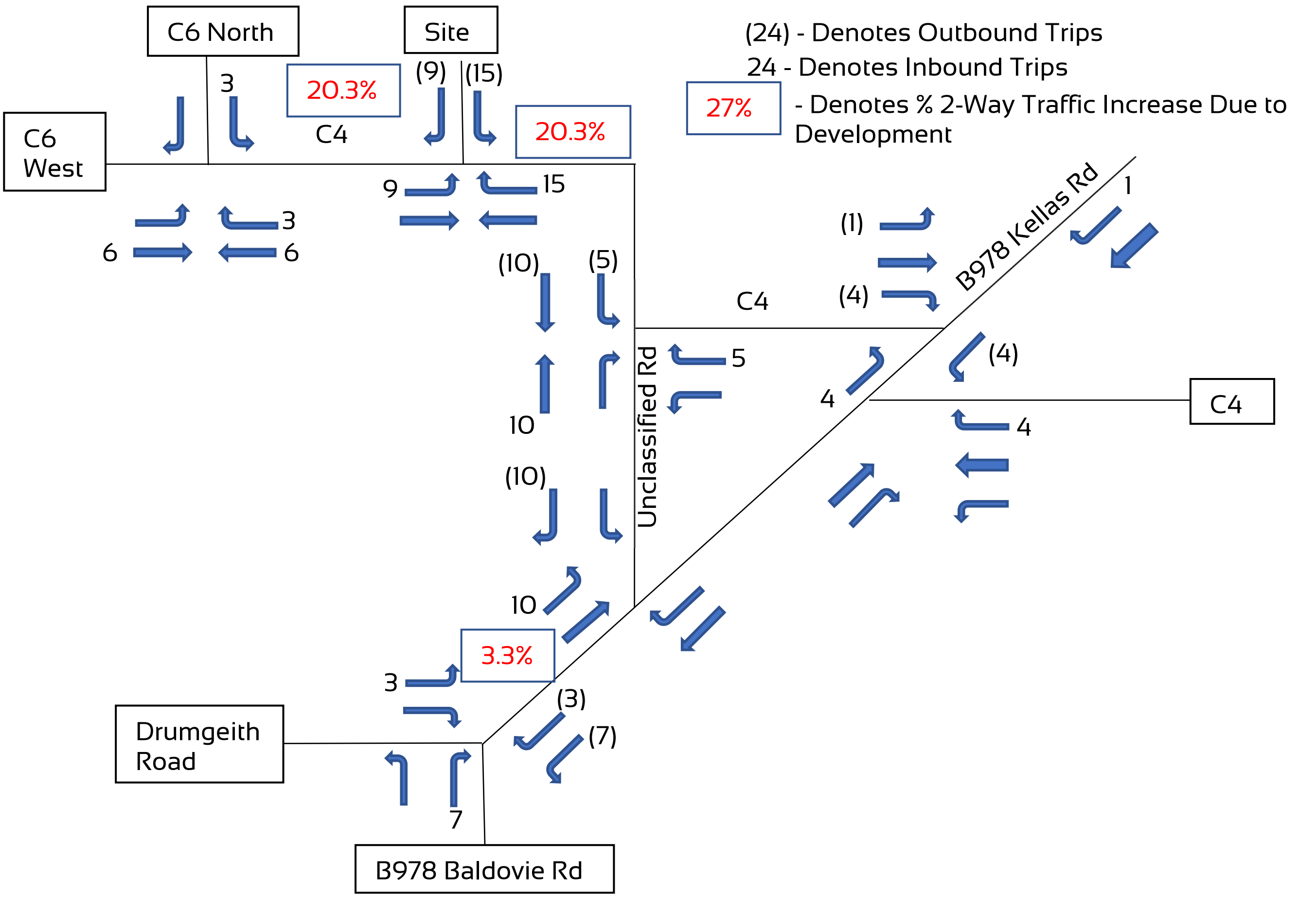

Figure 11 – 2-Way Traffic Threshold Assessment Generated Trips Based on Average Funerals Compared with 2021 PM Base Flow

5.15 The increases in traffic are only 3.3% for both AM and PM peak periods on Kellas Road itself and therefore there is no requirement for a capacity analysis of the Kellas Road junction with Baldovie Road. Even if it was considered that one maximum seating capacity funeral was followed by an average funeral the percentage increase on Kellas Road would then only increase to 4.4%.

5.0 CONCLUSIONS

5.1 The proposed 120 seating capacity crematorium is anticipated to serve primarily the Angus Council area.

5.2 Given its location close to Dundee a reasonable percentage of trips would be generated from Dundee which is the largest population within the nearby area.

5.3 The proposed site access will be in the form of a simple priority T-junction taken off the C4 with 4.5m x 120m visibility splays provided each side to suit the design speed of 40mph established through speed surveys.

5.4 Junction modelling for the proposed simple priority T-junction site access junction is not required as a result of the existing low traffic flows and the scale of the development would clearly not result in the proposed access junction having any capacity issues. It is also considered that there is no requirement to undertake junction capacity modelling on any of the existing road network junctions.

5.5 It is proposed to provide signage so that those accessing the site from the C4 West and from Baldovie Road are directed to use the unclassified Road rather than the C4 section between the unclassified Road and Kellas Road due to this section of the C4 having a lesser road width than the unclassified road. Also the C4 junction with B878 Kellas Road has substandard visibility.

5.6 A number of additional passing places will be provided along the C4 and unclassified road as identified on the drawings in **Appendix B**.

5.7 The existing road along the full length of the site frontage will be widened to 5.5m.

5.8 The unclassified junction with the B978 Kellas Road desired visibility is 4.5mx160m to suit a 50mph design speed which has been determined by speed survey data presented within this report. Bushes/shrubs within the adopted road envelope requires to be cleared in order for this to be achieved when looking to the South.

5.9 At the same junction the visibility achieved to the North is 2.2mx160m and again this will require shrubs and grass to be cut back within the road envelope in order to provide this visibility. Once this is undertaken this will improve the existing visibility at the junction and therefore it is considered that the visibility provided is acceptable.

5.10 A total of 90 spaces are proposed including 50 standard, 4 disabled , 32 overflow and 4 staff.

5.11 Bus services are available although these are some distance from the site however it is not expected that there would be any significant demand for public transport provision given the nature of the development.

5.12 There are currently no footpath or cycle links to the site and given the nature of the development there is no proposal to provide a footpath link.

5.13 As a result, of the low traffic impact on the surrounding road network and the proposed access provision and improvements to existing visibility splays there is no foreseeable reason for refusal of the proposed planning application, in terms of traffic impact or transport provision.

BAC
30.03.2020

APPENDIX A – TRAFFIC SURVEY AND SPEED SURVEY DATA

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EMISSIONS MONITORING TEST REPORT

East Devon Crematorium

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12th – 13th July 2011

Report Authorised by [redacted]
Mr S P Atherton
Business Manager
EA MCertS Level 2 + TE1,2,3
MM 03 336

Date 11th August 2011

ST/DEM0508/12.07.11

CONTENTS

1. INTRODUCTION

The cremator and associated flue gas treatment system at East Devon Crematorium was monitored between the 12th & 13th July 2011 to the requirements given in Process Guidance Note PG5/2 (2004) for emission releases to atmosphere for abated plant.

The work involved monitoring a range of flue gas components with the plant operating normally.

The plant comprises one Cremator of model type FTIII which has a wide hearth capable of accepting large coffin sizes. The cremator is fitted with two nozzle mix burners utilising propane as the support fuel.

The waste gases from the cremator are ducted to a flue gas treatment plant. The treatment plant comprises of a shell and tube boiler to cool the flue gases, a reagent feeder station that introduces a blend of activated carbon/sodium bicarbonate to react with the cooled gases, and a bag filter to clean the treated gases. The waste heat from the boiler in the form of warm water is dissipated to atmosphere via a finned tube air blast cooler situated outside the crematory.

The plant operates under full microprocessor based automatic control that requires little manual intervention.

The cremator and flue gas clean up system were manufactured, installed and commissioned by Facultatieve Technologies Limited to meet the requirements of the Environmental Permitting (England and Wales) Regulations 2007 – (EPR 2007) as relevant to cremators, summarised in the Secretary of State's Process Guidance Note PG 5/2 (2004).

The flue ducting and test points were in accordance with the requirements of EA TGN M1.

Measurements were undertaken to enable comparisons to be made of the operation of the cremator and associated flue gas treatment system with the requirements of the Guidance Note in terms of emission releases to air.

This report details the monitoring procedures used and the results obtained from this test work along with comparisons with the Guidance Note requirements and comments where appropriate.

Relevant procedures were followed to enable quality control to be maintained throughout the test preparation, site test work, laboratory analysis, calculations and reporting.

2. PROCEDURES

2.1 Total Particulate Matter

A flue gas sample was extracted and filtered to collect total particulate matter. A Whatman QM-A filter paper was used with a particle retention of not less than 99.5% at a particle size of 0.3 micron. The flue gas extraction employed techniques given in BS EN 13284 Part 1. The sampling was conducted using apparatus in accordance with the requirements of BS EN 13284 Part 1.

Sampling was undertaken at the centre point in the flue gas duct in accordance with the protocols and standards given that the duct is 250 mm in diameter.

This consisted of a heated known dimension Pyrex glass nozzle, heated Pyrex glass probe liner, heated Pyrex glass filter housing with Titanium filter support containing quartz microfibre filter (all heaters set to 160°C), PTFE sample line, dreschel absorption bottles, gas dryer (silica gel), sample line to pump, pump, gas meter, rotameter, pitot and impulse lines, electronic manometer, type K thermocouple, balance (for gravimetric moisture) and datalogger. Settings tables were pre-prepared to enable isokinetic flow to be maintained (based on online measurements of flue gas velocity and temperature to set nozzle flow / pump rate (l/min)).

Particulate matter analysis was carried out by weighing the filter and probe rinse collection on a calibrated balance, with the media being dried and weighed prior to and following the test.

The tests reported herein were conducted to prove the performance of the cremators relative to PG5/2(04).

2.2 Hydrogen Chloride

A flue gas sample was extracted and filtered. The gas sample was then passed through an absorption medium of de-ionised water to collect hydrogen chloride.

The method employed was BS EN 1911 Parts 1-3.

Laboratory analysis for hydrogen chloride was carried out on the absorption medium using Ion Chromatography (IC).

2.3 Mercury

A flue gas sample was extracted and filtered to collect solid phase mercury.

A Whatman QM-A filter paper was used with a particle retention of not less than 99.5% at a particle size of 0.3 micron. The flue gas extraction employed techniques given in BS EN 13284 Part 1.

The gas sample was then passed through an absorption medium of acidified potassium dichromate to collect vapour phase mercury.

The method employed was BS EN 13211.

Laboratory analysis for solid and vapour phase mercury was carried out on the filter and absorption medium using cold vapour atomic fluorescence spectroscopy (CVAFS).

2.4 Dioxins and Furans

A flue gas sample was extracted and filtered to collect total particulate matter and hence solid phase dioxins and furans. A Whatman QM-A filter paper was used with a particle retention of not less than 99.5% at a particle size of 0.3 micron. The flue gas extraction employed techniques given in BS EN 13284 Part 1.

The gas sample was then cooled by means of a water-cooled condenser before being passed through a pre-spiked XAD trap along with condensate collection to collect vapour phase dioxins and furans.

The method employed was BS EN 1948 Parts 1, 2 & 3, and BS EN 13284 Part 1.

Laboratory analysis for dioxins and furans was carried out on the filter, XAD trap and condensate / washings collection using high-resolution gas chromatography and high-resolution mass spectrometry (GC/MS (HR)).

2.5 Carbon Monoxide

A flue gas sample was continuously extracted, filtered and dried before being passed through a pre-calibrated Siemens Ultramat 21/O_2 infrared analyser for the on-line measurement of carbon monoxide. The analyser has a fixed range of 0-1250 mg/Nm³ and was zeroed with air and calibrated with a nominal 800 ppmv carbon monoxide in balance nitrogen gas.

The method employed was BS ISO 12039.

The analyser output was continuously recorded using a Grant 'Squirrel' data logger.

For these tests a relatively high range analyser was used due to the typical pattern of carbon monoxide concentration emissions from cremators being very low (often indicated as zero) for most of the cycle, but with occasional, high, short duration spikes of CO being emitted. The convention since non-continuous emissions monitoring became a mandatory requirement for cremators during 1990, has been to attempt to monitor the magnitude of spikes, as these are often the main contributor to total CO emissions. If the mean one minute emission of CO was say 200 mg/Nm³, it would be expected that the peak concentration during that one minute averaging period would be considerably higher than this. It follows that utilising a lower range analyser would frequently understate CO emissions, despite increasing sensitivity at low CO concentrations.

2.6 Volatile Organic Compounds

A flue gas sample was continuously extracted and filtered before being passed via a heated line through a pre-calibrated Signal 3030PM Flame Ionisation Detection (FID) analyser for the on-line measurement of volatile organic compounds. The analyser was ranged 0-100 ppmv total hydrocarbons and was zeroed with air passed through a catalytic converter and calibrated with a nominal 50 ppmv propane in balance air gas.

The method employed was BS EN 12619.

The analyser output was continuously recorded using a Grant 'Squirrel' data logger.

Similar comments apply to VOC's as CO, in that the analyser scaling is set to quantify the peaks that are the nature of the emission.

2.7 Oxygen

A flue gas sample was continuously extracted from the same position in the flue as the other pollutants extraction, filtered and dried before being passed through a pre-calibrated Siemens Ultramat 21/O_2 electrochemical cell analyser for the on-line measurement of flue oxygen.

An analogue output was taken from the plants own oxygen analyser for monitoring the oxygen content at the outlet of the secondary combustion chamber. This instrument measures the oxygen wet, and the readings were corrected to a dry basis for use in the secondary combustion chamber gas residence time calculations.

The method employed was BS ISO 12039.

The analysers were calibrated using a standard reference gas in the laboratory before and after the site visit, and with nitrogen "zero" gas and air at the start and end of each day's testing on site. It was assumed that calibration linearity was maintained during sampling, and the post checks indicated that this was the case.

The outputs of the analysers were continuously recorded using a Grant 'Squirrel' data logger.

2.8 Moisture

A flue gas sample was extracted and filtered. The gas sample was then passed through an absorption medium to collect any water vapour.

The method employed was BS EN 14790.

Flue gas moisture was determined gravimetrically by weighing the absorption medium and final gas drier prior to and following the test.

This was carried out alongside testing for hydrogen chloride and mercury.

2.9 Temperature

The cremator secondary chamber exit and flue (filter outlet) temperatures were measured by the use of calibrated Type K thermocouples.

The method employed was BS EN 13284 Part 1.

The gas temperatures were continuously recorded using a Grant 'Squirrel' data logger.

2.10 Velocity and Volumetric Flow

Flue gas velocity was found from inserting a calibrated s-type pitot tube into the flue. The pitot head pressure was then measured using a calibrated electronic manometer.

The method employed was BS EN 13284 Part 1.

The electronic manometer output was continuously recorded using a Grant 'Squirrel' data logger.

Flue gas velocity was then calculated from Bernoulli's equation as the density of the flue gas was known (from measurements of flue gas moisture and temperature).

Flue gas volumetric flow rate was found from the measurement of the flue duct size and hence its area and corrected to normalised conditions (again from measurements of flue gas moisture and temperature).

2.11 Secondary Combustion Chamber Gas Residence Time

The stated secondary chamber volume (provided by the cremator manufacturer) divided by the calculated gas volumetric flow exiting the secondary combustion zone gives the secondary combustion zone gas residence times, which are expressed as one-minute averages.

The test fitments are located in the outlet from the FGT Plant, downstream of the induced draught fan. The volumetric flow at this point is a combination of the waste gases from the operational cremator along with air drawn into the system via the reagent feeder system and other minor in-leakage.

In order to calculate the gas volume from the cremator, the oxygen content of the gases is monitored at the point of flow measurement and the outlet of the cremator. An oxygen balance calculation is performed to subtract the additional air contribution from the waste gas volume of the working cremator in order to calculate the secondary combustion chamber gas residence time.

An example of the calculation used is given in Appendix 1.

3. RESULTS

The results are summarised in Tables 1 to 3.

Total Particulate Matter, Hydrogen Chloride, Carbon Monoxide and Volatile Organic Compound determinations are given in Table 1.

Mercury determinations are given in Table 2.

Dioxin & Furan determinations are given in Table 3.

Secondary Combustion Chamber Residence Time is given in Plots 1 & 2.

Moisture determinations were made on all tests.

Carbon Monoxide, Volatile Organic Compounds, Oxygen, Temperature and Velocity and Volumetric Flow were continuously monitored.

Secondary Combustion Chamber Gas Residence Time was continuously monitored during Tests 2 & 3.

All values in the tables are corrected to the reference conditions of 273K, 101.3kPa, 11%v/v oxygen and dry gas as given in PG5/2(04) where required.

All the data logs and calculations can be seen in Appendix 1.

All the analysis reports can be seen in Appendix 2.

TABLE 1
East Devon Crematorium Abatement System Outlet
Emissions Monitoring 12th July 2011
Total Particulate Matter & Hydrogen Chloride Sampling

		Test 1	Test 2	Test 3	Average	Requirement to PG5/2 (2004)
Total Particulate Matter	- mg/Nm³c.	0.64 ± 1.02	0.82 ± 1.90	1.13 ± 1.61	**0.86**	<20
Hydrogen Chloride	- mg/Nm³c.	7.50 ± 0.79	10.63 ± 1.42	20.30 ± 1.13	**12.81**	<30
Carbon Monoxide	- mg/Nm³c.	3.46 ± 0.17	2.97 ± 0.15	4.87 ± 0.24	**3.77**	<100
Organic Compounds	- mg/Nm³c.	0.01 ± 0.00	0.01 ± 0.00	0.05 ± 0.00	**0.03**	<20

		Test 1	Test 2	Test 3	Average
Flue Oxygen	- %v/v dry	12.90 ± 0.10	14.28 ± 0.10	14.02 ± 0.10	**13.74**
Flue Moisture	- %v/v	6.9 ± 0.7	6.6 ± 0.7	7.0 ± 0.7	**6.9**
	- %w/w	4.4 ± 0.4	4.2 ± 0.4	4.5 ± 0.4	**4.4**
Flue Temperature	- Deg C	116 ± 2	116 ± 2	114 ± 2	**115**
Volumetric Flow	- Nm^3/h dry	1658 ± 33	1491 ± 30	1366 ± 27	**1505**

Note 1: All emissions as concentration levels are given as mg/Nm^3 corrected to 11%v/v oxygen and dry gas

Note 2: All uncertainties (±) are calculated to a 95% confidence interval.
Uncertainties estimated using the procedure suggested in the STA Quality Guidance Note QGN001-01

TABLE 2
East Devon Crematorium Abatement System Outlet
Emissions Monitoring 12th July 2011
Mercury Sampling

		Test 4	Test 5	Test 6	Average	Requirement to PG5/2 (2004)
Mercury	- µg/Nm³c.	8.46 ± 16.29	22.22 ± 21.23	17.44 ± 16.66	**16.04**	<50

		Test 4	Test 5	Test 6	Average
Flue Oxygen	- %v/v dry	14.22 ± 0.10	14.43 ± 0.10	14.71 ± 0.10	**14.45**
Flue Moisture	- %v/v	6.6 ± 0.7	9.7 ± 1.0	6.7 ± 0.7	**7.7**
	- %w/w	4.2 ± 0.4	6.2 ± 0.6	4.3 ± 0.4	**4.9**
Flue Temperature	- Deg C	113 ± 2	115 ± 2	113 ± 2	**114**
Volumetric Flow	- Nm³/h dry	1263 ± 25	1295 ± 26	1278 ± 26	**1279**

Note 1: All emissions as concentration levels are given as µg/Nm³ or mg/Nm³ corrected to 11%v/v oxygen and dry gas

Note 2: All uncertainties (±) are calculated to a 95% confidence interval
Uncertainties estimated using the procedure suggested in the STA Quality Guidance Note QGN001-01

TABLE 3
East Devon Crematorium Abatement System Outlet
Emissions Monitoring 13th July 2011
Dioxins Sampling

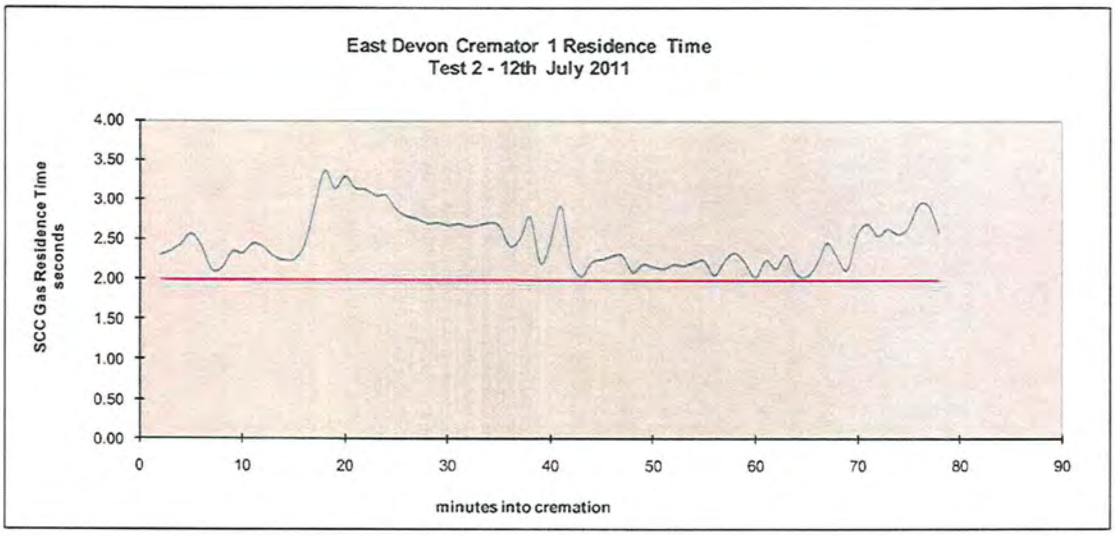
		Test 7	Requirement to PG5/2 (2004)
Dioxins and Furans			
(Using Lower Bound Value)	- ng/Nm^3c.	0.0032 ± 0.0002	<0.1
(Using Upper Bound Value)	- ng/Nm^3c.	0.0058 , 0.0003	

		Test 7
Flue Oxygen	- %v/v dry	14.08 ± 0.10
Flue Moisture	- %v/v	5.5 ± 0.6
	- %w/w	3.5 ± 0.4
Flue Temperature	- Deg C	115 ± 2
Volumetric Flow	- Nm^3/h dry	1348 ± 27

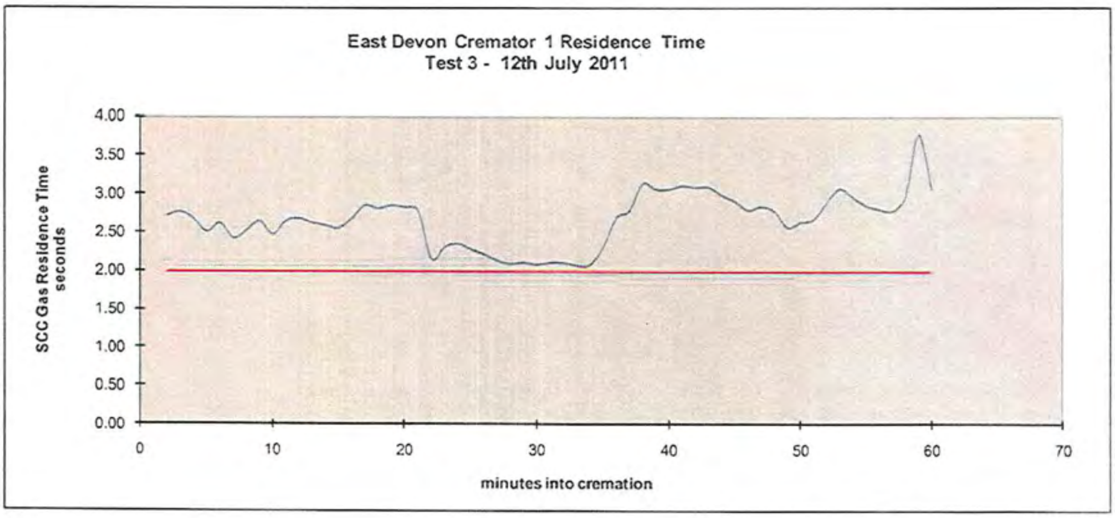
Note 1: All emissions as concentration levels are given as ng/Nm^3 corrected to 11%v/v oxygen and dry gas

Note 2: All uncertainties (±) are calculated to a 95% confidence interval
Uncertainties estimated using the procedure suggested in the STA Quality Guidance Note QGN001-01

PLOT 1


East Devon Cremator 1 Residence Time
Test 2 - 12th July 2011
SCC Gas Residence Time seconds
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
60
70
80
90
minutes into cremation

PLOT 2


East Devon Cremator 1 Residence Time
Test 3 - 12th July 2011
SCC Gas Residence Time seconds
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
10
20
30
40
50
60
70
minutes into cremation

4. COMMENTS

The results from these series of tests demonstrate that the plant satisfies the requirements of PG5/2(2004) for the releases to air of particulate matter, mercury, hydrogen chloride, carbon monoxide and volatile organic compounds.

The reported results for dioxins and furans are the calculated results using both the Lower and Upper Bound values from the Laboratory analysis report.

Lower bound: This represents the value of all samples for which the congeners found present at levels below their detection limits are represented as being at a level of zero.

Upper bound: This represents the value of all samples for which the congeners found present at levels below their detection limits are represented as being at a level of their detection limits.

The true emission value will lie between the Upper and Lower Bound results reported. The test gives a result well below the compliance limit of <0.1 ng/Nm^3 on the basis of Upper Bound value.

The oxygen content of the gases at the outlet of the secondary combustion zone was above 3% at all times, and mean concentrations were in excess of 6%.

The residence time of the gases in the Secondary Combustion Chamber of the Cremator was above 2 seconds at all times, and the temperature in excess of 800°C in accordance with the requirements.

Combustion within the cremator secondary combustion chamber was good as is indicated by the low emissions of CO and VOC's.

No visible chimney emissions were observed throughout the test work other than the expected steam plume during preheat.

5. QUALITY CONTROL

All the tests performed were carried out to the methods given in the appropriate listed Standards using calibrated equipment. The gas analysers were calibrated prior to use using suitable calibration gases.

Analysis of the filters and absorbers was carried out in-house and at an external laboratory.

For this test work the following external laboratory was used for the given determinations:

Scientific Analysis Laboratories (SAL)	}	Hydrogen Chloride Mercury Dioxins & Furans

APPENDIX 1

Data Logs and Calculations

Explanation of Data Logs

Data is taken from a Grant Squirrel data logger.

Time is from logger clock.
SCC Out Temp is direct from installed SCC thermocouple.
Flue Gas Temp is direct from test flue thermocouple.
Meter Temp is direct from gas meter.
(The stated meter temperature is that of the sampled gas at the meter, and is not the room ambient temperature. The temperature always increases during a test due to the heat gain from the sample pump that is contained in an enclosed box along with the gas meter, and this is quite normal).
SCC O2 is from the plants Fuji oxygen analyser corrected from wet to dry.
Flue O2 is from the Siemens Ultramat U21/O2 analyser.
CO is from the Siemens Ultramat U21/O2 analyser.
VOC is from the Signal 3030PM FID analyser expressed as carbon equivalent.
Sample Point Pa is from the pitot tube to an Airflow Developments electronic manometer.
Duct Mean Pa is Sample Point Pa corrected for average position from traverse logs included.

The room temperature was typically 20°C, and there were no issues with the analysers overheating. Functional and calibration checks at the start and end of each test confirmed correct operation of the analysers.

All values in the tables are corrected to the reference conditions of 273K, 101.3kPa, 11%v/v oxygen and dry gas as given in PG5/2(04) where required.

Example of Residence Time Calculation

CALCULATION PROCEDURE TO OBTAIN RESIDENCE TIME OF GASES IN CREMATOR SECONDARY CHAMBERS

From site measurements during a test the following values are known:

SCC Temperature	Deg C	919 }	
SCC Oxygen	% v/v dry	5.5 }	1 minute
Flue Temperature	Deg C	113 }	logs
Flue Oxygen	% v/v dry	14.94 }	
Flue Pitot Head	Pa	51.6 }	
Flue Gas Moisture Content	% v/v	6.17 }	1 measurement
Flue Gas Moisture Content	%w/w	3.93 }	
Flue Duct Size	mm	350 }	
Flue Duct Area	m2	0.0962 }	

Also known from design calculations is the SCC Volume:

SCC Volume 3.21 m3

Residence Time can found as given below:

Density of Flue Gas kg/m3

((Density of air x % dry gas)+(Density of water x %moisture) /100) x 273/(273+Flue T)

Where: Density of air = 1.2928 kg/m3 @ 273 K & 101.3 kpa
Density of water = 0.8039 kg/m3 @273 K & 101.3 kpa

Therefore Flue Gas Density = 0.90074603 kg/m3

Velocity of Flue Gas Am/s

Sqrt ((2 x h x g) / Flue Gas Density)

Devived from Bernoulli's Flow Equation
Where h x g = Pa

Therefore Flue Gas Velocity = 10.7038169 Am/s

Volumetric Flow Rate of Flue Gas

Velocity x Cross Sectional Area of Duct x 3600

Therefore Volumetric Flow Rate = 3707.38033 Am3/h

With H2O = 6.17 %

Volumetric Flow Rate Dry = 3478.63496 Am3/h

Volumetric Flow Rate Wet = 228.745366 Am3/h

Corrected to Normal Conditions:

Nm3/h = Am3/h x 273 / (273 + Flue T)

Volumetric Flow Rate Dry = 2460.27809 Nm3/h

Volumetric Flow Rate Wet = 161.781049 Nm3/h

Using a dry oxygen balance calculate proportions of flue gas originating from SCC and from cooling air respectively:

SCC V(1) O(1)		Flue V(2) O(2)
	Cooling Air V(3) O(3) = 20.95 %v/v dry	

From the above V(2) = V(1) + V(3)

V(3) = V(2) - V(1) [1]

(V(2) x O(2)) = (V(1) x O(1)) + (V(3) x O(3)) [2]

Substituting [1] into [2] gives:

V(1) = V(2) x (O(2) - O(3)) / (O(1) - O(3))

Therefore V(1) = V(2) x (O(2) - 20.95) / (O(1) - 20.95)

Assume V(2) = 100%

V(1) dry Nm3/h = 38.8996764 % of Volumetric Flowrate Dry

Therefore SCC Volumetric Flowrate Dry = 957.040216 Nm3/h

Assuming all cooling air is dry therefore all water in flue gas is from SCC:

SCC Volumetric Flowrate = 1118.82127 Nm3/h

This can then be corrected to actual SCC temperature:

Am3/h = Nm3/h x (273 + SCC T) / 273

SCC Volumetric Flowrate = 1.35697492 Am3/s

Therefore with SCC Volume = 3.21 m3

Residence Time = SCC Volume / SCC Volumetric Flowrate

= 2.36555588 seconds

The residence time of the gas in the SCC is 2.37 seconds

East Devon Crematorium Abatement System Outlet

Data Log 12/07/11

Test 1

Time	Flue Gas °C	Meter °C	Flue Oxygen %v/v dry	CO mg/Nm³ c.	VOC mg/Nm³ c.	Sample Point Pa	Sample Point Used	Factor	Duct Mean Pa
08:54	107	23.7	12.83	13.17	0.22	99.1	1C	0.9087	90.1
08:55	108	23.8	12.03	9.98	0.12	96.6	1C	0.9087	87.8
08:56	108	24.0	12.42	7.12	0.00	90.7	1C	0.9087	82.4
08:57	108	24.2	12.26	6.77	0.00	84.8	1C	0.9087	77.1
08:58	108	24.5	11.51	6.45	0.00	81.5	1C	0.9087	74.0
08:59	108	24.8	10.78	6.72	0.00	105.0	1C	0.9087	95.4
09:00	110	25.1	11.10	7.43	0.00	132.7	1C	0.9087	120.6
09:01	112	25.5	10.86	7.98	0.00	157.1	1C	0.9087	142.7
09:02	113	25.9	12.64	12.64	0.00	171.4	1C	0.9087	155.7
09:03	114	26.4	12.96	8.19	0.00	147.8	1C	0.9087	134.3
09:04	114	27.0	12.07	6.50	0.00	136.9	1C	0.9087	124.4
09:05	114	27.5	11.45	5.88	0.00	134.4	1C	0.9087	122.1
09:06	114	28.0	12.10	7.27	0.00	118.4	1C	0.9087	107.6
09:07	114	28.5	11.69	5.16	0.73	113.4	1C	0.9087	103.0
09:08	114	29.0	11.93	5.55	0.22	104.2	1C	0.9087	94.6
09:09	114	29.5	11.74	5.20	0.01	112.6	1C	0.9087	102.3
09:10	114	30.0	12.13	5.54	0.00	100.8	1C	0.9087	91.6
09:11	114	30.6	12.09	4.28	0.00	96.6	1C	0.9087	87.8
09:12	114	31.0	12.38	5.34	0.00	80.6	1C	0.9087	73.3
09:13	114	31.5	11.63	4.27	0.00	84.0	1C	0.9087	76.3
09:14	114	32.0	12.52	4.86	0.00	92.4	1C	0.9087	84.0
09:15	115	32.4	10.16	4.39	0.00	120.1	1C	0.9087	109.1
09:16	115	32.8	10.24	3.97	0.00	135.2	1C	0.9087	122.9
09:17	116	33.2	13.09	5.76	0.00	140.3	1C	0.9087	127.5
09:18	116	33.7	12.74	4.97	0.00	113.4	1C	0.9087	103.0
09:19	116	34.1	13.05	6.23	0.00	96.6	1C	0.9087	87.8
09:20	116	34.5	10.16	3.97	0.00	85.7	1C	0.9087	77.9
09:21	115	34.8	13.29	4.78	0.00	89.0	1C	0.9087	80.9
09:22	115	35.2	12.17	4.05	0.00	93.2	1C	0.9087	84.7
09:23	115	35.6	11.55	3.47	0.00	86.5	1C	0.9087	78.6
09:24	115	35.9	13.43	4.13	0.00	89.9	1C	0.9087	81.7
09:25	115	36.3	11.68	3.62	0.00	102.5	1C	0.9087	93.1
09:26	116	36.6	10.83	2.43	0.00	114.2	1C	0.9087	103.8
09:27	116	36.9	11.45	2.34	0.00	125.2	1C	0.9087	113.7
09:28	116	37.1	11.62	3.55	0.00	112.6	1C	0.9087	102.3
09:29	116	37.5	12.93	3.82	0.00	99.1	1C	0.9087	90.1
09:30	117	37.8	11.94	2.14	0.00	111.7	1C	0.9087	101.5
09:31	116	38.2	12.29	2.62	0.00	79.8	1C	0.9087	72.5
09:32	116	38.5	12.97	4.18	0.00	105.8	1C	0.9087	96.2
09:33	116	38.8	12.02	3.60	0.00	94.9	1C	0.9087	86.3

09:34	116	39.2	13.18	3.20	0.00	96.6	1C	0.9087	87.8
09:35	117	39.5	12.87	3.28	0.00	121.8	1C	0.9087	110.7
09:36	117	39.9	12.62	2.57	0.00	120.1	1C	0.9087	109.1
09:37	117	40.2	12.82	2.01	0.00	118.4	1C	0.9087	107.6
09:38	117	40.5	12.93	2.26	0.00	121.0	1C	0.9087	109.9
09:39	118	40.8	13.38	2.46	0.00	138.6	1C	0.9087	125.9
09:40	118	41.1	13.92	2.21	0.00	140.3	1C	0.9087	127.5
09:41	118	41.4	14.03	2.59	0.00	139.4	1C	0.9087	126.7
09:42	118	41.6	14.10	2.64	0.00	124.3	1C	0.9087	113.0
09:43	118	41.9	13.76	2.68	0.00	123.5	1C	0.9087	112.2
09:44	118	42.2	13.72	1.90	0.00	123.5	1C	0.9087	112.2
09:45	119	42.5	13.73	2.32	0.00	126.0	1C	0.9087	114.5
09:46	119	42.8	13.98	2.88	0.00	121.0	1C	0.9087	109.9
09:47	119	43.0	14.03	3.02	0.00	131.0	1C	0.9087	119.1
09:48	119	43.1	14.34	2.50	0.00	127.7	1C	0.9087	116.0
09:49	119	43.3	14.38	2.71	0.00	130.2	1C	0.9087	118.3
09:50	119	43.4	14.45	1.94	0.00	126.8	1C	0.9087	115.3
09:51	119	43.7	14.37	2.46	0.00	118.4	1C	0.9087	107.6
09:52	119	43.9	14.22	2.97	0.00	108.4	1C	0.9087	98.5
09:53	119	44.0	14.13	1.93	0.00	113.4	1C	0.9087	103.0
09:54	119	44.2	14.30	2.12	0.00	108.4	1C	0.9087	98.5
09:55	119	44.4	14.22	1.97	0.00	110.0	1C	0.9087	100.0
09:56	119	44.6	14.29	1.46	0.00	107.5	1C	0.9087	97.7
09:57	119	44.7	14.31	1.56	0.00	107.5	1C	0.9087	97.7
09:58	119	44.9	14.15	1.67	0.00	100.8	1C	0.9087	91.6
09:59	118	45.1	14.19	1.75	0.00	95.8	1C	0.9087	87.0
10:00	118	45.3	13.75	1.59	0.00	81.5	1C	0.9087	74.0
10:01	118	45.4	13.31	0.94	0.00	77.3	1C	0.9087	70.2
10:02	117	45.5	13.20	1.49	0.00	77.3	1C	0.9087	70.2
10:03	117	45.7	13.22	0.91	0.00	76.4	1C	0.9087	69.5
10:04	117	45.8	13.19	1.06	0.00	75.6	1C	0.9087	68.7
10:05	117	45.8	13.17	1.60	0.00	75.6	1C	0.9087	68.7
10:06	117	45.9	13.18	1.43	0.00	74.8	1C	0.9087	67.9
10:07	117	46.1	13.16	1.37	0.00	74.8	1C	0.9087	67.9
10:08	117	46.3	13.13	1.84	0.00	72.2	1C	0.9087	65.6
10:09	116	46.4	13.04	1.92	0.00	78.1	1C	0.9087	71.0
10:10	117	46.6	13.78	1.65	0.00	91.6	1C	0.9087	83.2
10:11	116	46.7	13.80	2.25	0.00	81.5	1C	0.9087	74.0
10:12	116	46.8	13.57	1.63	0.00	78.1	1C	0.9087	71.0
10:13	116	46.8	13.09	2.06	0.00	64.7	1C	0.9087	58.8
10:14	116	46.9	12.77	1.41	0.00	73.1	1C	0.9087	66.4
10:15	116	47.0	13.08	2.14	0.00	73.1	1C	0.9087	66.4
10:16	116	47.2	13.12	1.93	0.00	72.2	1C	0.9087	65.6
10:17	116	47.3	13.17	0.88	0.00	71.4	1C	0.9087	64.9
10:18	116	47.4	13.23	1.70	0.00	72.2	1C	0.9087	65.6
10:19	116	47.6	13.35	1.51	0.00	71.4	1C	0.9087	64.9
10:20	115	47.6	13.62	1.59	0.00	66.4	1C	0.9087	60.3
10:21	115	47.6	13.57	1.52	0.00	66.4	1C	0.9087	60.3
10:22	115	47.7	13.31	1.19	0.00	66.4	1C	0.9087	60.3
10:23	115	47.8	13.37	1.80	0.00	67.2	1C	0.9087	61.1

10:24	115	47.8	13.38	1.01	0.00	65.5	1C	0.9087	59.5
10:25	115	47.9	13.40	1.15	0.00	66.4	1C	0.9087	60.3
10:26	114	47.6	15.03	1.01	0.00	63.8	1C	0.9087	58.0
Average	116	38.9	12.90	3.46	0.01	101.2			92.0

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Test 2

Time	Flue Gas °C	Meter °C	Flue Oxygen %v/v dry	CO mg/Nm³ c.	VOC mg/Nm³ c.	Sample Point Pa	Sample Point Used	Factor	Duct Mean Pa
10:35	118	45.6	15.20	12.27	0.00	120.1	1C	0.9087	109.1
10:36	118	45.6	14.32	10.30	0.23	98.3	1C	0.9087	89.3
10:37	118	45.5	14.12	4.72	0.01	87.4	1C	0.9087	79.4
10:38	118	45.3	13.65	3.50	0.00	85.7	1C	0.9087	77.9
10:39	118	45.2	12.37	2.19	0.00	93.2	1C	0.9087	84.7
10:40	118	45.1	12.01	1.65	0.00	92.4	1C	0.9087	84.0
10:41	118	45.1	13.68	2.31	0.00	85.7	1C	0.9087	77.9
10:42	118	45.1	15.20	1.44	0.00	89.9	1C	0.9087	81.7
10:43	118	45.2	15.11	0.90	0.00	82.3	1C	0.9087	74.8
10:44	118	45.2	14.80	1.39	0.00	93.2	1C	0.9087	84.7
10:45	118	45.3	14.15	1.08	0.00	84.8	1C	0.9087	77.1
10:46	118	45.3	14.15	0.56	0.00	95.8	1C	0.9087	87.0
10:47	118	45.4	13.83	0.91	0.00	97.4	1C	0.9087	88.5
10:48	118	45.4	14.16	1.19	0.00	101.6	1C	0.9087	92.4
10:49	118	45.5	14.04	0.71	0.00	82.3	1C	0.9087	74.8
10:50	117	45.5	13.88	0.70	0.01	67.2	1C	0.9087	61.1
10:51	117	45.6	12.56	0.62	0.55	48.7	1C	0.9087	44.3
10:52	116	45.7	11.83	0.58	0.13	47.0	1C	0.9087	42.7
10:53	116	45.7	12.09	0.48	0.00	44.5	1C	0.9087	40.5
10:54	116	45.7	12.20	0.68	0.00	50.4	1C	0.9087	45.8
10:55	116	45.8	11.99	0.64	0.00	50.4	1C	0.9087	45.8
10:56	116	45.8	11.71	0.57	0.00	49.6	1C	0.9087	45.0
10:57	115	45.8	12.13	0.68	0.00	48.7	1C	0.9087	44.3
10:58	115	45.8	12.64	0.75	0.00	53.8	1C	0.9087	48.9
10:59	115	45.9	13.19	0.24	0.00	63.0	1C	0.9087	57.2
11:00	115	45.9	12.97	0.72	0.00	63.0	1C	0.9087	57.2
11:01	115	45.9	13.06	0.53	0.00	62.2	1C	0.9087	56.5
11:02	115	46.0	13.18	0.22	0.00	62.2	1C	0.9087	56.5
11:03	115	46.1	13.38	0.00	0.00	61.3	1C	0.9087	55.7
11:04	115	46.2	13.66	0.78	0.00	60.5	1C	0.9087	55.0
11:05	115	46.2	13.97	0.46	0.00	60.5	1C	0.9087	55.0
11:06	115	46.2	14.37	0.57	0.00	60.5	1C	0.9087	55.0
11:07	115	46.2	14.59	0.74	0.00	60.5	1C	0.9087	55.0
11:08	115	46.4	14.96	1.21	0.00	73.1	1C	0.9087	66.4
11:09	115	46.7	13.47	0.53	0.00	72.2	1C	0.9087	65.6
11:10	115	47.0	14.73	1.31	0.00	60.5	1C	0.9087	55.0
11:11	115	47.1	15.62	2.78	0.00	73.9	1C	0.9087	67.2
11:12	116	47.0	13.44	1.29	0.00	84.0	1C	0.9087	76.3

11:13	116	47.0	15.08	2.90	0.00	60.5	1C	0.9087	55.0
11:14	116	47.1	16.00	3.48	0.00	77.3	1C	0.9087	70.2
11:15	117	47.1	13.41	2.26	0.00	104.2	1C	0.9087	94.6
11:16	117	47.0	12.92	2.02	0.00	100.8	1C	0.9087	91.6
11:17	116	47.0	13.85	3.99	0.00	92.4	1C	0.9087	84.0
11:18	117	46.9	14.23	5.91	0.00	94.1	1C	0.9087	85.5
11:19	117	46.9	14.39	4.85	0.00	92.4	1C	0.9087	84.0
11:20	117	46.8	14.43	5.94	0.00	91.6	1C	0.9087	83.2
11:21	117	46.7	14.58	6.79	0.00	101.6	1C	0.9087	92.4
11:22	117	46.7	15.02	7.67	0.00	100.0	1C	0.9087	90.8
11:23	117	46.7	15.12	7.49	0.00	101.6	1C	0.9087	92.4
11:24	117	46.6	15.36	6.91	0.00	117.6	1C	0.9087	106.9
11:25	117	46.5	14.42	3.00	0.00	103.3	1C	0.9087	93.9
11:26	117	46.3	14.61	5.27	0.00	85.7	1C	0.9087	77.9
11:27	117	46.3	15.27	8.22	0.00	105.0	1C	0.9087	95.4
11:28	117	46.2	14.49	4.68	0.00	102.5	1C	0.9087	93.1
11:29	117	46.1	14.09	3.19	0.00	96.6	1C	0.9087	87.8
11:30	117	46.0	15.01	7.05	0.00	86.5	1C	0.9087	78.6
11:31	117	46.0	15.31	7.78	0.00	103.3	1C	0.9087	93.9
11:32	117	45.9	14.18	3.59	0.00	95.8	1C	0.9087	87.0
11:33	117	45.8	14.14	2.19	0.00	104.2	1C	0.9087	94.6
11:34	117	45.7	14.83	5.07	0.00	90.7	1C	0.9087	82.4
11:35	117	45.6	15.73	9.04	0.00	96.6	1C	0.9087	87.8
11:36	117	45.6	15.64	7.01	0.00	107.5	1C	0.9087	97.7
11:37	117	45.5	14.67	4.61	0.00	104.2	1C	0.9087	94.6
11:38	117	45.4	14.67	3.55	0.00	105.8	1C	0.9087	96.2
11:39	117	45.4	14.77	2.67	0.00	95.8	1C	0.9087	87.0
11:40	117	45.2	15.82	7.20	0.00	90.7	1C	0.9087	82.4
11:41	117	45.2	15.90	8.53	0.00	108.4	1C	0.9087	98.5
11:42	117	45.1	14.78	4.27	0.00	100.8	1C	0.9087	91.6
11:43	117	45.0	14.34	2.92	0.00	69.7	1C	0.9087	63.4
11:44	116	44.9	14.42	4.89	0.00	57.1	1C	0.9087	51.9
11:45	116	44.9	14.87	5.55	0.00	75.6	1C	0.9087	68.7
11:46	116	44.8	13.98	2.26	0.00	71.4	1C	0.9087	64.9
11:47	116	44.8	13.39	2.46	0.00	65.5	1C	0.9087	59.5
11:48	115	44.7	13.89	2.25	0.00	52.1	1C	0.9087	47.3
11:49	115	44.7	14.63	1.95	0.00	51.2	1C	0.9087	46.6
11:50	115	44.8	14.65	1.85	0.00	51.2	1C	0.9087	46.6
11:51	115	44.7	14.77	1.32	0.00	68.0	1C	0.9087	61.8
11:52	115	44.7	14.30	0.57	0.00	80.6	1C	0.9087	73.3
11:53	115	44.7	14.69	1.03	0.00	78.1	1C	0.9087	71.0
11:54	115	44.7	15.98	1.48	0.00	96.6	1C	0.9087	87.8
11:55	115	44.7	14.91	0.91	0.00	90.7	1C	0.9087	82.4
11:56	115	44.8	14.67	1.51	0.00	89.9	1C	0.9087	81.7
11:57	115	44.8	14.66	1.82	0.00	89.9	1C	0.9087	81.7
11:58	115	44.7	14.69	0.87	0.00	86.5	1C	0.9087	78.6
11:59	115	44.7	15.67	2.98	0.00	89.9	1C	0.9087	81.7
12:00	116	44.7	15.67	1.55	0.00	91.6	1C	0.9087	83.2
12:01	116	44.6	14.79	2.71	0.00	89.9	1C	0.9087	81.7
12:02	115	44.6	14.76	1.56	0.00	73.1	1C	0.9087	66.4

12:03	114	43.5	18.36	2.54	0.00	49.6	1C	0.9087	45.0
Average	**116**	**45.7**	**14.28**	**2.97**	**0.01**	**81.5**			**74.1**

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Test 3

Time	Flue Gas °C	Meter °C	Flue Oxygen %v/v dry	CO mg/Nm³ c.	VOC mg/Nm³ c.	Sample Point Pa	Sample Point Used	Factor	Duct Mean Pa
12:12	115	41.8	14.84	6.33	2.28	98.3	1C	0.9087	89.3
12:13	115	42.0	13.46	10.68	0.20	65.5	1C	0.9087	59.5
12:14	114	42.0	13.26	11.68	0.00	62.2	1C	0.9087	56.5
12:15	115	41.9	14.22	12.46	0.00	81.5	1C	0.9087	74.0
12:16	115	41.8	13.09	4.66	0.00	85.7	1C	0.9087	77.9
12:17	115	41.9	11.57	4.71	0.00	78.1	1C	0.9087	71.0
12:18	115	41.9	11.75	4.78	0.00	78.1	1C	0.9087	71.0
12:19	114	41.9	11.74	2.60	0.00	69.7	1C	0.9087	63.4
12:20	115	42.0	11.56	2.23	0.00	77.3	1C	0.9087	70.2
12:21	115	42.0	12.36	2.10	0.00	71.4	1C	0.9087	64.9
12:22	114	42.1	12.27	2.19	0.00	68.0	1C	0.9087	61.8
12:23	114	42.3	12.53	2.39	0.00	70.6	1C	0.9087	64.1
12:24	114	42.3	12.56	2.10	0.00	75.6	1C	0.9087	68.7
12:25	114	42.3	12.51	2.12	0.00	74.8	1C	0.9087	67.9
12:26	114	42.3	12.67	2.01	0.00	71.4	1C	0.9087	64.9
12:27	114	42.4	12.18	2.52	0.00	62.2	1C	0.9087	56.5
12:28	114	42.5	12.02	1.91	0.16	62.2	1C	0.9087	56.5
12:29	114	42.6	11.99	1.90	1.77	61.3	1C	0.9087	55.7
12:30	114	42.6	11.94	2.44	0.01	62.2	1C	0.9087	56.5
12:31	114	42.6	11.80	2.23	0.00	66.4	1C	0.9087	60.3
12:32	114	42.7	11.44	1.63	0.00	97.4	1C	0.9087	88.5
12:33	115	42.8	12.48	2.67	0.00	95.8	1C	0.9087	87.0
12:34	114	42.8	12.02	2.80	0.00	89.0	1C	0.9087	80.9
12:35	115	42.9	11.99	2.17	0.00	93.2	1C	0.9087	84.7
12:36	115	43.0	11.93	2.64	0.00	100.0	1C	0.9087	90.8
12:37	116	43.0	11.68	3.05	0.00	109.2	1C	0.9087	99.2
12:38	116	43.0	11.62	2.79	0.00	108.4	1C	0.9087	98.5
12:39	116	43.1	11.78	2.82	0.00	107.5	1C	0.9087	97.7
12:40	116	43.2	11.79	2.85	0.00	107.5	1C	0.9087	97.7
12:41	117	43.2	12.04	3.05	0.00	107.5	1C	0.9087	97.7
12:42	117	43.2	12.00	2.51	0.00	108.4	1C	0.9087	98.5
12:43	117	43.2	11.89	3.01	0.00	107.5	1C	0.9087	97.7
12:44	117	43.2	12.15	2.76	0.00	105.8	1C	0.9087	96.2
12:45	117	43.3	12.38	2.48	0.00	88.2	1C	0.9087	80.1
12:46	116	43.3	12.41	2.14	0.00	67.2	1C	0.9087	61.1
12:47	116	43.3	12.28	1.97	0.00	58.8	1C	0.9087	53.4
12:48	115	43.3	12.36	1.62	0.00	48.7	1C	0.9087	44.3
12:49	115	43.4	12.24	1.63	0.00	46.2	1C	0.9087	42.0

12:50	115	43.5	12.81	1.72	0.00	46.2	1C	0.9087	42.0
12:51	114	43.5	13.32	1.37	0.00	45.4	1C	0.9087	41.2
12:52	114	43.5	13.57	1.28	0.00	44.5	1C	0.9087	40.5
12:53	114	43.6	13.92	1.60	0.00	43.7	1C	0.9087	39.7
12:54	114	43.6	14.23	1.38	0.00	47.0	1C	0.9087	42.7
12:55	114	43.7	14.47	1.67	0.00	51.2	1C	0.9087	46.6
12:56	114	43.7	14.58	1.97	0.00	52.1	1C	0.9087	47.3
12:57	114	43.7	14.95	3.15	0.00	50.4	1C	0.9087	45.8
12:58	114	43.8	15.28	3.77	0.00	51.2	1C	0.9087	46.6
12:59	114	43.8	15.77	7.26	0.00	55.4	1C	0.9087	50.4
13:00	113	43.8	16.13	9.76	0.00	56.3	1C	0.9087	51.1
13:01	114	43.8	16.25	9.70	0.00	53.8	1C	0.9087	48.9
13:02	113	43.9	16.41	10.10	0.00	44.5	1C	0.9087	40.5
13:03	113	43.7	16.51	10.51	0.00	42.8	1C	0.9087	38.9
13:04	113	43.6	16.42	11.80	0.00	42.8	1C	0.9087	38.9
13:05	112	43.5	16.57	9.40	0.00	42.8	1C	0.9087	38.9
13:06	112	43.5	16.89	12.35	0.00	42.8	1C	0.9087	38.9
13:07	112	43.4	17.19	14.71	0.00	42.0	1C	0.9087	38.2
13:08	112	43.4	17.52	14.74	0.00	44.5	1C	0.9087	40.5
13:09	112	43.4	16.46	12.34	0.00	42.0	1C	0.9087	38.2
13:10	112	43.3	15.72	8.79	0.00	37.0	1C	0.9087	33.6
13:11	112	43.3	17.56	14.68	0.00	51.2	1C	0.9087	46.6
13:12	113	43.2	16.32	12.53	0.00	59.6	1C	0.9087	54.2
13:13	112	43.2	15.34	8.64	0.00	42.8	1C	0.9087	38.9
13:14	112	43.1	18.00	20.34	0.00	55.4	1C	0.9087	50.4
13:15	112	43.1	15.33	5.52	0.00	58.8	1C	0.9087	53.4
13:16	112	43.0	16.24	7.88	0.00	42.8	1C	0.9087	38.9
13:17	112	43.0	18.24	16.67	0.00	75.6	1C	0.9087	68.7
13:18	113	43.0	13.83	1.84	0.00	69.7	1C	0.9087	63.4
13:19	112	43.0	16.81	6.63	0.00	52.1	1C	0.9087	47.3
13:20	113	43.0	16.99	5.88	0.00	89.9	1C	0.9087	81.7
13:21	114	42.9	13.65	0.75	0.00	83.2	1C	0.9087	75.6
13:22	114	43.1	14.52	2.21	0.00	78.1	1C	0.9087	71.0
13:23	114	43.2	14.61	2.34	0.00	77.3	1C	0.9087	70.2
13:24	114	43.3	14.79	1.81	0.00	77.3	1C	0.9087	70.2
13:25	114	43.3	14.93	1.79	0.00	74.8	1C	0.9087	67.9
13:26	113	43.4	14.92	1.86	0.00	70.6	1C	0.9087	64.1
13:27	113	43.4	14.94	0.84	0.00	71.4	1C	0.9087	64.9
13:28	113	43.5	15.12	0.73	0.00	71.4	1C	0.9087	64.9
13:29	113	43.4	15.18	0.93	0.00	69.7	1C	0.9087	63.4
13:30	113	43.4	15.25	0.70	0.00	68.9	1C	0.9087	62.6
13:31	113	43.4	15.30	1.04	0.00	69.7	1C	0.9087	63.4
13:32	113	43.3	15.92	0.61	0.00	69.7	1C	0.9087	63.4
Average	**114**	**43.0**	**14.02**	**4.87**	**0.05**	**68.5**			**62.2**

East Devon Crematorium Abatement System Outlet

Total Particulate Matter and Hydrogen Chloride

Contract	East Devon Crematorium, DEM0508
Date	12th July 2011
Location	Flue Gas Abatement System Outlet
Engineer(s)	JB & ST
Absorbent	H_2O

Test Log	Test 1	Test 2	Test 3
Barometric Pressure(kPa)	101.7	101.7	101.7
Gas Meter Temperature(Deg C)	38.9	45.7	43.0
Oxygen Concentration(%v/v dry)	12.90	14.28	14.02
Flue Gas Volumetric Flow(Nm^3/h dry)	1658	1491	1366

	Test 1 Start	Test 1 End	Test 2 Start	Test 2 End	Test 3 Start	Test 3 End
Time	08:54	10:26	10:35	12:03	12:12	13:32
Gas Meter Reading(Am^3 dry)	256.618	257.572	257.572	258.206	258.206	258.918
Absorber Weight(g)	3407.2	3457.2	3512.8	3544.0	3434.3	3471.8
Filter Reference	ED120711F1		ED120711F2		ED120711F3	
Filter Weight(g)	0.54954	0.54986	0.54839	0.54861	0.54712	0.54748
Probe Rinse Reference	ED120711R1		ED120711R2		ED120711R3	
Probe Rinse Weight(g)	79.5023	79.5024	79.5024	79.5025	79.5025	79.5026
Sample Reference HCl	ED120711HA1		ED120711HA2		ED120711HA3 A&B	
Absorbent Volume(ml)	500		500		250	250
Absorbent(mg/l as HCl)	11		8.6		35	0.76
Blank(mg/l as HCl)	0.83		0.83		0.83	0.83

Calculation: General

	Test 1	Test 2	Test 3
Barometric Pressure(kPa)	101.7	101.7	101.7
Gas Meter temperature(Deg C)	38.9	45.7	43.0
Gas Volume Sampled(Am^3 dry)	0.954	0.634	0.712
Gas Volume Sampled(Nm^3 dry)	0.8382	0.5453	0.6175
Mass of Dry Gas(g @ 1292.8 g/Nm^3)	1083.66	704.94	798.29
Change in Absorber Weight(g)	50.0	31.2	37.5
Water Vapour Volume(Nm^3 @ 803.9 g/Nm^3)	0.0622	0.0388	0.0466
Gas Volume(Nm^3 wet)	0.9004	0.5841	0.6641
Mass of Wet Gas(g)	1133.66	736.14	835.79
Moisture Concentration(%v/v)	**6.9**	**6.6**	**7.0**
Moisture Concentration(%w/w)	**4.4**	**4.2**	**4.5**

Calculation: Particulate

Increase In Filter Weights(g)	0.00043	0.00030	0.00049
Particulate Emission(mg/Nm^3 dry)	0.52	0.55	0.79
Oxygen Concentration(%v/v dry)	12.90	14.28	14.02
Particulate Emission (mg/Nm^3 @ 11 %v/v Oxygen dry)	**0.64**	**0.82**	**1.13**
Flue Gas Volumetric Flow(Nm^3/h dry)	1658	1491	1366
Particulate Emission(g/h)	**0.86**	**0.82**	**1.08**
Required Sample Velocity(Nm/s)	9.85	8.85	8.11
Nozzle Used(mm)	4.5	4.0	4.5
Area of Nozzle(m^2)	0.00001590	0.00001257	0.00001590
Test Duration(mins)	92	88	80
Actual Sample Velocity(Nm/s)	9.55	8.22	8.09
Isokinetic Closure(%)	97	93	100
		97	

Calculation: HCl

Absorbent(mg/l as HCl)	11.00	8.60	35.76
Blank(mg/l as HCl)	0.83	0.83	0.83
Chloride Absorbed(mg/l as HCl)	10.17	7.77	34.93
Chloride Absorbed(mg as HCl)	5.09	3.89	8.73
HCl(mg)	5.09	3.89	8.73
HCl Emission(mg/Nm^3 dry)	6.07	7.12	14.14
Oxygen Concentration(%v/v dry)	12.90	14.28	14.02
HCl Emission (mg/Nm^3 @ 11 %v/v Oxygen dry)	**7.50**	**10.63**	**20.30**
Flue Gas Volumetric Flow(Nm^3/h dry)	1658	1491	1366
HCl Emission(g/h)	**10.06**	**10.62**	**19.31**

East Devon Crematorium Abatement System Outlet

Flue Gas Volumetric Flow

Contract	East Devon Crematorium, DEM0508
Date	12th July 2011
Location	Flue Gas Abatement System Outlet
Engineer(s)	JB & ST

Test Log	Test 1	Test 2	Test 3
Flue Gas Temperature(Deg C)	116	116	114
Flue Gas Pitot Head Sample Points(Pa)	101.2	81.5	68.5
Flue Gas Pitot Head Duct Mean(Pa)	92.0	74.1	62.2
Flue Gas Moisture(%v/v)	6.9	6.6	7.0
Flue Gas Moisture(%w/w)	4.4	4.2	4.5
Flue Gas Duct Dimensions(mm)	250 mm Diameter Circular Stack		
Flue Gas Duct Area(m^2)	0.0491		

Calculation			
Flue Gas Density(kg/m^3)	0.8930	0.8921	0.8966
Sample Points			
Flue Gas Velocity(Am/s)	15.06	13.52	12.36
Flue Gas Volumetric Flowrate(Am^3/h)	2660	2389	2184
Flue Gas Volumetric Flowrate(Am^3/h dry)	2477	2230	2031
Flue Gas Volumetric Flowrate(Nm^3/h dry)	1740	1564	1433
Duct Mean			
Flue Gas Velocity(Am/s)	14.35	12.89	11.78
Flue Gas Volumetric Flowrate(Am^3/h)	2536	2277	2082
Flue Gas Volumetric Flowrate(Am^3/h dry)	2361	2126	1936
Flue Gas Volumetric Flowrate(Nm^3/h dry)	**1658**	**1491**	**1366**

East Devon Crematorium Abatement System Outlet

Preliminary Pitot Traverse

Traverse Position	Plane 1 / Top Pa	Plane 1 / Top Root(Pa)	Probe Position	Plane 2 / Side Pa	Plane 2 / Side Root(Pa)	Probe Position
1 Near	64	8.00		63	7.94	
2	71	8.43		69	8.31	
3	75	8.66		76	8.72	
4	80	8.94		82	9.06	
5	83	9.11	1C	83	9.11	2C
6	82	9.06		83	9.11	
7	79	8.89		81	9.00	
8	76	8.72		78	8.83	
9	73	8.54		75	8.66	
10 Far	68	8.25		70	8.37	
Sum		86.59			87.10	

Overall Total Root(Pa)	173.69
Average Root(Pa)	8.68
Equivalent Pa	75.4

Duct Mean Correction Factor	0.9087	1C	Velocity Within 3:1 (9:1 Pa)
			Flow > 5 Pa All Points
	1.0930	2C	No Negative Flow
			Swirl < 15°

East Devon Crematorium Abatement System Outlet

Data Log 12/07/11

Test 4

Time	Flue Gas °C	Meter °C	Flue O_2 %v/v dry	Sample Point Pa	Sample Point	Factor	Duct Mean Pa
13:42	114	41.1	14.92	61.3	1C	0.9087	55.7
13:43	114	41.0	14.36	69.7	1C	0.9087	63.4
13:44	114	40.9	15.07	76.4	1C	0.9087	69.5
13:45	114	40.9	14.63	76.4	1C	0.9087	69.5
13:46	115	40.8	14.62	83.2	1C	0.9087	75.6
13:47	115	40.8	14.04	87.4	1C	0.9087	79.4
13:48	115	40.8	12.57	89.9	1C	0.9087	81.7
13:49	116	40.8	10.66	117.6	1C	0.9087	106.9
13:50	116	40.8	12.80	98.3	1C	0.9087	89.3
13:51	116	40.8	12.49	77.3	1C	0.9087	70.2
13:52	116	40.9	11.73	85.7	1C	0.9087	77.9
13:53	116	40.9	11.82	91.6	1C	0.9087	83.2
13:54	116	41.0	11.60	89.9	1C	0.9087	81.7
13:55	116	41.0	12.54	73.9	1C	0.9087	67.2
13:56	115	41.1	12.13	62.2	1C	0.9087	56.5
13:57	115	41.2	12.46	52.9	1C	0.9087	48.1
13:58	114	41.2	12.25	46.2	1C	0.9087	42.0
13:59	114	41.3	12.11	42.8	1C	0.9087	38.9
14:00	114	41.3	12.70	40.3	1C	0.9087	36.6
14:01	113	41.4	12.59	37.8	1C	0.9087	34.3
14:02	113	41.5	12.15	36.1	1C	0.9087	32.8
14:03	113	41.6	12.64	33.6	1C	0.9087	30.5
14:04	113	41.7	12.94	36.1	1C	0.9087	32.8
14:05	113	41.8	13.86	39.5	1C	0.9087	35.9
14:06	112	41.8	14.20	43.7	1C	0.9087	39.7
14:07	112	41.9	14.09	43.7	1C	0.9087	39.7
14:08	112	41.9	14.41	42.8	1C	0.9087	38.9
14:09	112	41.9	14.66	41.2	1C	0.9087	37.4
14:10	112	42.0	14.78	41.2	1C	0.9087	37.4
14:11	112	42.0	14.85	42.0	1C	0.9087	38.2
14:12	112	42.1	14.88	42.8	1C	0.9087	38.9
14:13	112	42.2	14.92	42.0	1C	0.9087	38.2
14:14	112	42.2	15.28	41.2	1C	0.9087	37.4
14:15	112	42.2	15.44	41.2	1C	0.9087	37.4
14:16	111	42.2	15.47	41.2	1C	0.9087	37.4
14:17	111	42.3	15.80	40.3	1C	0.9087	36.6
14:18	111	42.3	16.18	39.5	1C	0.9087	35.9
14:19	111	42.2	16.57	38.6	1C	0.9087	35.1
14:20	111	42.2	16.99	43.7	1C	0.9087	39.7
14:21	112	42.3	17.20	72.2	1C	0.9087	65.6
14:22	112	42.3	13.98	73.1	1C	0.9087	66.4

14:23	112	42.4	13.74	74.8	1C	0.9087	67.9
14:24	113	42.4	13.94	74.8	1C	0.9087	67.9
14:25	113	42.5	14.10	73.9	1C	0.9087	67.2
14:26	113	42.7	14.21	73.1	1C	0.9087	66.4
14:27	113	42.7	14.34	72.2	1C	0.9087	65.6
14:28	113	42.8	14.44	73.1	1C	0.9087	66.4
14:29	113	42.9	14.59	73.1	1C	0.9087	66.4
14:30	113	42.9	14.72	71.4	1C	0.9087	64.9
14:31	113	42.9	14.67	62.2	1C	0.9087	56.5
14:32	113	43.0	14.42	63.0	1C	0.9087	57.2
14:33	112	43.1	14.58	61.3	1C	0.9087	55.7
14:34	112	43.2	14.63	62.2	1C	0.9087	56.5
14:35	112	43.2	14.72	62.2	1C	0.9087	56.5
14:36	112	43.2	14.78	61.3	1C	0.9087	55.7
14:37	112	43.2	14.89	58.8	1C	0.9087	53.4
14:38	112	43.2	14.71	58.0	1C	0.9087	52.7
14:39	112	43.3	14.75	56.3	1C	0.9087	51.1
14:40	112	43.4	14.77	56.3	1C	0.9087	51.1
14:41	112	43.4	14.82	57.1	1C	0.9087	51.9
14:42	112	43.4	14.87	57.1	1C	0.9087	51.9
14:43	112	43.5	14.92	56.3	1C	0.9087	51.1
14:44	112	43.4	14.99	52.1	1C	0.9087	47.3
14:45	111	43.4	14.68	47.9	1C	0.9087	43.5
14:46	111	43.4	14.38	33.6	1C	0.9087	30.5
14:47	110	43.5	16.60	36.1	1C	0.9087	32.8
14:48	111	43.5	18.52	52.9	1C	0.9087	48.1
14:49	110	43.6	14.90	32.8	1C	0.9087	29.8
14:50	110	43.6	13.23	31.9	1C	0.9087	29.0
14:51	110	43.7	13.12	31.9	1C	0.9087	29.0
Average	**113**	**42.2**	**14.22**	**57.9**			**52.6**

East Devon Crematorium Abatement System Outlet

Data Log 12/07/11

Test 5

Time	Flue Gas °C	Meter °C	Flue O_2 %v/v dry	Sample Point Pa	Sample Point	Factor	Duct Mean Pa
-							
15:04	114	41.2	14.93	85.7	1C	0.9087	77.9
15:05	113	41.2	13.88	58.0	1C	0.9087	52.7
15:06	114	41.1	13.97	60.5	1C	0.9087	55.0
15:07	114	41.0	14.50	60.5	1C	0.9087	55.0
15:08	114	40.9	14.33	67.2	1C	0.9087	61.1
15:09	114	40.9	14.03	69.7	1C	0.9087	63.4
15:10	114	40.9	13.11	65.5	1C	0.9087	59.5
15:11	114	40.9	13.82	59.6	1C	0.9087	54.2
15:12	114	40.9	14.74	59.6	1C	0.9087	54.2
15:13	114	41.0	14.02	68.9	1C	0.9087	62.6
15:14	115	41.1	9.84	106.7	1C	0.9087	96.9
15:15	117	41.1	11.11	142.8	1C	0.9087	129.8
15:16	118	41.2	11.87	150.4	1C	0.9087	136.6
15:17	119	41.4	12.75	142.8	1C	0.9087	129.8
15:18	119	41.5	12.88	118.4	1C	0.9087	107.6
15:19	118	41.6	12.56	94.9	1C	0.9087	86.3
15:20	118	41.7	12.61	77.3	1C	0.9087	70.2
15:21	117	41.8	12.60	58.0	1C	0.9087	52.7
15:22	117	41.8	12.20	47.9	1C	0.9087	43.5
15:23	117	42.0	12.20	47.9	1C	0.9087	43.5
15:24	116	42.1	11.88	47.0	1C	0.9087	42.7
15:25	116	42.1	12.05	41.2	1C	0.9087	37.4
15:26	115	42.2	12.01	39.5	1C	0.9087	35.9
15:27	115	42.3	12.21	37.8	1C	0.9087	34.3
15:28	115	42.3	12.64	43.7	1C	0.9087	39.7
15:29	115	42.3	12.98	42.8	1C	0.9087	38.9
15:30	115	42.3	13.54	42.8	1C	0.9087	38.9
15:31	115	42.4	13.87	42.8	1C	0.9087	38.9
15:32	114	42.4	14.26	42.8	1C	0.9087	38.9
15:33	114	42.4	14.77	42.0	1C	0.9087	38.2
15:34	114	42.5	15.09	42.0	1C	0.9087	38.2
15:35	114	42.5	15.43	40.3	1C	0.9087	36.6
15:36	114	42.6	15.64	40.3	1C	0.9087	36.6
15:37	114	42.6	15.86	39.5	1C	0.9087	35.9
15:38	113	42.6	16.13	39.5	1C	0.9087	35.9
15:39	113	42.6	16.35	39.5	1C	0.9087	35.9
15:40	113	42.7	16.65	39.5	1C	0.9087	35.9
15:41	113	42.7	16.88	40.3	1C	0.9087	36.6
15:42	113	42.7	17.08	39.5	1C	0.9087	35.9
15:43	113	42.7	17.38	39.5	1C	0.9087	35.9
15:44	112	42.7	17.50	39.5	1C	0.9087	35.9
15:45	113	42.7	17.76	58.8	1C	0.9087	53.4

15:46	114	42.7	15.51	72.2	1C	0.9087	65.6
15:47	114	42.7	13.75	73.1	1C	0.9087	66.4
15:48	115	42.7	13.92	73.9	1C	0.9087	67.2
15:49	115	42.7	14.09	72.2	1C	0.9087	65.6
15:50	114	42.8	17.13	57.1	1C	0.9087	51.9
15:51	114	42.9	17.42	72.2	1C	0.9087	65.6
15:52	115	42.8	14.67	91.6	1C	0.9087	83.2
15:53	115	42.8	15.04	86.5	1C	0.9087	78.6
15:54	115	42.9	15.01	77.3	1C	0.9087	70.2
15:55	115	42.9	15.01	76.4	1C	0.9087	69.5
15:56	115	43.0	15.15	74.8	1C	0.9087	67.9
15:57	115	43.0	15.21	75.6	1C	0.9087	68.7
15:58	115	42.9	15.30	75.6	1C	0.9087	68.7
15:59	115	42.9	15.37	74.8	1C	0.9087	67.9
16:00	114	42.9	15.43	70.6	1C	0.9087	64.1
16:01	114	42.9	15.34	69.7	1C	0.9087	63.4
16:02	114	42.9	15.41	69.7	1C	0.9087	63.4
16:03	114	41.6	15.68	69.7	1C	0.9087	63.4
16:04	114	40.5	16.03	67.2	1C	0.9087	61.1
Average	**115**	**42.1**	**14.43**	**65.0**			**59.0**

East Devon Crematorium Abatement System Outlet

Data Log 12/07/11

Test 6

Time	Flue Gas °C	Meter °C	Flue O_2 %v/v dry	Sample Point Pa	Sample Point	Factor	Duct Mean Pa
16:14	116	39.3	17.71	82.3	1C	0.9087	74.8
16:15	115	40.0	14.16	52.9	1C	0.9087	48.1
16:16	115	39.9	14.22	55.4	1C	0.9087	50.4
16:17	115	39.9	14.90	56.3	1C	0.9087	51.1
16:18	115	39.9	14.46	64.7	1C	0.9087	58.8
16:19	116	39.9	11.44	80.6	1C	0.9087	73.3
16:20	116	40.0	10.12	67.2	1C	0.9087	61.1
16:21	116	40.0	12.06	63.8	1C	0.9087	58.0
16:22	116	40.1	12.07	73.1	1C	0.9087	66.4
16:23	116	40.1	11.58	72.2	1C	0.9087	65.6
16:24	116	40.2	12.06	72.2	1C	0.9087	65.6
16:25	116	40.3	12.23	63.8	1C	0.9087	58.0
16:26	116	40.5	12.00	68.0	1C	0.9087	61.8
16:27	116	40.6	12.46	66.4	1C	0.9087	60.3
16:28	115	40.6	13.10	65.5	1C	0.9087	59.5
16:29	115	40.7	13.40	61.3	1C	0.9087	55.7
16:30	115	40.8	13.04	47.0	1C	0.9087	42.7
16:31	114	40.9	12.11	38.6	1C	0.9087	35.1
16:32	114	41.0	12.26	35.3	1C	0.9087	32.1
16:33	113	41.0	12.19	33.6	1C	0.9087	30.5
16:34	113	41.1	12.26	36.1	1C	0.9087	32.8
16:35	113	41.1	12.07	33.6	1C	0.9087	30.5
16:36	113	41.1	12.64	32.8	1C	0.9087	29.8
16:37	112	41.1	13.06	32.8	1C	0.9087	29.8
16:38	112	41.2	13.48	39.5	1C	0.9087	35.9
16:39	112	41.2	14.35	42.8	1C	0.9087	38.9
16:40	112	41.1	14.79	42.0	1C	0.9087	38.2
16:41	112	41.1	15.41	42.0	1C	0.9087	38.2
16:42	112	41.1	15.78	40.3	1C	0.9087	36.6
16:43	112	41.1	15.98	39.5	1C	0.9087	35.9
16:44	112	41.1	16.24	40.3	1C	0.9087	36.6
16:45	112	41.1	16.39	40.3	1C	0.9087	36.6
16:46	111	41.0	16.56	40.3	1C	0.9087	36.6
16:47	111	41.0	16.83	41.2	1C	0.9087	37.4
16:48	111	41.1	17.06	40.3	1C	0.9087	36.6
16:49	111	41.1	17.28	39.5	1C	0.9087	35.9
16:50	111	41.1	17.25	39.5	1C	0.9087	35.9
16:51	111	41.2	17.28	40.3	1C	0.9087	36.6
16:52	111	41.2	17.58	52.9	1C	0.9087	48.1
16:53	112	41.3	14.24	75.6	1C	0.9087	68.7
16:54	113	41.4	12.71	77.3	1C	0.9087	70.2

16:55	112	41.6	16.07	54.6	1C	0.9087	49.6
16:56	112	41.6	16.28	68.9	1C	0.9087	62.6
16:57	113	41.6	13.11	84.0	1C	0.9087	76.3
16:58	112	41.7	16.93	58.8	1C	0.9087	53.4
16:59	113	41.8	16.05	79.0	1C	0.9087	71.7
17:00	113	41.8	13.70	87.4	1C	0.9087	79.4
17:01	114	41.9	14.26	86.5	1C	0.9087	78.6
17:02	113	42.0	18.22	66.4	1C	0.9087	60.3
17:03	114	42.0	15.67	89.9	1C	0.9087	81.7
17:04	113	42.1	14.46	79.0	1C	0.9087	71.7
17:05	113	42.1	14.22	76.4	1C	0.9087	69.5
17:06	114	42.2	14.46	93.2	1C	0.9087	84.7
17:07	114	42.4	14.93	93.2	1C	0.9087	84.7
17:08	114	42.5	15.12	91.6	1C	0.9087	83.2
17:09	114	42.7	15.23	88.2	1C	0.9087	80.1
17:10	114	42.8	15.20	86.5	1C	0.9087	78.6
17:11	114	42.9	15.23	86.5	1C	0.9087	78.6
17:12	115	43.0	15.33	87.4	1C	0.9087	79.4
17:13	115	43.1	15.52	89.0	1C	0.9087	80.9
17:14	114	43.2	15.33	73.1	1C	0.9087	66.4
17:15	114	43.3	14.97	60.5	1C	0.9087	55.0
17:16	114	43.4	14.31	47.9	1C	0.9087	43.5
17:17	113	43.5	13.63	46.2	1C	0.9087	42.0
17:18	113	43.5	14.41	48.7	1C	0.9087	44.3
17:19	113	43.4	19.32	56.3	1C	0.9087	51.1
17:20	113	43.4	16.21	73.9	1C	0.9087	67.2
17:21	114	43.5	15.46	68.0	1C	0.9087	61.8
17:22	113	43.5	15.11	52.9	1C	0.9087	48.1
17:23	113	43.5	14.38	51.2	1C	0.9087	46.6
17:24	113	43.5	14.36	51.2	1C	0.9087	46.6
17:25	113	43.5	14.43	51.2	1C	0.9087	46.6
17:26	113	43.5	14.51	51.2	1C	0.9087	46.6
17:27	112	43.5	14.52	40.3	1C	0.9087	36.6
17:28	112	43.6	17.92	42.8	1C	0.9087	38.9
17:29	113	43.5	18.19	62.2	1C	0.9087	56.5
17:30	113	43.5	15.58	65.5	1C	0.9087	59.5
17:31	113	43.5	15.64	62.2	1C	0.9087	56.5
17:32	113	43.5	15.33	49.6	1C	0.9087	45.0
17:33	113	43.5	14.80	49.6	1C	0.9087	45.0
17:34	112	43.5	14.82	49.6	1C	0.9087	45.0
17:35	112	43.3	15.89	47.9	1C	0.9087	43.5
Average	**113**	**41.8**	**14.71**	**59.5**			**54.1**

East Devon Crematorium Abatement System Outlet

Mercury

Contract	East Devon Crematorium, DEM0508
Date	12th July 2011
Location	Flue Gas Abatement System Outlet
Engineer(s)	JB & ST
Absorbent	4% $K_2CR_2O_7$ / 20% HNO_3 in H_2O

Test Log	Test 4		Test 5		Test 6	
Barometric Pressure(kPa)	101.7		101.7		101.7	
Gas Meter Temperature(Deg C)	42.2		42.1		41.8	
Oxygen Concentration(%v/v dry)	14.22		14.43		14.71	
Flue Gas Volumetric Flow(Nm^3/h dry)	1263		1295		1278	
	Start	End	Start	End	Start	End
Time	13:42	14:51	15:04	16:04	16:14	17:20
Gas Meter Reading(Am^3 dry)	258.918	259.521	259.521	259.999	259.999	260.634
Absorber Weight(g)	3491.7	3521.3	3414.9	3450.7	3449.2	3481.2
Filter Reference	ED120711FHGA4		ED120711FHGA5		ED120711FHGA6	
Filter Fraction Analysed	1		1		1	
Filter(µg as Hg)	0.02		0.07		0.07	
Filter Blank(µg as Hg)	0.02		0.02		0.02	
Probe Rinse Reference	Washed into HgA4		Washed into HgA5		Washed into HgA6A	
Probe Rinse Volume(ml)	0		0		0	
Probe Rinse(µg/l as Hg)	0		0		0	
Probe Rinse Blank(µg/l as Hg)	0		0		0	
Absorbent Reference	ED120711HGA4		ED120711HGA5		ED120711HGA6 A&B	
Absorbent Volume(ml)	500		500		250	250
Absorbent(µg/l as Hg)	11		17		29	5
Absorbent Blank(µg/l as Hg)	5		5		5	5

Calculation: General

	Test 4	Test 5	Test 6
Barometric Pressure(kPa)	101.7	101.7	101.7
Gas Meter Temperature(Deg C)	42.2	42.1	41.8
Gas Volume Sampled(Am^3 dry)	0.603	0.478	0.635
Gas Volume Sampled(Nm^3 dry)	0.5243	0.4157	0.5529
Mass of Dry Gas(g @ 1292.8 g/Nm^3)	677.85	537.45	714.74
Change in Absorber Weight(g)	29.6	35.8	32.0
Water Vapour Volume(Nm^3 @ 803.9 g/Nm^3)	0.0368	0.0445	0.0398
Gas Volume(Nm^3 wet)	0.5612	0.4603	0.5927
Mass of Wet Gas(g)	707.45	573.25	746.74
Moisture Concentration(%v/v)	6.6	9.7	6.7
Moisture Concentration(%w/w)	4.2	6.2	4.3

Calculation: Mercury

Filter(µg as Hg)	0.00	0.05	0.05
Probe Rinse(µg as Hg)	0.00	0.00	0.00
Absorbent(µg as Hg)	3.00	6.00	6.00
Total Mercury Sampled(µg)	3.00	6.05	6.05
Mercury Emission(µg/Nm^3 dry)	5.72	14.55	10.94
Oxygen Concentration(%v/v dry)	14.22	14.43	14.71
Mercury Emission (µg/Nm^3 @ 11 %v/v Oxygen dry)	**8.46**	**22.22**	**17.44**
Flue Gas Volumetric Flowrate(Nm^3/h dry)	1263	1295	1278
Mercury Emission(g/h)	**0.007**	**0.019**	**0.014**
Required Sample Velocity(Nm/s)	7.50	7.69	7.58
Nozzle Used(mm)	4.5	4.5	4.5
Area of Nozzle(m^2)	0.00001590	0.00001590	0.00001590
Test Duration(mins)	69	60	66
Actual Sample Velocity(Nm/s)	7.96	7.26	8.78
Isokinetic Closure(%)	106	94	116
		105	

East Devon Crematorium Abatement System Outlet

Flue Gas Volumetric Flow

Contract	East Devon Crematorium, DEM0508
Date	12th July 2011
Location	Flue Gas Abatement System Outlet
Engineer(s)	JB & ST

Test Log	Test 1	Test 2	Test 3
Flue Gas Temperature(Deg C)	113	115	113
Flue Gas Pitot Head Sample Points(Pa)	57.9	65.0	59.5
Flue Gas Pitot Head Duct Mean(Pa)	52.6	59.0	54.1
Flue Gas Moisture(%v/v)	6.6	9.7	6.7
Flue Gas Moisture(%w/w)	4.2	6.2	4.3
Flue Gas Duct Dimensions(mm)	250 mm Diameter Circular Stack		
Flue Gas Duct Area(m^2)	0.0491		

Calculation	Test 1	Test 2	Test 3
Flue Gas Density(kg/m^3)	0.9005	0.8889	0.8988
Sample Points			
Flue Gas Velocity(Am/s)	11.34	12.09	11.51
Flue Gas Volumetric Flowrate(Am^3/h)	2004	2137	2033
Flue Gas Volumetric Flowrate(Am^3/h dry)	1873	1930	1897
Flue Gas Volumetric Flowrate(Nm^3/h dry)	1325	1359	1340
Duct Mean			
Flue Gas Velocity(Am/s)	10.81	11.53	10.97
Flue Gas Volumetric Flowrate(Am^3/h)	1910	2037	1938
Flue Gas Volumetric Flowrate(Am^3/h dry)	1785	1840	1808
Flue Gas Volumetric Flowrate(Nm^3/h dry)	**1263**	**1295**	**1278**

East Devon Crematorium Abatement System Outlet

Dioxin & Furan Test 7

Data Log 13-Jul-11

Time	Flue Gas °C	Meter °C	Flue O_2 %v/v dry	Sample Point Pa	Sample Point	Factor	Duct Mean Pa
09:31	111	18.1	12.11	126.8	1C	0.9087	115.3
09:32	112	18.3	13.83	111.7	1C	0.9087	101.5
09:33	112	18.5	12.94	99.1	1C	0.9087	90.1
09:34	112	18.9	13.02	99.1	1C	0.9087	90.1
09:35	112	19.3	13.07	89.0	1C	0.9087	80.9
09:36	113	19.8	11.35	91.6	1C	0.9087	83.2
09:37	113	20.3	11.50	92.4	1C	0.9087	84.0
09:38	113	20.8	11.98	104.2	1C	0.9087	94.6
09:39	113	21.3	12.78	92.4	1C	0.9087	84.0
09:40	113	21.7	11.56	100.8	1C	0.9087	91.6
09:41	114	22.3	12.15	106.7	1C	0.9087	96.9
09:42	114	22.8	11.80	119.3	1C	0.9087	108.4
09:43	116	23.4	11.71	147.8	1C	0.9087	134.3
09:44	116	23.9	12.23	138.6	1C	0.9087	125.9
09:45	117	24.4	11.97	156.2	1C	0.9087	142.0
09:46	118	24.8	12.23	160.4	1C	0.9087	145.8
09:47	119	25.3	11.92	170.5	1C	0.9087	154.9
09:48	119	25.8	11.98	169.7	1C	0.9087	154.2
09:49	120	26.3	11.87	168.0	1C	0.9087	152.7
09:50	121	26.7	12.19	168.0	1C	0.9087	152.7
09:51	121	27.1	12.45	167.2	1C	0.9087	151.9
09:52	122	27.6	12.65	161.3	1C	0.9087	146.6
09:53	122	28.0	12.44	152.9	1C	0.9087	138.9
09:54	122	28.4	12.39	142.8	1C	0.9087	129.8
09:55	123	28.8	12.29	152.0	1C	0.9087	138.2
09:56	123	29.3	12.40	160.4	1C	0.9087	145.8
09:57	124	29.7	12.42	158.8	1C	0.9087	144.3
09:58	124	30.1	12.46	142.8	1C	0.9087	129.8
09:59	124	30.4	12.43	134.4	1C	0.9087	122.1
10:00	124	30.8	12.16	120.1	1C	0.9087	109.1
10:01	123	31.1	12.28	115.1	1C	0.9087	104.6
10:02	123	31.4	12.34	102.5	1C	0.9087	93.1
10:03	123	31.7	12.33	98.3	1C	0.9087	89.3
10:04	122	32.0	12.25	85.7	1C	0.9087	77.9
10:05	122	32.3	12.04	81.5	1C	0.9087	74.0

10:06	121	32.7	11.38	71.4	1C	0.9087	64.9
10:07	121	32.9	12.50	76.4	1C	0.9087	69.5
10:08	121	33.1	11.59	68.0	1C	0.9087	61.8
10:09	120	33.4	11.82	69.7	1C	0.9087	63.4
10:10	120	33.7	12.97	74.8	1C	0.9087	67.9
10:11	119	33.9	13.32	63.0	1C	0.9087	57.2
10:12	119	34.2	13.29	68.9	1C	0.9087	62.6
10:13	119	34.5	11.23	55.4	1C	0.9087	50.4
10:14	118	34.8	12.23	51.2	1C	0.9087	46.6
10:15	118	35.0	12.32	61.3	1C	0.9087	55.7
10:16	119	35.4	10.27	49.6	1C	0.9087	45.0
10:17	118	35.6	13.76	27.7	1C	0.9087	25.2
10:18	119	35.9	11.94	38.6	1C	0.9087	35.1
10:19	118	36.1	12.54	30.2	1C	0.9087	27.5
10:20	118	36.4	13.18	46.2	1C	0.9087	42.0
10:21	119	36.6	10.72	54.6	1C	0.9087	49.6
10:22	118	36.8	14.65	31.1	1C	0.9087	28.2
10:23	118	37.0	14.11	53.8	1C	0.9087	48.9
10:24	119	37.2	11.19	61.3	1C	0.9087	55.7
10:25	119	37.3	12.36	44.5	1C	0.9087	40.5
10:26	118	37.5	13.45	34.4	1C	0.9087	31.3
10:27	119	37.6	13.08	59.6	1C	0.9087	54.2
10:28	118	37.8	12.51	88.2	1C	0.9087	80.1
10:29	118	38.0	13.12	82.3	1C	0.9087	74.8
10:30	118	38.2	12.98	71.4	1C	0.9087	64.9
10:31	117	38.2	12.72	60.5	1C	0.9087	55.0
10:32	117	38.3	14.39	65.5	1C	0.9087	59.5
10:33	117	38.4	12.98	86.5	1C	0.9087	78.6
10:34	117	38.5	12.19	74.8	1C	0.9087	67.9
10:35	116	38.7	12.79	70.6	1C	0.9087	64.1
10:36	116	38.8	12.84	70.6	1C	0.9087	64.1
10:37	116	39.0	12.88	73.1	1C	0.9087	66.4
10:38	116	39.1	13.57	74.8	1C	0.9087	67.9
10:39	116	39.2	13.43	67.2	1C	0.9087	61.1
10:40	115	39.3	13.46	66.4	1C	0.9087	60.3
10:41	116	39.4	13.51	77.3	1C	0.9087	70.2
10:42	116	39.5	13.50	90.7	1C	0.9087	82.4
10:43	116	39.7	14.03	87.4	1C	0.9087	79.4
10:44	116	39.8	13.84	89.0	1C	0.9087	80.9
10:45	116	39.8	14.21	101.6	1C	0.9087	92.4
10:46	117	39.9	14.79	104.2	1C	0.9087	94.6
10:47	117	40.0	14.99	124.3	1C	0.9087	113.0
10:48	118	40.1	14.30	119.3	1C	0.9087	108.4

10:49	118	40.1	14.40	118.4	1C	0.9087	107.6
10:50	118	40.1	14.98	97.4	1C	0.9087	88.5
10:51	117	40.2	15.21	91.6	1C	0.9087	83.2
10:52	117	40.2	13.92	87.4	1C	0.9087	79.4
10:53	117	40.3	13.88	87.4	1C	0.9087	79.4
10:54	117	40.4	13.86	86.5	1C	0.9087	78.6
10:55	117	40.6	13.89	88.2	1C	0.9087	80.1
10:56	117	40.6	13.98	86.5	1C	0.9087	78.6
10:57	117	40.7	14.07	86.5	1C	0.9087	78.6
10:58	117	40.7	14.13	86.5	1C	0.9087	78.6
10:59	117	40.9	14.21	85.7	1C	0.9087	77.9
11:00	117	41.0	14.24	85.7	1C	0.9087	77.9
11:01	117	41.1	14.23	85.7	1C	0.9087	77.9
11:02	117	41.1	14.31	85.7	1C	0.9087	77.9
11:03	117	41.3	14.35	84.8	1C	0.9087	77.1
11:04	117	41.4	14.42	84.0	1C	0.9087	76.3
11:05	117	41.4	14.53	84.8	1C	0.9087	77.1
11:06	117	41.4	14.59	84.8	1C	0.9087	77.1
11:07	117	41.5	14.67	84.0	1C	0.9087	76.3
11:08	117	41.5	14.77	84.0	1C	0.9087	76.3
11:09	117	41.7	14.84	84.0	1C	0.9087	76.3
11:10	117	41.6	14.87	84.8	1C	0.9087	77.1
11:11	117	41.5	14.90	84.0	1C	0.9087	76.3
11:12	117	41.6	14.95	84.0	1C	0.9087	76.3
11:13	117	41.7	14.98	83.2	1C	0.9087	75.6
11:14	117	41.7	15.01	77.3	1C	0.9087	70.2
11:15	116	41.9	17.08	44.5	1C	0.9087	40.5
11:16	115	41.9	18.09	44.5	1C	0.9087	40.5
11:17	115	42.0	18.33	36.1	1C	0.9087	32.8
11:18	115	42.0	14.37	35.3	1C	0.9087	32.1
11:19	115	42.1	9.44	41.2	1C	0.9087	37.4
11:20	117	42.1	17.10	126.8	1C	0.9087	115.3
11:21	119	42.2	12.34	123.5	1C	0.9087	112.2
11:22	118	42.3	13.67	89.0	1C	0.9087	80.9
11:23	118	42.3	14.21	67.2	1C	0.9087	61.1
11:24	117	42.5	13.80	65.5	1C	0.9087	59.5
11:25	117	42.5	14.64	64.7	1C	0.9087	58.8
11:26	117	42.6	15.06	67.2	1C	0.9087	61.1
11:27	117	42.6	14.91	76.4	1C	0.9087	69.5
11:28	117	42.7	14.59	77.3	1C	0.9087	70.2
11:29	118	42.8	11.09	105.0	1C	0.9087	95.4
11:30	119	42.9	11.64	122.6	1C	0.9087	111.4
11:31	119	43.0	12.46	107.5	1C	0.9087	97.7

11:32	120	43.0	12.20	106.7	1C	0.9087	96.9
11:33	119	43.1	12.69	90.7	1C	0.9087	82.4
11:34	119	43.1	12.63	70.6	1C	0.9087	64.1
11:35	118	43.2	12.05	63.8	1C	0.9087	58.0
11:36	118	43.3	12.39	62.2	1C	0.9087	56.5
11:37	117	43.3	12.20	52.9	1C	0.9087	48.1
11:38	117	43.3	12.29	45.4	1C	0.9087	41.2
11:39	116	43.3	11.85	42.0	1C	0.9087	38.2
11:40	116	43.3	12.22	41.2	1C	0.9087	37.4
11:41	116	43.4	12.42	41.2	1C	0.9087	37.4
11:42	115	43.4	11.74	39.5	1C	0.9087	35.9
11:43	115	43.4	12.06	37.8	1C	0.9087	34.3
11:44	115	43.4	12.24	32.8	1C	0.9087	29.8
11:45	114	43.5	12.41	34.4	1C	0.9087	31.3
11:46	114	43.5	12.51	37.0	1C	0.9087	33.6
11:47	114	43.5	12.27	37.8	1C	0.9087	34.3
11:48	114	43.5	12.77	37.8	1C	0.9087	34.3
11:49	113	43.5	13.57	37.0	1C	0.9087	33.6
11:50	113	43.5	14.06	36.1	1C	0.9087	32.8
11:51	114	43.5	14.73	49.6	1C	0.9087	45.0
11:52	114	43.5	13.69	47.0	1C	0.9087	42.7
11:53	113	43.7	13.98	37.8	1C	0.9087	34.3
11:54	113	43.9	15.66	37.8	1C	0.9087	34.3
11:55	113	43.9	15.91	50.4	1C	0.9087	45.8
11:56	113	44.0	14.62	47.0	1C	0.9087	42.7
11:57	113	44.0	14.63	46.2	1C	0.9087	42.0
11:58	113	44.0	15.11	38.6	1C	0.9087	35.1
11:59	113	44.1	17.11	47.9	1C	0.9087	43.5
12:00	113	44.2	15.62	43.7	1C	0.9087	39.7
12:01	113	44.2	15.32	43.7	1C	0.9087	39.7
12:02	113	44.1	15.40	43.7	1C	0.9087	39.7
12:03	113	44.1	15.60	51.2	1C	0.9087	46.6
12:04	113	44.1	15.10	52.1	1C	0.9087	47.3
12:05	113	44.1	14.95	64.7	1C	0.9087	58.8
12:06	114	44.1	13.82	73.1	1C	0.9087	66.4
12:07	113	44.1	14.74	49.6	1C	0.9087	45.0
12:08	113	44.1	16.33	66.4	1C	0.9087	60.3
12:09	113	44.2	16.00	70.6	1C	0.9087	64.1
12:10	114	44.2	15.51	77.3	1C	0.9087	70.2
12:11	114	44.2	14.44	73.9	1C	0.9087	67.2
12:12	114	44.1	14.90	66.4	1C	0.9087	60.3
12:13	113	44.1	14.94	64.7	1C	0.9087	58.8
12:14	113	44.0	14.99	63.8	1C	0.9087	58.0

12:15	113	44.0	15.09	70.6	1C	0.9087	64.1
12:16	114	44.0	15.09	84.8	1C	0.9087	77.1
12:17	114	44.0	14.20	74.8	1C	0.9087	67.9
12:18	114	44.0	15.37	73.9	1C	0.9087	67.2
12:19	114	44.1	15.24	76.4	1C	0.9087	69.5
12:20	114	44.1	13.78	72.2	1C	0.9087	65.6
12:21	113	44.0	14.58	56.3	1C	0.9087	51.1
12:22	113	44.0	15.14	52.1	1C	0.9087	47.3
12:23	113	44.0	15.00	58.8	1C	0.9087	53.4
12:24	113	44.0	14.83	65.5	1C	0.9087	59.5
12:25	113	44.0	13.81	58.8	1C	0.9087	53.4
12:26	113	44.0	15.16	64.7	1C	0.9087	58.8
12:27	113	44.0	14.79	64.7	1C	0.9087	58.8
12:28	113	44.0	13.90	63.8	1C	0.9087	58.0
12:29	113	44.0	13.91	61.3	1C	0.9087	55.7
12:30	112	44.1	15.11	47.9	1C	0.9087	43.5
12:31	112	44.1	15.00	32.8	1C	0.9087	29.8
12:32	111	44.0	14.02	31.9	1C	0.9087	29.0
12:33	111	44.0	17.96	34.4	1C	0.9087	31.3
12:34	111	44.1	14.66	36.1	1C	0.9087	32.8
12:35	110	44.1	13.35	22.7	1C	0.9087	20.6
12:36	110	44.0	16.20	26.0	1C	0.9087	23.7
12:37	110	44.0	16.66	26.0	1C	0.9087	23.7
12:38	110	44.0	16.44	20.2	1C	0.9087	18.3
12:39	109	43.9	11.90	21.8	1C	0.9087	19.8
12:40	109	43.9	9.31	10.9	1C	0.9087	9.9
12:41	108	43.8	13.25	11.8	1C	0.9087	10.7
12:42	109	43.7	15.33	63.8	1C	0.9087	58.0
12:43	114	43.7	14.82	143.6	1C	0.9087	130.5
12:44	115	43.6	10.91	108.4	1C	0.9087	98.5
12:45	115	43.5	14.04	82.3	1C	0.9087	74.8
12:46	115	43.6	15.05	54.6	1C	0.9087	49.6
12:47	115	43.6	13.09	52.1	1C	0.9087	47.3
12:48	115	43.6	11.99	51.2	1C	0.9087	46.6
12:49	115	43.6	11.98	53.8	1C	0.9087	48.9
12:50	115	43.6	11.74	56.3	1C	0.9087	51.1
12:51	115	43.6	12.57	37.0	1C	0.9087	33.6
12:52	115	43.6	12.80	10.9	1C	0.9087	9.9
12:53	115	43.5	13.43	16.8	1C	0.9087	15.3
12:54	115	43.6	14.00	10.9	1C	0.9087	9.9
12:55	115	43.6	14.36	10.9	1C	0.9087	9.9
12:56	115	43.6	14.59	31.9	1C	0.9087	29.0
12:57	115	43.6	13.51	23.5	1C	0.9087	21.4

12:58	115	43.6	13.42	27.7	1C	0.9087	25.2
12:59	115	43.6	13.48	17.6	1C	0.9087	16.0
13:00	114	43.6	14.07	15.1	1C	0.9087	13.7
13:01	114	43.6	14.06	16.0	1C	0.9087	14.5
13:02	113	43.6	13.55	16.8	1C	0.9087	15.3
13:03	112	43.6	12.88	18.5	1C	0.9087	16.8
13:04	113	43.5	12.69	19.3	1C	0.9087	17.6
13:05	113	43.6	11.15	20.2	1C	0.9087	18.3
13:06	112	43.6	12.68	21.8	1C	0.9087	19.8
13:07	112	43.6	13.40	17.6	1C	0.9087	16.0
13:08	112	43.6	13.59	17.6	1C	0.9087	16.0
13:09	112	43.6	14.78	0.8	1C	0.9087	0.8
13:10	113	43.6	14.78	28.6	1C	0.9087	26.0
13:11	113	43.6	11.20	27.7	1C	0.9087	25.2
13:12	112	43.6	15.98	5.0	1C	0.9087	4.6
13:13	112	43.6	16.27	9.2	1C	0.9087	8.4
13:14	112	43.6	15.30	7.6	1C	0.9087	6.9
13:15	112	43.6	15.13	10.9	1C	0.9087	9.9
13:16	112	43.7	15.28	10.1	1C	0.9087	9.2
13:17	112	43.6	16.80	6.7	1C	0.9087	6.1
13:18	112	43.6	16.77	10.1	1C	0.9087	9.2
13:19	112	43.5	15.71	5.0	1C	0.9087	4.6
13:20	111	43.6	15.79	5.0	1C	0.9087	4.6
13:21	112	43.6	16.14	16.0	1C	0.9087	14.5
13:22	112	43.5	13.57	30.2	1C	0.9087	27.5
13:23	113	43.5	13.49	26.9	1C	0.9087	24.4
13:24	113	43.5	13.70	23.5	1C	0.9087	21.4
13:25	113	43.5	13.93	55.4	1C	0.9087	50.4
13:26	113	43.6	14.16	70.6	1C	0.9087	64.1
13:27	113	43.6	14.71	74.8	1C	0.9087	67.9
13:28	113	43.5	14.89	75.6	1C	0.9087	68.7
13:29	113	43.5	14.89	71.4	1C	0.9087	64.9
13:30	113	43.5	14.68	63.0	1C	0.9087	57.2
13:31	113	43.6	14.62	67.2	1C	0.9087	61.1
13:32	113	43.5	14.85	67.2	1C	0.9087	61.1
13:33	113	43.5	14.84	67.2	1C	0.9087	61.1
13:34	113	43.5	14.80	65.5	1C	0.9087	59.5
13:35	113	43.5	14.77	66.4	1C	0.9087	60.3
13:36	113	43.6	14.78	65.5	1C	0.9087	59.5
13:37	113	43.7	14.91	65.5	1C	0.9087	59.5
13:38	113	43.7	15.01	65.5	1C	0.9087	59.5
13:39	113	43.9	15.14	65.5	1C	0.9087	59.5
13:40	113	43.8	15.26	66.4	1C	0.9087	60.3

13:41	112	43.8	15.33	66.4	1C	0.9087	60.3
13:42	112	43.8	15.41	66.4	1C	0.9087	60.3
13:43	113	43.9	15.56	68.9	1C	0.9087	62.6
13:44	112	43.9	15.73	67.2	1C	0.9087	61.1
13:45	113	43.9	15.92	85.7	1C	0.9087	77.9
13:46	113	43.9	15.09	84.0	1C	0.9087	76.3
13:47	113	43.9	15.26	71.4	1C	0.9087	64.9
13:48	113	43.8	16.10	73.9	1C	0.9087	67.2
13:49	114	44.0	15.99	88.2	1C	0.9087	80.1
13:50	113	44.0	14.75	62.2	1C	0.9087	56.5
13:51	112	43.9	14.36	46.2	1C	0.9087	42.0
13:52	112	44.1	15.03	44.5	1C	0.9087	40.5
13:53	112	44.2	15.20	58.0	1C	0.9087	52.7
13:54	112	44.3	14.49	69.7	1C	0.9087	63.4
13:55	113	44.3	15.12	89.0	1C	0.9087	80.9
13:56	113	44.4	16.87	79.8	1C	0.9087	72.5
13:57	113	44.5	15.77	51.2	1C	0.9087	46.6
13:58	112	44.5	12.52	35.3	1C	0.9087	32.1
13:59	111	44.6	12.86	25.2	1C	0.9087	22.9
14:00	111	44.7	17.41	22.7	1C	0.9087	20.6
14:01	110	44.6	16.51	15.1	1C	0.9087	13.7
14:02	110	44.6	15.36	16.0	1C	0.9087	14.5
14:03	109	44.6	16.47	16.0	1C	0.9087	14.5
14:04	110	44.7	12.97	31.9	1C	0.9087	29.0
14:05	113	44.8	14.82	130.2	1C	0.9087	118.3
14:06	115	45.0	10.89	110.9	1C	0.9087	100.8
14:07	116	45.0	13.75	90.7	1C	0.9087	82.4
14:08	115	44.9	14.49	62.2	1C	0.9087	56.5
14:09	115	45.1	13.95	45.4	1C	0.9087	41.2
14:10	115	45.1	12.70	49.6	1C	0.9087	45.0
14:11	116	45.1	11.38	75.6	1C	0.9087	68.7
14:12	115	45.1	12.91	58.8	1C	0.9087	53.4
14:13	115	45.2	13.21	56.3	1C	0.9087	51.1
14:14	115	45.2	11.91	61.3	1C	0.9087	55.7
14:15	116	45.2	12.41	76.4	1C	0.9087	69.5
14:16	116	45.3	12.62	67.2	1C	0.9087	61.1
14:17	116	45.3	12.34	67.2	1C	0.9087	61.1
14:18	116	45.4	12.31	74.8	1C	0.9087	67.9
14:19	116	45.3	12.48	69.7	1C	0.9087	63.4
14:20	116	45.3	12.53	58.8	1C	0.9087	53.4
14:21	116	45.4	13.03	53.8	1C	0.9087	48.9
14:22	115	45.5	12.74	40.3	1C	0.9087	36.6
14:23	115	45.5	12.12	39.5	1C	0.9087	35.9

14:24	114	45.6	12.02	39.5	1C	0.9087	35.9
14:25	114	45.6	12.12	39.5	1C	0.9087	35.9
14:26	114	45.7	12.90	40.3	1C	0.9087	36.6
14:27	114	45.6	12.19	37.0	1C	0.9087	33.6
14:28	114	45.7	12.33	34.4	1C	0.9087	31.3
14:29	113	45.7	12.45	31.1	1C	0.9087	28.2
14:30	113	45.7	12.67	32.8	1C	0.9087	29.8
14:31	113	45.7	13.24	37.8	1C	0.9087	34.3
14:32	113	45.8	13.36	37.8	1C	0.9087	34.3
14:33	112	45.8	13.98	26.9	1C	0.9087	24.4
14:34	112	45.8	15.10	16.0	1C	0.9087	14.5
14:35	112	45.9	15.25	19.3	1C	0.9087	17.6
14:36	112	46.0	15.95	27.7	1C	0.9087	25.2
14:37	112	46.0	15.57	36.1	1C	0.9087	32.8
14:38	112	46.0	15.29	34.4	1C	0.9087	31.3
14:39	111	46.0	15.55	34.4	1C	0.9087	31.3
14:40	111	45.9	15.78	33.6	1C	0.9087	30.5
14:41	111	45.9	16.03	33.6	1C	0.9087	30.5
14:42	111	45.9	16.31	32.8	1C	0.9087	29.8
14:43	111	45.9	16.40	33.6	1C	0.9087	30.5
14:44	111	46.0	16.49	32.8	1C	0.9087	29.8
14:45	111	46.0	16.70	33.6	1C	0.9087	30.5
14:46	111	46.0	17.01	32.8	1C	0.9087	29.8
14:47	110	46.0	17.24	32.8	1C	0.9087	29.8
14:48	110	46.0	17.53	31.9	1C	0.9087	29.0
14:49	110	46.0	17.72	39.5	1C	0.9087	35.9
14:50	111	46.0	17.85	47.9	1C	0.9087	43.5
14:51	112	46.1	14.36	71.4	1C	0.9087	64.9
14:52	113	46.0	13.72	73.1	1C	0.9087	66.4
14:53	113	46.0	13.99	79.8	1C	0.9087	72.5
14:54	114	46.0	14.34	79.8	1C	0.9087	72.5
14:55	114	46.0	14.54	79.8	1C	0.9087	72.5
14:56	114	46.0	14.67	73.9	1C	0.9087	67.2
14:57	114	46.1	14.51	66.4	1C	0.9087	60.3
14:58	114	46.0	14.44	65.5	1C	0.9087	59.5
14:59	114	46.0	14.48	65.5	1C	0.9087	59.5
15:00	114	46.0	14.63	64.7	1C	0.9087	58.8
15:01	114	46.0	14.71	65.5	1C	0.9087	59.5
15:02	114	46.0	14.78	64.7	1C	0.9087	58.8
15:03	114	46.0	14.93	70.6	1C	0.9087	64.1
15:04	114	46.0	15.38	75.6	1C	0.9087	68.7
15:05	114	45.9	15.69	79.8	1C	0.9087	72.5
15:06	114	45.9	16.09	79.8	1C	0.9087	72.5

15:07	115	45.9	16.29	78.1	1C	0.9087	71.0
15:08	115	46.0	16.38	78.1	1C	0.9087	71.0
15:09	115	46.0	16.47	78.1	1C	0.9087	71.0
15:10	115	46.1	16.54	79.0	1C	0.9087	71.7
15:11	115	46.1	16.61	78.1	1C	0.9087	71.0
15:12	115	46.1	16.67	77.3	1C	0.9087	70.2
15:13	115	46.1	16.70	78.1	1C	0.9087	71.0
15:14	115	46.2	16.75	77.3	1C	0.9087	70.2
15:15	116	46.2	17.59	74.8	1C	0.9087	67.9
15:16	116	46.2	19.50	78.1	1C	0.9087	71.0
15:17	117	46.2	15.92	93.2	1C	0.9087	84.7
15:18	117	46.2	17.16	85.7	1C	0.9087	77.9
15:19	117	46.2	17.16	86.5	1C	0.9087	78.6
15:20	117	46.1	17.18	86.5	1C	0.9087	78.6
15:21	117	46.1	17.20	86.5	1C	0.9087	78.6
15:22	117	46.1	17.23	98.3	1C	0.9087	89.3
Average	115	41.3	14.1	65.0			59.0

East Devon Crematorium Abatement System Outlet

Dioxins and Furans

Contract	East Devon Crematorium, DEM0508
Date	13th July 2011
Location	Flue Gas Abatement System Outlet
Engineer(s)	JB & ST
Absorbent	XAD-2

Test Log	Dioxins Test	
Barometric Pressure(kPa)	102.0	
Gas Meter Temperature(Deg C)	41.3	
Oxygen Concentration(%v/v dry)	14.08	
Flue Gas Volumetric Flow(Nm^3/h dry)	1348	
	Start	End
Time	09:31	15:22
Gas Meter Reading(Am^3 dry)	260.634	264.091
Sample Reference	Combined ED130711 DX1 + ED130711 DC1 + ED130711 DF1	

Calculation: General

Barometric Pressure(kPa)	101.9
Gas Meter temperature(Deg C)	41.3
Gas Volume Sampled(Am^3 dry)	3.457
Gas Volume Sampled(Nm^3 dry)	3.020

Calculation: Dioxins and Furans

	Lower Bound	Upper Bound
Total I-TEQ(ng)	0.0066	0.0120
Total I-TEQ Emission (ng/Nm^3 dry)	0.0022	0.0040
Total I-TEQ Emission (ng/Nm^3 @ 11 %v/v Oxygen dry)	**0.0032**	**0.0058**

N.B. **The above result is the average over 4 cremation cycles**
The secondary chamber temperature control set points were 800°C

Required Sample Velocity(Nm/s)	8.00
Nozzle Used(mm)	4.5
Area of Nozzle(m^2)	0.00001590
Test Duration(mins)	351
Actual Sample Velocity(Nm/s)	9.02
Isokinetic Closure(%)	113

East Devon Crematorium Abatement System Outlet

Flue Gas Volumetric Flow

Contract	East Devon Crematorium, DEM0508
Date	13th July 2011
Location	Flue Gas Abatement System Outlet
Engineer(s)	JB & ST

Test Log	Dioxins Test
Flue Gas Temperature(Deg C)	115
Flue Gas Pitot Head Sample Points(Pa)	65.0
Flue Gas Pitot Head Duct Mean(Pa)	59.0
Flue Gas Moisture(%v/v)	5.5
Flue Gas Moisture(%w/w)	3.5
Flue Gas Duct Dimensions(mm)	250mm Diameter Circular Flue
Flue Gas Duct Area(m^2)	0.0491

Calculation

Flue Gas Density(kg/m^3)	0.8979
Sample Points	
Flue Gas Velocity(Am/s)	12.03
Flue Gas Volumetric Flowrate(Am^3/h)	2126
Flue Gas Volumetric Flowrate(Am^3/h dry)	2009
Flue Gas Volumetric Flowrate(Nm^3/h dry)	1414
Duct Mean	
Flue Gas Velocity(Am/s)	11.47
Flue Gas Volumetric Flowrate(Am^3/h)	2027
Flue Gas Volumetric Flowrate(Am^3/h dry)	1915
Flue Gas Volumetric Flowrate(Nm^3/h dry)	**1348**

East Devon Crematorium Abatement System Outlet

Residence Time Calculation 12/07/11

Test 2

Moisture %v/v:	6.64	Exit Area m2:	0.0491
Moisture %w/w:	4.24	Duct Area m2:	0.0491
SCC Vol m3:	3.21		

Oxygen Balance

Time	Mean Pa	Flue O_2 %v/v	SCC O_2 %v/v	Flue Temp °C	SCC Temp °C	Out Density kg/m^3	Velocity m/s	Efflux Velocity m/s	Vol Am^3/h	Vol Am^3/h dry	Vol Am^3/h wet	Vol Nm^3/h dry	Vol Nm^3/h wet	SCC Fraction	SCC Vol Nm^3/h	SCC Vol m^3/s @ SCC T	Residence Time
10:35	109.1	15.20	11.5	118	847	0.8887	15.67	15.67	2769.59	2578.28	191.31	1802.48	133.75	0.6070	1227.88	1.40	2.29
10:36	89.3	14.32	11.0	118	838	0.8883	14.18	14.18	2505.83	2332.74	173.09	1629.99	120.95	0.6679	1209.69	1.37	2.35
10:37	79.4	14.12	11.0	118	837	0.8883	13.37	13.37	2362.52	2199.32	163.19	1536.77	114.03	0.6874	1170.40	1.32	2.43
10:38	77.9	13.65	9.8	118	839	0.8885	13.24	13.24	2339.39	2177.80	161.59	1522.12	112.94	0.6530	1106.84	1.25	2.56
10:39	84.7	12.37	8.0	118	847	0.8878	13.82	13.82	2441.35	2272.72	168.64	1587.24	117.77	0.6634	1170.81	1.33	2.41
10:40	84.0	12.01	9.4	118	849	0.8876	13.75	13.75	2430.64	2262.75	167.90	1579.87	117.23	0.7722	1337.18	1.53	2.10
10:41	77.9	13.68	11.9	118	840	0.8880	13.24	13.24	2339.99	2178.35	161.64	1521.73	112.91	0.8003	1330.81	1.51	2.13
10:42	81.7	15.20	12.8	118	834	0.8883	13.56	13.56	2396.35	2230.82	165.53	1558.78	115.66	0.7079	1219.14	1.37	2.34
10:43	74.8	15.11	13.2	118	836	0.8883	12.98	12.98	2293.35	2134.94	158.41	1491.78	110.69	0.7492	1228.40	1.39	2.32
10:44	84.7	14.80	11.6	118	837	0.8880	13.81	13.81	2441.04	2272.43	168.62	1587.44	117.79	0.6590	1163.89	1.31	2.44
10:45	77.1	14.15	11.4	118	835	0.8885	13.17	13.17	2327.89	2167.09	160.80	1514.64	112.39	0.7089	1186.04	1.34	2.40
10:46	87.0	14.15	11.3	118	832	0.8883	14.00	14.00	2473.49	2302.63	170.86	1608.96	119.39	0.7044	1252.77	1.41	2.28
10:47	88.5	13.83	10.9	118	836	0.8878	14.12	14.12	2495.73	2323.34	172.39	1622.59	120.40	0.7115	1274.87	1.44	2.23
10:48	92.4	14.16	11.2	118	835	0.8878	14.42	14.42	2548.95	2372.88	176.07	1657.19	122.96	0.6954	1275.38	1.44	2.23
10:49	74.8	14.04	11.3	118	835	0.8885	12.98	12.98	2293.06	2134.67	158.39	1491.97	110.71	0.7181	1182.03	1.33	2.41
10:50	61.1	13.88	10.1	117	836	0.8894	11.72	11.72	2070.74	1927.70	143.04	1348.70	100.07	0.6524	979.96	1.11	2.90
10:51	44.3	12.56	8.1	117	843	0.8910	9.97	9.97	1761.59	1639.90	121.68	1149.41	85.29	0.6548	837.88	0.95	3.38
10:52	42.7	11.83	8.3	116	847	0.8917	9.79	9.79	1730.28	1610.76	119.52	1129.85	83.84	0.7184	895.50	1.02	3.14
10:53	40.5	12.09	8.3	116	850	0.8924	9.52	9.52	1682.65	1566.42	116.23	1099.59	81.59	0.6997	850.96	0.97	3.30
10:54	45.8	12.20	8.2	116	853	0.8928	10.13	10.13	1789.86	1666.23	123.63	1170.26	86.83	0.6863	890.01	1.02	3.15
10:55	45.8	11.99	7.9	116	856	0.8933	10.13	10.13	1789.40	1665.80	123.60	1170.56	86.86	0.6871	891.10	1.02	3.14
10:56	45.0	11.71	8.0	116	859	0.8933	10.04	10.04	1774.43	1651.86	122.57	1160.76	86.13	0.7127	913.38	1.05	3.05
10:57	44.3	12.13	8.7	115	860	0.8938	9.95	9.95	1758.87	1637.38	121.49	1151.18	85.42	0.7172	911.02	1.05	3.06
10:58	48.9	12.64	9.5	115	861	0.8938	10.46	10.46	1847.61	1719.98	127.62	1209.26	89.73	0.7277	969.66	1.12	2.87

Davies & Co (Engineering) Ltd

10:59	57.2	13.19	9.7	115	863	0.8938	11.32	11.32	2000.10	1861.94	138.16	1309.06	97.13	0.6877	997.37	1.15	2.79
11:00	57.2	12.97	9.5	115	865	0.8940	11.32	11.32	1999.84	1861.70	138.14	1309.23	97.15	0.6949	1006.98	1.17	2.75
11:01	56.5	13.06	9.9	115	866	0.8942	11.24	11.24	1986.20	1849.01	137.20	1300.64	96.51	0.7171	1029.18	1.19	2.69
11:02	56.5	13.18	10.1	115	867	0.8945	11.24	11.24	1985.95	1848.77	137.18	1300.81	96.52	0.7129	1023.87	1.19	2.70
11:03	55.7	13.38	10.6	115	867	0.8945	11.16	11.16	1972.48	1836.23	136.25	1291.99	95.87	0.7283	1036.79	1.20	2.67
11:04	55.0	13.66	10.9	115	867	0.8942	11.09	11.09	1959.18	1823.85	135.33	1282.94	95.20	0.7277	1028.86	1.19	2.69
11:05	55.0	13.97	11.5	115	866	0.8942	11.09	11.09	1959.18	1823.85	135.33	1282.94	95.20	0.7392	1043.56	1.21	2.65
11:06	55.0	14.37	12.0	115	865	0.8947	11.08	11.08	1958.68	1823.38	135.30	1283.28	95.22	0.7340	1037.13	1.20	2.67
11:07	55.0	14.59	12.2	115	864	0.8949	11.08	11.08	1958.42	1823.14	135.28	1283.44	95.23	0.7254	1026.28	1.19	2.70
11:08	66.4	14.96	11.9	115	863	0.8945	12.19	12.19	2153.34	2004.59	148.74	1410.45	104.66	0.6645	1041.91	1.20	2.66
11:09	65.6	13.47	10.9	115	868	0.8938	12.12	12.12	2141.75	1993.81	147.94	1401.78	104.01	0.7445	1147.57	1.33	2.41
11:10	55.0	14.73	13.1	115	864	0.8945	11.09	11.09	1958.93	1823.61	135.31	1283.11	95.21	0.7921	1111.61	1.29	2.50
11:11	67.2	15.62	12.5	115	862	0.8935	12.26	12.26	2166.79	2017.12	149.67	1417.80	105.20	0.6313	1000.19	1.15	2.78
11:12	76.3	13.44	11.1	116	869	0.8917	13.08	13.08	2312.19	2152.47	159.71	1509.83	112.03	0.7620	1262.58	1.47	2.19
11:13	55.0	15.08	13.6	116	864	0.8931	11.09	11.09	1960.44	1825.02	135.42	1282.12	95.13	0.8033	1125.01	1.30	2.47
11:14	70.2	16.00	12.4	116	862	0.8926	12.54	12.54	2216.63	2063.52	153.11	1448.92	107.51	0.5822	951.08	1.10	2.92
11:15	94.6	13.41	9.7	117	872	0.8910	14.58	14.58	2575.73	2397.81	177.92	1680.62	124.70	0.6707	1251.87	1.46	2.20
11:16	91.6	12.92	10.2	117	876	0.8906	14.34	14.34	2534.50	2359.43	175.07	1652.87	122.64	0.7460	1355.62	1.58	2.03
11:17	84.0	13.85	11.1	116	863	0.8912	13.73	13.73	2425.66	2258.11	167.55	1583.11	117.47	0.7219	1260.35	1.46	2.20
11:18	85.5	14.23	11.4	117	856	0.8910	13.85	13.85	2447.93	2278.84	169.09	1597.24	118.52	0.7072	1248.04	1.43	2.24
11:19	84.0	14.39	11.6	117	852	0.8910	13.73	13.73	2425.98	2258.40	167.57	1582.91	117.45	0.7014	1227.73	1.41	2.28
11:20	83.2	14.43	11.7	117	850	0.8910	13.67	13.67	2414.92	2248.11	166.81	1575.70	116.92	0.7031	1224.86	1.40	2.29
11:21	92.4	14.58	12.3	117	848	0.8906	14.40	14.40	2545.04	2369.24	175.80	1659.74	123.15	0.7407	1352.50	1.54	2.08
11:22	90.8	15.02	12.6	117	845	0.8906	14.28	14.28	2523.92	2349.58	174.34	1645.97	122.13	0.7122	1294.37	1.47	2.18
11:23	92.4	15.12	12.8	117	843	0.8903	14.40	14.40	2545.36	2369.54	175.82	1659.53	123.14	0.7178	1314.28	1.49	2.15
11:24	106.9	15.36	12.6	117	844	0.8890	15.51	15.51	2740.03	2550.76	189.27	1783.70	132.35	0.6721	1331.25	1.51	2.12
11:25	93.9	14.42	11.5	117	859	0.8892	14.53	14.53	2567.96	2390.58	177.38	1672.12	124.07	0.6908	1279.21	1.47	2.18
11:26	77.9	14.61	12.8	117	852	0.8901	13.23	13.23	2337.29	2175.84	161.45	1523.48	113.04	0.7768	1296.54	1.48	2.16
11:27	95.4	15.27	12.7	117	845	0.8894	14.65	14.65	2588.42	2409.63	178.80	1685.87	125.09	0.6854	1280.53	1.46	2.20
11:28	93.1	14.49	11.4	117	858	0.8892	14.47	14.47	2557.50	2380.84	176.66	1665.31	123.57	0.6770	1250.90	1.44	2.23
11:29	87.8	14.09	12.0	117	864	0.8892	14.05	14.05	2483.04	2311.53	171.52	1616.83	119.97	0.7669	1359.94	1.57	2.04
11:30	78.6	15.01	13.0	117	851	0.8903	13.29	13.29	2348.42	2186.20	162.22	1531.13	113.61	0.7464	1256.45	1.44	2.23
11:31	93.9	15.31	12.2	117	851	0.8894	14.53	14.53	2567.63	2390.27	177.36	1672.33	124.09	0.6477	1207.20	1.38	2.33

11:32	87.0	14.18	11.4	117	863	0.8896	13.99	13.99	2471.59	2300.87	170.73	1610.19	119.48	0.7102	1263.01	1.46	2.20
11:33	94.6	14.14	11.8	117	868	0.8892	14.59	14.59	2578.38	2400.28	178.10	1678.90	124.58	0.7416	1369.63	1.59	2.02
11:34	82.4	14.83	12.5	117	860	0.8896	13.61	13.61	2405.67	2239.50	166.17	1567.25	116.29	0.7206	1245.72	1.44	2.24
11:35	87.8	15.73	13.9	117	846	0.8899	14.05	14.05	2482.09	2310.64	171.45	1617.45	120.02	0.7451	1325.23	1.51	2.13
11:36	97.7	15.64	12.7	117	851	0.8892	14.82	14.82	2619.63	2438.68	180.95	1705.77	126.57	0.6400	1218.20	1.39	2.30
11:37	94.6	14.67	12.3	117	862	0.8890	14.59	14.59	2578.71	2400.58	178.12	1678.69	124.56	0.7302	1350.37	1.56	2.06
11:38	96.2	14.67	12.4	117	866	0.8890	14.71	14.71	2599.42	2419.86	179.56	1692.17	125.56	0.7319	1364.04	1.58	2.03
11:39	87.0	14.77	12.3	117	863	0.8892	13.99	13.99	2472.23	2301.46	170.77	1609.78	119.45	0.7178	1274.90	1.47	2.18
11:40	82.4	15.82	13.2	117	848	0.8899	13.61	13.61	2405.36	2239.21	166.15	1567.45	116.31	0.6582	1147.93	1.31	2.45
11:41	98.5	15.90	13.2	117	848	0.8890	14.88	14.88	2630.18	2448.50	181.68	1712.20	127.05	0.6503	1240.48	1.41	2.27
11:42	91.6	14.78	12.4	117	860	0.8890	14.36	14.36	2536.77	2361.55	175.23	1651.39	122.53	0.7257	1320.94	1.52	2.11
11:43	63.4	14.34	11.6	117	864	0.8906	11.93	11.93	2107.85	1962.25	145.60	1374.64	102.00	0.7106	1078.75	1.25	2.57
11:44	51.9	14.42	12.4	116	851	0.8922	10.79	10.79	1906.19	1774.52	131.67	1245.36	92.41	0.7636	1043.41	1.19	2.69
11:45	68.7	14.87	12.3	116	846	0.8919	12.41	12.41	2193.25	2041.75	151.50	1432.53	106.29	0.6998	1108.74	1.26	2.54
11:46	64.9	13.98	10.8	116	860	0.8924	12.06	12.06	2130.91	1983.72	147.19	1392.53	103.33	0.6861	1058.68	1.22	2.63
11:47	59.5	13.39	10.7	116	867	0.8931	11.55	11.55	2040.49	1899.55	140.95	1334.47	99.02	0.7360	1081.19	1.25	2.56
11:48	47.3	13.89	12.3	115	856	0.8942	10.29	10.29	1818.04	1692.46	125.58	1190.52	88.34	0.8116	1054.62	1.21	2.65
11:49	46.6	14.63	12.4	115	846	0.8949	10.20	10.20	1802.62	1678.11	124.52	1181.34	87.66	0.7382	959.76	1.09	2.94
11:50	46.6	14.65	12.5	115	841	0.8956	10.20	10.20	1801.93	1677.46	124.47	1181.80	87.69	0.7444	967.43	1.10	2.93
11:51	61.8	14.77	12.5	115	840	0.8954	11.75	11.75	2076.69	1933.24	143.45	1361.65	101.03	0.7311	1096.50	1.24	2.58
Average	73.7	14.13	11.3	116	853	0.8911	12.76	12.76	2255.09	2099.32	155.77	1471.12	109.16	0.7102	1152.04	1.32	2.47
Minimum			7.9		832												2.02

East Devon Crematorium Abatement System Outlet

Residence Time Calculation 12/07/11

Test 3

Moisture %v/v:	7.02	Exit Area m2:	0.0491
Moisture %w/w:	4.49	Duct Area m2:	0.0491
SCC Vol m3:	3.21		

Oxygen Balance

Time	Mean Pa	Flue O_2 %v/v	SCC O_2 %v/v	Flue Temp °C	SCC Temp °C	Out Density kg/m³	Velocity m/s	Efflux Velocity m/s	Vol Am³/h	Vol Am³/h dry	Vol Am³/h wet	Vol Nm³/h dry	Vol Nm³/h wet	SCC Fraction	SCC Vol Nm³/h	SCC Vol m³/s @ SCC T	Residence Time
12:12	89.3	14.84	9.7	115	882	0.8935	14.14	14.14	2498.44	2325.86	172.58	1634.81	121.30	0.5425	1008.15	1.18	2.71
12:13	59.5	13.46	9.9	115	866	0.8954	11.53	11.53	2037.87	1897.10	140.77	1336.19	99.15	0.6750	1001.07	1.16	2.77
12:14	56.5	13.26	10.4	114	855	0.8961	11.23	11.23	1984.16	1847.10	137.06	1301.98	96.61	0.7290	1045.79	1.20	2.67
12:15	74.0	14.22	11.1	115	846	0.8954	12.86	12.86	2272.55	2115.58	156.98	1490.07	110.56	0.6815	1126.05	1.28	2.50
12:16	77.9	13.09	8.3	115	861	0.8951	13.19	13.19	2330.69	2169.70	160.99	1527.80	113.36	0.6212	1062.50	1.23	2.62
12:17	71.0	11.57	7.7	115	870	0.8951	12.59	12.59	2225.49	2071.76	153.73	1458.84	108.25	0.7075	1140.33	1.33	2.42
12:18	71.0	11.75	7.4	115	868	0.8954	12.59	12.59	2225.20	2071.50	153.71	1459.03	108.26	0.6782	1097.83	1.27	2.52
12:19	63.4	11.74	7.5	114	869	0.8958	11.89	11.89	2101.62	1956.45	145.17	1378.71	102.30	0.6834	1044.50	1.21	2.65
12:20	70.2	11.56	7.5	115	871	0.8956	12.52	12.52	2212.92	2060.06	152.86	1451.35	107.69	0.6956	1117.28	1.30	2.47
12:21	64.9	12.36	8.2	115	870	0.8956	12.04	12.04	2127.07	1980.14	146.93	1395.04	103.51	0.6732	1042.67	1.21	2.65
12:22	61.8	12.27	8.2	114	868	0.8961	11.75	11.75	2075.88	1932.49	143.39	1362.17	101.07	0.6831	1031.64	1.20	2.68
12:23	64.1	12.53	8.7	114	867	0.8961	11.96	11.96	2113.97	1967.95	146.02	1387.17	102.93	0.6882	1057.62	1.23	2.62
12:24	68.7	12.56	8.4	114	867	0.8958	12.38	12.38	2188.45	2037.29	151.17	1435.67	106.53	0.6711	1070.02	1.24	2.59
12:25	67.9	12.51	8.6	114	867	0.8961	12.31	12.31	2175.98	2025.67	150.31	1427.86	105.95	0.6845	1083.30	1.26	2.56
12:26	64.9	12.67	8.5	114	866	0.8963	12.03	12.03	2126.25	1979.38	146.87	1395.58	103.55	0.6669	1034.25	1.20	2.68
12:27	56.5	12.18	7.9	114	867	0.8972	11.22	11.22	1982.88	1845.91	136.97	1302.83	96.67	0.6708	970.63	1.13	2.85
12:28	56.5	12.02	7.9	114	868	0.8972	11.22	11.22	1982.88	1845.91	136.97	1302.83	96.67	0.6819	985.10	1.14	2.81
12:29	55.7	11.99	7.7	114	868	0.8975	11.14	11.14	1969.18	1833.16	136.02	1294.16	96.03	0.6752	969.90	1.13	2.85
12:30	56.5	11.94	7.6	114	869	0.8975	11.22	11.22	1982.62	1845.67	136.95	1302.99	96.68	0.6762	977.80	1.14	2.83
12:31	60.3	11.80	7.1	114	870	0.8977	11.59	11.59	2048.24	1906.76	141.48	1346.47	99.91	0.6627	992.27	1.15	2.78
12:32	88.5	11.44	7.5	114	875	0.8963	14.06	14.06	2483.89	2312.32	171.58	1630.33	120.97	0.7097	1277.99	1.49	2.15
12:33	87.0	12.48	8.2	115	876	0.8956	13.94	13.94	2463.34	2293.19	170.16	1615.59	119.88	0.6627	1190.50	1.39	2.31
12:34	80.9	12.02	7.7	114	879	0.8958	13.44	13.44	2375.03	2210.97	164.06	1558.07	115.61	0.6741	1165.88	1.37	2.35
12:35	84.7	11.99	7.8	115	881	0.8951	13.76	13.76	2431.34	2263.39	167.95	1593.78	118.26	0.6803	1202.45	1.41	2.27
12:36	90.8	11.93	7.6	115	884	0.8945	14.25	14.25	2518.41	2344.45	173.96	1649.57	122.40	0.6742	1234.57	1.45	2.21

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12:37	99.2	11.68	7.0	116	890	0.8933	14.90	14.90	2633.93	2451.99	181.94	1723.02	127.85	0.6661	1275.57	1.51	2.13
12:38	98.5	11.62	7.3	116	895	0.8926	14.85	14.85	2624.79	2443.48	181.31	1715.72	127.31	0.6812	1296.07	1.54	2.08
12:39	97.7	11.78	7.4	116	896	0.8919	14.80	14.80	2615.60	2434.93	180.67	1708.39	126.76	0.6766	1282.62	1.53	2.10
12:40	97.7	11.79	7.6	116	897	0.8915	14.81	14.81	2616.28	2435.56	180.72	1707.95	126.73	0.6875	1300.93	1.55	2.07
12:41	97.7	12.04	7.8	117	898	0.8910	14.81	14.81	2616.95	2436.18	180.77	1707.52	126.70	0.6765	1281.78	1.53	2.10
12:42	98.5	12.00	7.7	117	900	0.8906	14.87	14.87	2627.82	2446.31	181.52	1713.73	127.16	0.6734	1281.15	1.53	2.10
12:43	97.7	11.89	7.8	117	902	0.8903	14.81	14.81	2617.96	2437.12	180.84	1706.86	126.65	0.6879	1300.72	1.55	2.06
12:44	96.2	12.15	8.2	117	901	0.8896	14.70	14.70	2598.42	2418.94	179.49	1692.82	125.61	0.6914	1296.06	1.55	2.07
12:45	80.1	12.38	8.4	117	900	0.8903	13.42	13.42	2371.11	2207.33	163.78	1545.92	114.71	0.6826	1169.92	1.40	2.30
12:46	61.1	12.41	8.2	116	898	0.8915	11.70	11.70	2068.35	1925.48	142.87	1350.26	100.19	0.6687	1003.14	1.20	2.69
12:47	53.4	12.28	8.5	116	897	0.8926	10.94	10.94	1933.52	1799.96	133.56	1263.86	93.78	0.6941	971.03	1.16	2.78
12:48	44.3	12.36	8.2	115	895	0.8938	9.95	9.95	1758.87	1637.38	121.49	1151.18	85.42	0.6738	861.06	1.02	3.14
12:49	42.0	12.24	8.8	115	893	0.8947	9.69	9.69	1711.90	1593.65	118.25	1121.59	83.22	0.7144	884.52	1.05	3.06
12:50	42.0	12.81	9.6	115	891	0.8954	9.68	9.68	1711.23	1593.03	118.20	1122.03	83.25	0.7154	885.96	1.05	3.06
12:51	41.2	13.32	10.2	114	889	0.8961	9.59	9.59	1694.95	1577.87	117.08	1112.21	82.53	0.7108	873.14	1.03	3.11
12:52	40.5	13.57	10.8	114	887	0.8965	9.50	9.50	1678.75	1562.79	115.96	1102.15	81.78	0.7257	881.59	1.04	3.08
12:53	39.7	13.92	11.4	114	885	0.8970	9.41	9.41	1662.41	1547.58	114.83	1091.98	81.03	0.7328	881.26	1.04	3.09
12:54	42.7	14.23	11.8	114	883	0.8970	9.76	9.76	1725.16	1606.00	119.17	1133.20	84.08	0.7326	914.25	1.08	2.98
12:55	46.6	14.47	12.0	114	883	0.8968	10.19	10.19	1800.76	1676.38	124.39	1182.56	87.75	0.7204	939.72	1.10	2.91
12:56	47.3	14.58	12.4	114	881	0.8970	10.27	10.27	1815.23	1689.84	125.39	1192.37	88.47	0.7475	979.77	1.15	2.79
12:57	45.8	14.95	12.9	114	879	0.8975	10.10	10.10	1785.25	1661.93	123.32	1173.28	87.06	0.7485	965.26	1.13	2.84
12:58	46.6	15.28	13.5	114	878	0.8977	10.18	10.18	1799.83	1675.51	124.32	1183.17	87.79	0.7611	988.25	1.16	2.77
12:59	50.4	15.77	14.4	114	875	0.8979	10.59	10.59	1871.90	1742.60	129.30	1230.87	91.33	0.7968	1072.07	1.25	2.56
13:00	51.1	16.13	14.7	113	873	0.8982	10.67	10.67	1885.79	1755.52	130.26	1240.32	92.03	0.7699	1046.92	1.22	2.63
13:01	48.9	16.25	14.9	114	871	0.8979	10.43	10.43	1843.32	1715.99	127.33	1212.07	89.94	0.7793	1034.48	1.20	2.67
13:02	40.5	16.41	15.2	113	869	0.8986	9.49	9.49	1676.80	1560.97	115.82	1103.43	81.88	0.7922	956.06	1.11	2.89
13:03	38.9	16.51	15.1	113	866	0.8993	9.30	9.30	1644.22	1530.64	113.57	1082.83	80.35	0.7591	902.37	1.05	3.07
13:04	38.9	16.42	15.2	113	865	0.9000	9.30	9.30	1643.58	1530.05	113.53	1083.25	80.38	0.7930	939.41	1.09	2.95
13:05	38.9	16.57	15.7	112	862	0.9005	9.30	9.30	1643.15	1529.65	113.50	1083.53	80.40	0.8267	976.20	1.13	2.85
13:06	38.9	16.89	16.1	112	859	0.9010	9.30	9.30	1642.72	1529.25	113.47	1083.82	80.42	0.8442	995.43	1.15	2.80
13:07	38.2	17.19	16.6	112	856	0.9014	9.20	9.20	1626.12	1513.79	112.32	1073.42	79.65	0.8637	1006.73	1.16	2.78
13:08	40.5	17.52	16.6	112	852	0.9017	9.47	9.47	1673.97	1558.34	115.63	1105.29	82.01	0.7816	945.93	1.08	2.97
13:09	38.2	16.46	13.7	112	855	0.9012	9.20	9.20	1626.33	1513.99	112.34	1073.28	79.64	0.6160	740.80	0.85	3.78
13:10	33.6	15.72	14.7	112	852	0.9019	8.63	8.63	1525.04	1419.69	105.34	1007.22	74.74	0.8354	916.12	1.05	3.06
Average	62.6	13.42	10.1	114	876	0.8960	11.67	11.67	2062.82	1920.33	142.49	1352.88	100.38	0.7081	1050.45	1.23	2.66
Minimum			7.0		846												2.06

Davies & Co (Engineering) Ltd

APPENDIX 2

Analysis Reports

SAL

Scientific Analysis Laboratories Ltd is a Limited Company registered in England and Wales No 2514788. Registered address at Hadfield House, Hadfield Street, Manchester, M16 9FE

Scientific Analysis Laboratories

Certificate of Analysis

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

Report Number:	244742-1
Date of Report:	01-Aug-2011
Customer:	Davies & Co (Engineering) Moor Road Leeds LS10 2DD
Customer Contact:	Mr Steve Atherton
Customer Job Reference:	DEM0508
Customer Purchase Order:	50000515
Date Job Received at SAL:	22-Jul-2011
Date Analysis Started:	26-Jul-2011
Date Analysis Completed:	01-Aug-2011

The results reported relate to samples received in the laboratory
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 SAL SOPs

UKAS TESTING 1549

Report checked and authorised by :
Mary Drury
Project Manager

Issued by : Signature valid
Digitally signed by Mary Drury
Date: 2011.08.01 10:41:55 BST
Reason: Issued
Location: SAL

SAL Reference: 244742
Customer Reference: DEM0508

Impinger(DI water) Analysed as Impinger(DI water)
Miscellaneous

				SAL Reference	244742 001	244742 002	244742 003	244742 004	244742 005
				Customer Sample Reference	ED120711 HA1	ED120711 HA2	ED120711 HA3A	ED120711 HA3B	ED120711 HOB
				Test Sample	AR	AR	AR	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Hydrogen Chloride	IC	0.05	mg/l	U	11	8.6	35	0.78	0.83
Volume	Vol	1	ml	U	60	65	65	65	60

SAL Reference: 244742
Customer Reference: DEM0508

Filter Analysed as Filter
Miscellaneous

				SAL Reference	244742 006	244742 007	244742 008	244742 009
				Customer Sample Reference	ED120711 FHGA4	ED120711 FHGA5	ED120711 FHGA6	ED120711 FHGABLANK
				Test Sample	AR	AR	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**				
Mercury	CVAFS (HF Digest BS EN 13211)	0.01	ug	U	(13) 0.02	(13) 0.07	(13) 0.07	(13) 0.02

SAL Reference: 244742
Customer Reference: DEM0508

Impinger (4%K2Cr2O7/20%HNO3) Analysed as Impinger (4%K2Cr2O7/20%HNO3)
Miscellaneous

				SAL Reference	244742 010	244742 011	244742 012	244742 013	244742 014
				Customer Sample Reference	ED120711 HGA4	ED120711 HGA5	ED120711 HGA6A	ED120711 HGA6B	ED120711 HGOB
				Test Sample	AR	AR	AR	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Mercury	CVAFS (BS EN 13211)	5	ug/l	U	11	17	29	<5	<5
Volume	CVAFS (BS EN 13211)	1	ml	U	65	60	60	65	65

Index to symbols used in 244742-1

Value	Description
AR	As Received
13	Results have been blank corrected
U	Analysis is UKAS accredited

Scientific Analysis Laboratories

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

Scientific Analysis Laboratories

Certificate of Analysis

Report Number: 244749-1

Date of Report: 03-Aug-2011

Customer: Davies & Co (Engineering)
Moor Road
Leeds
LS10 2DD

Customer Contact: Mr Steve Atherton

Customer Job Reference: DEM0508
Customer Purchase Order: 50000515
Date Job Received at SAL: 22-Jul-2011
Date Analysis Started: 27-Jul-2011
Date Analysis Completed: 01-Aug-2011

The results reported relate to samples received in the laboratory
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 SAL SOPs

UKAS TESTING 1549

Report checked and authorised by :
Ms Jennifer Hughes
Customer Service Manager
(Air Division)

Issued by : Signature valid

Davies & Co (Engineering) Ltd

Summary Of Results

Composite (Filt, Trap. Wash)

SAL Reference	Customer Sample Reference	Analysis	Symbol	ITEQ Toxic Equivalents ng Lower Bound	ITEQ Toxic Equivalents ng Upper Bound
244749.004	Combined ED130711 DX1 + ED130711 DC1 + ED130711 DF1	Dioxins and Furans (BS EN 1948:96)	U	0.0066	0.012
244749.006	Combined METHOD BLANK TRAP + METHOD BLANK FILTER + METHOD BLANK WASH	Dioxins and Furans (BS EN 1948:96)	U	0.00042	0.0096

Sampling Recoveries

SAL Reference	Customer Sample Reference	Determinand	Sampling Recovery %
244749.004	Combined ED130711 DX1 + ED130711 DC1 + ED130711 DF1	1,2,3,7,8-PeCDF	86
		1,2,3,7,8,9-HxCDF	82
		1,2,3,4,7,8,9-HpCDF	97

Composite (Filt, Trap, Wash)

Customer Sample Reference : Combined ED130711 DX1 + ED130711 DC1 + ED130711 DF1

SAL Sample Reference : 244749 004

Dioxins and Furans (BS EN 1948:96)

Technique : GC/MS (HR)

Determinand	Symbol	LOD ng	Result ng	Internal Recovery %	ITEQ Toxic Equivalents ng	
					Lower Bound	Upper Bound
2,3,7,8-TCDD	U	0.0029	<0.0029	69	0.0	0.0029
1,2,3,7,8-PeCDD	U	0.0030	<0.003	67	0.0	0.0015
1,2,3,4,7,8-HxCDD	U	0.0019	<0.0019	104	0.0	0.00019
1,2,3,6,7,8-HxCDD	U	0.0026	<0.0026	75	0.0	0.00026
1,2,3,7,8,9-HxCDD	U	0.0026	**0.0045**		0.00045	0.00045
1,2,3,4,6,7,8-HpCDD	U	0.0051	**0.024**	63	0.00024	0.00024
OCDD	U	0.0086	**0.063**	46	0.00006	0.00006
				Dioxins Totals :	0.00075	0.0056
2,3,7,8-TCDF	U	0.0036	**0.0055**	56	0.00055	0.00055
1,2,3,7,8-PeCDF	U	0.0031	<0.0031		0.0	0.00016
2,3,4,7,8-PeCDF	U	0.0031	**0.0051**	65	0.0026	0.0026
1,2,3,4,7,8-HxCDF	U	0.0021	**0.0058**	98	0.00058	0.00058
1,2,3,6,7,8-HxCDF	U	0.0011	**0.0062**	177	0.00062	0.00062
2,3,4,6,7,8-HxCDF	U	0.0019	**0.011**	103	0.0011	0.0011
1,2,3,7,8,9-HxCDF	U	0.0031	<0.0031		0.0	0.00031
1,2,3,4,6,7,8-HpCDF	U	0.0027	**0.031**	75	0.00031	0.00031
1,2,3,4,7,8,9-HpCDF	U	0.0053	**0.0091**		0.00009	0.00009
OCDF	U	0.0071	**0.055**	57	0.00005	0.00005
				Furans Totals :	0.0059	0.0063
				Totals :	**0.0066**	**0.012**

Composite (Filt, Trap, Wash)

Customer Sample Reference : Combined METHOD BLANK TRAP + METHOD BLANK FILTER + METHOD BLANK WASH

SAL Sample Reference : 244749 008

Dioxins and Furans (BS EN 1948:96)

Technique : GC/MS (HR)

Determinand	Symbol	LOD ng	Result ng	Internal Recovery %	ITEQ Toxic Equivalents ng Lower Bound	ITEQ Toxic Equivalents ng Upper Bound
2,3,7,8-TCDD	U	0.0030	<0.003	67	0.0	0.0030
1,2,3,7,8-PeCDD	U	0.0041	<0.0041	48	0.0	0.0021
1,2,3,4,7,8-HxCDD	U	0.0021	<0.0021	96	0.0	0.00021
1,2,3,6,7,8-HxCDD	U	0.0027	<0.0027	74	0.0	0.00027
1,2,3,7,8,9-HxCDD	U	0.0027	<0.0027		0.0	0.00027
1,2,3,4,6,7,8-HpCDD	U	0.0045	<0.0045	71	0.0	0.00004
OCDD	U	0.0077	<0.0077	52	0.0	0.00001
				Dioxins Totals :	0.0	0.0059
2,3,7,8-TCDF	U	0.0031	**0.0042**	64	0.00042	0.00042
1,2,3,7,8-PeCDF	U	0.0041	<0.0041		0.0	0.00021
2,3,4,7,8-PeCDF	U	0.0041	<0.0041	48	0.0	0.0021
1,2,3,4,7,8-HxCDF	U	0.0025	<0.0025	60	0.0	0.00025
1,2,3,6,7,8-HxCDF	U	0.0016	<0.0016	123	0.0	0.00016
2,3,4,6,7,8-HxCDF	U	0.0023	<0.0023	65	0.0	0.00023
1,2,3,7,8,9-HxCDF	U	0.0038	<0.0038		0.0	0.00038
1,2,3,4,6,7,8-HpCDF	U	0.0026	<0.0026	77	0.0	0.00003
1,2,3,4,7,8,9-HpCDF	U	0.0052	<0.0052		0.0	0.00005
OCDF	U	0.0077	<0.0077	52	0.0	0.00001
				Furans Totals :	0.00042	0.0038
				Totals :	**0.00042**	**0.0096**

Index to symbols used in 244749-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

Davies & Co (Engineering) Ltd

Particulate Weight Determination

Filter / Rinse Reference		Clean Dry Weight g	Dirty Dry Weight g
ED120711F1	M11	0.54954	0.54986
ED120711F2	M12	0.54839	0.54861
ED120711F3	M13	0.54712	0.54748
ED120711R1	1	79.50227	79.50238
ED120711R2	2	79.50238	79.50246
ED120711R3	3	79.50246	79.50259

Stack Emission Monitoring Report

City of London Crematorium
Manor Park, London E12

January 2010

Part 1	Executive Summary
Operator	City of London Crematorium
Site	Aldersbrook Road Manor Park London E12 5DQ
Plant	Cremators 1, 6, 7 and 8
Monitoring Dates	5th to 13th January 2010
Project Number	091121
Written By MCERTS Number MCERTS Accreditation Position	Adrian Moss MM 02 041 Level 2, TE1, TE2, TE3, TE4 Consultant (team leader)
Signed	[redacted]
Approved By MCERTS Number MCERTS Accreditation Position	Mike Davies MM 02 087 Level 2, TE1, TE2, TE3 & TE4 Operations Manager
Signed	
Monitoring Organisation	Scientifics Ltd Unit 13/1 Acacia Building Vantage Point Business Village Mitcheldean, Gloucestershire GL17 0DD
Report Ref	091121
Issue Date	24th February 2010

MCERTS

UKAS TESTING 1015

Contents

1 Introduction

The Corporation of London operates the City of London Crematorium at Manor Park, London E12 5DQ. It is equipped with five gas-fired cremators. One is a newly-installed model numbered 1 and the others are numbered 5 to 8. All of the cremators are FT III models and are manufactured by Facultatieve Technologies, who took over Evans Universal in 1998. Cremator number 5 was non-operational while the test team were on site.

In order to check compliance with authorised limits Scientifics Ltd were contracted by the Corporation of London to quantify the emissions from the cremators.

The work was carried out on 5th – 13th January 2010 by the following site team:

Team Leader:	Steve Huntley MCERTs Level 2, TEs 1, 2, 3 & 4 MCERTs number MM 02 081.
Assistant:	Tom Swannack MCERTs Level 1, TEs 1, 2, 3 & 4 MCERTs number MM 05 663.

2 Monitoring Objectives

The following table details the determinands required to be monitored for each cremator and the monitoring actually undertaken. The schedule called for dioxins & furans to be monitored on one cremator only, and number 8 had had the longest interval since previous monitoring.

Determinand	Cremator 1	Cremators 5 and 7	Cremators 6 and 8
Total particulates	Required and completed	Required but not completed	Required and completed
O_2	Required and completed	Required but not completed	Required and completed
CO	Required and completed	Required but not completed	Required and completed
CO_2	Required and completed	Required but not completed	Required and completed
VOCs	Required and completed	Required but not completed	Required and completed
Dioxins & furans	Required and completed	Not required	Not required

The schedule called for dioxins & furans to be monitored on one cremator only. Number 1 was selected for testing as it had not been tested before.

Cremator 7 was found to be faulty and was shut down after the second cremation, so testing was incomplete. Cremator 5 was not operational during the visit to site.

3 Summary of Results

The following tables are a summary of the results of the monitoring exercise. The site data record sheets are given in Part 2 of this report.

3.1 Cremator 1 run 1, 7th January 2010

Cremation number 251327, medium female

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	0950	1105	43 ± 17 mg/m^3	57	80 mg/m^3 120 g/h
Carbon monoxide	CO	0954	1103	14 ± 14 mg/m^3	19	100 mg/m^3 150 g/h
Total VOCs	C	0950	1105	<1 ± 1 mg/m^3	<1.4	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	0950	1105	53 ± 6 mg/m^3	72	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	17.1
Carbon dioxide, %, dry gas	2.4
Water, %	3.5
Gas Velocity, m s^{-1}	13.6
Volumetric Flow @ Reference Conditions, m^3 s^{-1}	0.37
Stack Gas Temperature, °C	344

3.2 Cremator 1 run 2, 7th January 2010

Cremation number 251330, medium male

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	1140	1310	24 ± 9 mg/m³	18	80 mg/m³ 120 g/h
Carbon monoxide	CO	1143	1313	8 ± 8 mg/m³	6.2	100 mg/m³ 150 g/h
Total VOCs	C	1140	1310	2.3 ± 2.3 mg/m³	1.8	20 mg/m³ 30 g/h
Hydrogen chloride	HCl	1140	1310	0.8 ± 0.8 mg/m³	0.6	200 mg/m³ 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	18.3
Carbon dioxide, %, dry gas	1.6
Water, %	3.7
Gas Velocity, m s^{-1}	11.0
Volumetric Flow @ Reference Conditions, $m^3 s^{-1}$	0.21
Stack Gas Temperature, °C	346

3.3 Cremator 1 run 3, 7th January 2010

Cremation number 251329, medium male

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration				Discharge rate(g/h)	ELV
Total particulate matter	TPM	1341	1521	12	±	12	mg/m^3	8	80 mg/m^3 120 g/h
Carbon monoxide	CO	1343	1521	44	±	6	mg/m^3	30	100 mg/m^3 150 g/h
Total VOCs	C	1341	1523	3.5	±	3.5	mg/m^3	2.3	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	1341	1521	36	±	4	mg/m^3	24	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	18.4
Carbon dioxide, %, dry gas	1.5
Water, %	3.2
Gas Velocity, $m\ s^{-1}$	9.8
Volumetric Flow @ Reference Conditions, $m^3\ s^{-1}$	0.19
Stack Gas Temperature, °C	340

3.4 Cremator 1 dioxins & furans sampling, 12th January 2010

Cremation numbers 251368, heavy female, 251367 heavy female
251372 heavy male and 251374 heavy male

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(ng/h)	ELV
PCDDs & PCDFs	I-TEQ	0902	1609	0.008 ± 0.008 ng/m^3	12	None set

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

The total sampling time was 375 minutes.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	18.0
Water, %	3.5
Gas Velocity, m s^{-1}	10.2
Volumetric Flow @ Reference Conditions, m^3 s^{-1}	0.41
Stack Gas Temperature, °C	56

The quoted oxygen and moisture contents are the average figures for the first three sampled cremations on this unit.

The fairly low temperature of the flue gas was noted but the operators were happy with the operation of the cremator during the tests.

3.5 Cremator 6 run 1, 13th January 2010

Cremation number 251380, heavy female

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	0922	1042	70 ± 27 mg/m^3	76	80 mg/m^3 120 g/h
Carbon monoxide	CO	0930	1049	19 ± 6 mg/m^3	21	100 mg/m^3 150 g/h
Total VOCs	C	0924	1048	1.4 ± 1.4 mg/m^3	1.5	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	0922	1042	9.5 ± 1.1 mg/m^3	10.4	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	17.0
Carbon dioxide, %, dry gas	3.0
Water, %	2.2
Gas Velocity, m s^{-1}	10.8
Volumetric Flow @ Reference Conditions, m^3 s^{-1}	0.30
Stack Gas Temperature, ^{o}C	368

3.6 Cremator 6 run 2, 13th January 2010

Cremation number 251379, medium male

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	1112	1227	195 ± 76 mg/m^3	165	80 mg/m^3 120 g/h
Carbon monoxide	CO	1114	1229	22 ± 6 mg/m^3	18.6	100 mg/m^3 150 g/h
Total VOCs	C	1113	1227	<1 ± 1 mg/m^3	<0.9	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	1112	1227	58 ± 7 mg/m^3	49	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	17.4
Carbon dioxide, %, dry gas	2.7
Water, %	2.8
Gas Velocity, $m\ s^{-1}$	9.1
Volumetric Flow @ Reference Conditions, $m^3\ s^{-1}$	0.24
Stack Gas Temperature, °C	354

3.7 Cremator 6 run 3, 13th January 2010

Cremation number 251387, small female

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	1418	1523	106 ± 41 mg/m^3	66	80 mg/m^3 120 g/h
Carbon monoxide	CO	1424	1524	27 ± 8 mg/m^3	16.9	100 mg/m^3 150 g/h
Total VOCs	C	1420	1524	<1 ± 1 mg/m^3	<0.7	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	1418	1523	36 ± 4 mg/m^3	22	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	18.4
Carbon dioxide, %, dry gas	1.9
Water, %	3.0
Gas Velocity, $m\ s^{-1}$	9.5
Volumetric Flow @ Reference Conditions, $m^3\ s^{-1}$	0.17
Stack Gas Temperature, °C	354

3.8 Cremator 7 run 1, 5th January 2010

Cremation number 251314, medium male

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	1200	1340	230 ± 90 mg/m³	174	80 mg/m³ 120 g/h
Carbon monoxide	CO	1206	1346	47 ± 7 mg/m³	35	100 mg/m³ 150 g/h
Total VOCs	C	-	-	n/m ± - mg/m³	-	20 mg/m³ 30 g/h
Hydrogen chloride	HCl	1200	1340	89 ± 10 mg/m³	67	200 mg/m³ 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen. Due to a fault with the logger no VOC measurements were recorded during this cremation.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	18.1
Carbon dioxide, %, dry gas	2.1
Water, %	4.9
Gas Velocity, m s^{-1}	9.9
Volumetric Flow @ Reference Conditions, $m^3 s^{-1}$	0.21
Stack Gas Temperature, °C	324

3.9 Cremator 7 run 2, 5th January 2010

Cremation number 251315, medium female

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration				Discharge rate(g/h)	ELV
Total particulate matter	TPM	1420	1555	176	±	69	mg/m^3	127	80 mg/m^3 120 g/h
Carbon monoxide	CO	1420	1554	21	±	21	mg/m^3	15.4	100 mg/m^3 150 g/h
Total VOCs	C	1420	1555	64	±	48	mg/m^3	46	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	1420	1555	113	±	13	mg/m^3	81	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	18.2
Carbon dioxide, %, dry gas	2.1
Water, %	5.8
Gas Velocity, m s^{-1}	10.0
Volumetric Flow @ Reference Conditions, $m^3 s^{-1}$	0.20
Stack Gas Temperature, °C	327

3.10 Cremator 8 run 1, 6th January 2010

Cremation number 251317, medium female

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	0854	1034	144 ± 56 mg/m^3	200	80 mg/m^3 120 g/h
Carbon monoxide	CO	0858	1037	<5 ± 5 mg/m^3	<7	100 mg/m^3 150 g/h
Total VOCs	C	0854	1034	<1 ± 1 mg/m^3	<1.4	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	0854	1034	46 ± 5 mg/m^3	64	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	17.2
Carbon dioxide, %, dry gas	2.5
Water, %	3.3
Gas Velocity, m s^{-1}	14.1
Volumetric Flow @ Reference Conditions, m^3 s^{-1}	0.39
Stack Gas Temperature, °C	347

3.11 Cremator 8 run 2, 6th January 2010

Cremation number 251320, medium male

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration				Discharge rate(g/h)	ELV
Total particulate matter	TPM	1114	1254	108	±	42	mg/m³	110	80 mg/m³ 120 g/h
Carbon monoxide	CO	1121	1256	<5	±	5	mg/m³	<5	100 mg/m³ 150 g/h
Total VOCs	C	1114	1254	<1	±	1	mg/m³	<1.1	20 mg/m³ 30 g/h
Hydrogen chloride	HCl	1114	1254	48	±	5	mg/m³	49	200 mg/m³ 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	17.5
Carbon dioxide, %, dry gas	2.2
Water, %	4.0
Gas Velocity, m s^{-1}	11.3
Volumetric Flow @ Reference Conditions, $m^3 s^{-1}$	0.28
Stack Gas Temperature, °C	347

3.12 Cremator 8 run 3, 6th January 2010

Cremation number 251322, medium female

Pollutant Parameters

Determinand	Reported as	Time Start	Time End	Concentration	Discharge rate(g/h)	ELV
Total particulate matter	TPM	1315	1455	129 ± 50 mg/m^3	118	80 mg/m^3 120 g/h
Carbon monoxide	CO	1318	1457	<5 ± 5 mg/m^3	<5	100 mg/m^3 150 g/h
Total VOCs	C	1315	1455	<1 ± 1 mg/m^3	<1	20 mg/m^3 30 g/h
Hydrogen chloride	HCl	1315	1455	52 ± 6 mg/m^3	48	200 mg/m^3 300 g/h

Emission concentrations are expressed at reference conditions of 273K temperature and 101.3kPa pressure (Standard Temperature and Pressure (STP)) in a dry gas containing 11% oxygen.

Non-pollutant Parameters

Parameter	Result
Oxygen, %, dry gas	17.7
Carbon dioxide, %, dry gas	2.2
Water, %	4.5
Gas Velocity, $m\ s^{-1}$	10.9
Volumetric Flow @ Reference Conditions, $m^3\ s^{-1}$	0.25
Stack Gas Temperature, °C	348

4 Monitoring Methods & Accreditation

Monitoring was undertaken using the following sampling and analytical methods.

Parameter	Method	Technical Procedure	Accreditation	
			Sampling	Analysis
VOCs	BS EN 12619	IEM002	1015	1015
CO	BS EN 15058	IEM002	1015	1015
CO_2	ISO 12039	IEM002	1015	1015
HCl	BS EN 1911:1998	IEM011	1015	1015
PCDDs & PCDFs	BS EN 1948-1:2006	IEM009	1015	1015
Total particulates	BS ISO 9096	AE104	1015	1015
O_2	BS EN 14789	IEM002	1015	1015
H_2O	BS EN 14790	AE105	1015	1015

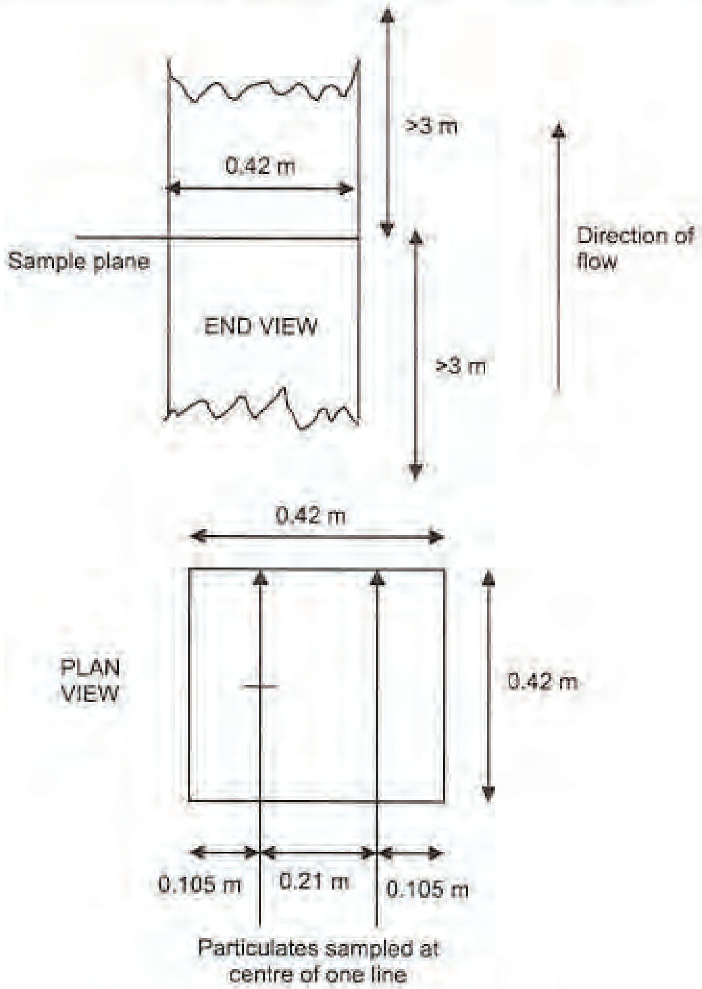
A measurement is determined to comply with the requirements of MCERTs where the laboratories involved have UKAS accreditation to the MCERTs performance standard for the methods employed. If either of the sampling or analysis tasks is not accredited then the entire measurement is outside the scope of accreditation.

All measurements undertaken are UKAS accredited to the MCERTs performance standard.

5 Sampling Location and Process Details

Details of the sample plane on each cremator are shown in the table below. The locations appeared to satisfy the positional requirements of BS ISO 9096 and the gas flows were found to be reasonably uniform, though substantial variations in velocity occurred during each cremation. A group of three sample ports had been fitted, of which at least two were accessible on each cremator, giving two horizontal sample lines.

Configuration	Square, Vertical
Diameter / Dimensions (m)	0.42 x 0.42
Area (m^2)	0.18
No. of Sample Lines	2
Sample Points per Line	All pollutants sampled simultaneously at the mid-point of one line.



Drawing of sample plane and points

Pollutant data were measured during separate complete cremations on each unit, in each case omitting the first two minutes and the final ash recovery. The exception was the dioxins and furans sample from cremator 1, which was obtained cumulatively over four consecutive cremations.

Cremator 7 was faulty and was shut down after only two cremations out of three had been tested. Otherwise no unusual feature of any coffin or cremation was reported.

6 Monitoring Deviations

In this section the compliance of the measurements with the requirements of the relevant standards is discussed, along with any issues affecting the representativeness of the measurements made.

Particulate sampling was confined to one line instead of two in order to sample continuously for the duration of each cremation. In addition the restricted access to the sample locations meant that it was only possible to sample from a single point. As a result the minimum measurement uncertainty for total particulates has been increased to ±39%. A similar sampling strategy had to be adopted for the dioxins and furans sampling on cremator 1, also leading to an increased uncertainty.

A requirement of particulate sampling to BS ISO 9096 is that the sampling rate is maintained at between 90 and 110% isokinetic. The particulate sampling records in Part 2 imply that this was not always the case. The gas velocity during a cremation is subject to frequent large fluctuations as the controlling software alters the air flows. The sampling rate was adjusted to match these fluctuations and the calculated isokinetic rate was therefore subject to increased uncertainty. The true average isokinetic rate is unlikely to have been significantly outside the specified range.

The blank result for particulate sampling on some runs was more than would comply with the requirements of BS ISO 9096. This is a result of the unusually large adjustment required in order to correct the figures to 11% oxygen and does not reflect unusual contamination of the sample train.

It is not considered that the noted non-compliances had a significant impact on the representativeness of the measurements made. In all cases uncertainties have been adjusted, where appropriate, to take into account deviations from the requirements of the standard methods.

7 Comments

The third particulate sample on cremator 6 and the second and third on cremator 8 gave emission concentrations slightly above the limit value of 80 mg m^{-3}. However, taking into account the uncertainty in the reported results, it cannot be stated unequivocally that the limit had been exceeded in either case. In fact the limit applies to 95% of all cremations, and a higher figure is appropriate for all cremations. In all three cases the calculated emission rate was below the limit value of 120 g h^{-1}.

The second particulate sample on cremator 6, both completed samples on cremator 7 and the first on cremator 8 gave concentrations significantly above the limit. In these cases the emission rate was also above the limit.

VOCs concentrations during the second cremation on cremator 7 exceeded the limit value of 20 mg m^{-3}.

No other exceedences of authorised limits were observed.

Part 2 Supporting Information

Operator	City of London Crematorium
Site	Aldersbrook Road Manor Park London E12 5DQ
Plant	Cremators 1, 6, 7 and 8
Monitoring Dates	5th to 13th January 2010
Project Number	091121
Written By **MCERTS Number** **MCERTS Accreditation** **Position**	Adrian Moss MM 02 041 Level 2, TE1, TE2, TE3, TE4 Consultant (team leader)
Signed	[redacted]
Approved By **MCERTS Number** **MCERTS Accreditation** **Position**	Mike Davies MM 02 087 Level 2, TE1, TE2, TE3 & TE4 Operations Manager
Signed	
Monitoring Organisation	Scientifics Ltd Unit 13/1 Acacia Building Vantage Point Business Village Mitcheldean, Gloucestershire GL17 0DD
Report Ref	091121
Issue Date	24th February 2010

MONITORING REPORT FORMS

Cremator 8

ANALYTICAL REPORTS

SCIENTIFICS MONITORING REPORT FORM
PITOT TRAVERSE (BS EN 13284-1)

Company	City of London	Date	07-Jan-10
Site	Crematorium	Test Ref	crem 1 flow
Sample point	Cremator 1	Time Start	08:46
Test carried out by	S Huntley & T Swannack	Time End	08:56

SAMPLING PLANE GEOMETRY

Geometry of duct		Rectangular
Dimension traversed by sampling probe (D)	m	0.42
Other dimension (if applicable)	m	0.4200
Cross sectional area of sampling plane (A)	m^2	0.1764

MOLECULAR WEIGHT & DENSITY DETERMINATION

Duct gas conditions

Ambient temperature (T_a)	°C	7.00
Duct static gas pressure	kPa	-0.05
Average duct gas temperature (T_{duct})	°C	344.45
Barometric pressure (P_{ar})	kPa	99.00

Calculation of molecular weight from assumed gas composition

Gas	Vol% Dry gas	Vol% Wet gas	Dry Mol Wt g/gmole	Wet Mol Wt g/gmole
CO_2	2.70	2.60	1.19	1.15
O_2	17.10	16.48	5.47	5.28
CO	0.00	0.00	0.00	0.00
N_2	80.20	77.31	22.46	21.65
H_2O	———	3.60	———	0.65
		Total	29.12	28.72

Calculation of dry and wet gas density from molecular weight results

Dry density	kg/m^3	1.30	At STP
Wet density	kg/m^3	1.28	(0°C & 101.3 kPa)
Dry density	kg/m^3	0.56	At Duct Conditions
Wet density (ρ_d)	kg/m^3	0.55	(see above)
Wet specific gravity (sg)		0.99	

CALCULATION OF NOZZLE SIZE & K FACTOR

Exhaust & sample gas conditions

Desired sampling rate at orifice (SR_c)	10 l/min	0.353 ft^3/min
Expected meter outlet temperature (T_m)	20 °C	

(guide is a sampling rate of 0.75 ft^3/min or 21.2 l/min at the orifice)

Conditions at nozzle		Conditions at orifice/meter	
Sampling rate (SR_n)	21.87 l/min	Sampling rate (SR_o)	10.00 l/min
Temperature (T_{duct})	344.45 °C	Temperature (T_o)	20.00 °C
Pressure (P_{duct})	98.95 kPa	Pressure (P_m)	99.00 kPa
Water vapour (H_2O_{duct})	3.60 %	Water vapour (H_2O_m)	0 %
Molecular weight (M_{duct})	28.72	Molecular weight (M_m)	29.12

Orifice Parameters

Orifice plate coefficient ($\Delta H_@$)	2.1935 " w.g.

Determination of nozzle diameter

based on isokinetic sampling and the average gas velocity

$D_{rr} = 2000 \times \sqrt{[SR_n / V_{duct} \times \pi \times 60000]}$

where D_{rr} is the recommended nozzle diameter (mm)

Recommended nozzle diameter (D_{rr} = 6.672 mm

Diameter of nozzle selected (D_n) = 6.28 mm

Determination of K Factor

based on preliminary exhaust gas conditions

K Factor is a proportionality factor relating the pressure drop measured with the Pitot tube in the duct (h) with the corresponding pressure drop at the orifice (ΔH), i.e.

$\Delta H = K * h$

$K = 8.038 \times 10^{-5} \times C_p^2 \times \Delta H_@ \times D_n^4 \times (M_m/M_{duct}) \times [(100-H_2O_{duct})/(100-H_2O_m)]^2 \cdot (T_m+273/T_{duct}+273) \cdot (P_{duct}/P_m)$

where $\Delta H_@$ is the orifice plate coefficient (mm w.g.)

K Factor = 3.1129

K Factor, (independent of C_p) = 3.1129

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 1
Site	Crematorium		
Sample point	Cremator 1 run 1		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		07-Jan-10
Time Start		9:50
Time End		11:05
Duration (t)	min	75

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.15

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	7.0
Average duct gas temperature (T_{duct})	°C	343.7
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	99.00
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.37
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_e)		0.55
Exhaust gas conditions measurements		crem 1

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	343.7
Total pressure (P_{duct})	kPa	98.95
Oxygen (O_{2duct})	%vol,dry	17.20
Water vapour (H_2O_{duct})	%vol	3.53
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination				tpm
Nozzle diameter (d)	T124	Titanium	mm	8.280
Initial gas meter reading			m^3	629.057
Final gas meter reading			m^3	630.077
Sampled volume (SV_M)			m^3	1.020

Calculation of sample gas volume at reference conditions, SV_{Ref}

SV_{Ref} = $SV_{Meter} \times Y \times$

	Corrections
$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
P_{Baro}/P_{Ref}	Pressure
$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.325

SAMPLING DATA tpm

Test Ref: [illegible]

Initial gas meter reading: 629057 | Start Time: 9:50

Distance From Duct Wall Fraction of D	Port	Time of Day hh:mm	Run time min	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice Desired (ΔH_d) mm w.g.	Orifice Actual (ΔH_a) mm w.g.	Isokinetic difference ($\Delta H_a/\Delta H_d$) %	Temperatures: Gas (T_{duct}) °C	Temperatures: Probe (T_p) °C	Temperatures: Filter (T_f) °C	Temperatures: Meter (T_m) Inlet °C	Temperatures: Meter (T_m) Outlet °C	Temperatures: Impinger (T_{imp}) °C	Oxygen Content % v/v, dry
0.500	A	9:50	0	629057	4	8.70	9.4	107	337	156	155	17.0		2	
		09:55	5	629111	4.1	9.01	9.7	108	340	158	158	17.0		6	
		10:00	10	629166	3.9	8.57	9.2	107	346	160	160	17.0		7	
		10:05	15	629219	4.2	9.23	9.9	107	347	160	160	17.0		8	
		10:10	20	629272	3.9	8.57	9.2	107	366	160	160	17.0		8	
		10:15	25	629326	3.9	8.57	9.2	107	347	160	160	17.0		9	
		10:20	30	629383	4	8.79	9.4	107	352	160	160	17.0		11	
		10:25	35	629434	3.5	7.69	8.3	108	354	160	160	17.0		11	
		10:30	40	629493	7.6	17.13	18.4	107	354	161	160	17.0		12	
		10:35	45	629560	12.2	26.80	28.8	107	347	160	160	17.0		12	
		10:40	50	629645	15.4	33.83	36.3	107	345	160	160	17.0		12	
		10:45	55	629739	12.6	27.68	29.7	107	334	160	160	17.0		12	
		10:50	60	629825	13.4	29.43	31.6	107	332	160	160	17.0		14	
		10:55	65	629917	14.5	31.85	34	107	347	160	160	16.8		15	
		11:00	70	630013	15.2	33.39	35.8	107	331	160	160	16.9		15	
		11:05	75	630077											
	Averages								342.7	159.7	159.4	17.1		10.1	n/a

Final gas meter reading: 630077 | End Time: 11:05

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (γ)	0.926
K factor (K_o independent of C_p)	3.112
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple — Titanium	P1097
Duct gas thermocouple	P1611
Oven thermocouple	P1335
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		09:27	11:07
End Time		09:29	11:09
Initial meter reading	m^3	629.8566	630.0773
Final meter reading	m^3	629.8566	630.0777
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.15	0.2
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{avg})	13.8 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	75 min
Theoretical isokinetic sample volume SV_t	1855.43 l
Actual sample volume (SV_a)	2082.37 l
Approach to isokinetic sampling (a)	105.9 %

where: [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

Determination of exhaust gas flow rate
based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	2.48 m^3/s
Flow rate at STP (Q_{STP})	1.04 m^3/s
Flow rate at reference conditions (Q_{ref})	0.37 m^3/s

where:
$Q_{duct} = V_{avg} \times A$
[illegible]
[illegible]

PARTICULATE WEIGHINGS

Test Ref crem 1

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012376	012454
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7427	0.8426
after 2 min	g		0.7429	0.8426
after 3 min	g		0.7429	0.8427
Weight extrapolated to zero time (M_{fa0})	g		0.7426	0.8425
Post-sampling weights				
after 1 min	g		0.7448	0.8499
after 2 min	g		0.7448	0.8499
after 3 min	g		0.7448	0.8499
Weight extrapolated to zero time (M_{ft0})	g		0.7448	0.8499

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		74.2573	70.2705
after 2 min	g		74.2573	70.2704
after 3 min	g		74.2572	70.2703
Weight extrapolated to zero time (M_{ra0})	g		74.2574	70.2706
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		74.2573	70.2770
after 2 min	g		74.2573	70.2770
after 3 min	g		74.2573	70.2769
Weight extrapolated to zero time (M_{rt0})	g		74.2573	70.2771

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{ft0}$- M_{fa0}- M_{fmb}))	g	0.0000	0.0022	0.0074
Mass collected in rinsings ($M_r = (M_{rt0}$-M_{ra0}-M_{rmb}))	g	0.0000	-0.0001	0.0065
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0021	0.0138

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS Test Ref crem 1

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m³ = M x 1000/ SV_{Ref}

Discharge rate, kg/h = C x Q_{Ref} x 0.0036

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m³	6.46	42.54
Uncertainty	mg/m³	6.46	5.17
Particulate concentration at duct conditions (raw)	mg/m³	1.01	6.64
Particulate discharge rate	kg/h	0.01	0.06
Uncertainty	kg/h	0.00	0.01

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.06	0.40
Filter weighings (m_f)	mg	1.58	0.57
Rinsings weighings (m_w)	mg	-0.07	0.50
Total for uncorrected measurement (U_u)	mg	1.58	0.86
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	1.58	0.86
Concentration at 95% confidence interval (U_{95c})	mg/m³	6.46	5.17

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	EN 13284-1
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS EN 13284-1

Blank value is less than 10% of ELV (Clause 4f)
Nozzle diameter greater than 6 mm (Clause 6.2.4)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 8.4)
Leak rate is within 2% of sample rate (Clause 8.4)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl1
Site	Crematorium	Date	07-Jan-10
Sample point	Cremator 1 run 1	Time start	9:50
Test carried out by	S Huntley & T Swannack	Time End	11:05
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	75
		Sampling conditions	crem 1

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	568
Volume of sampling solution in field blank (Vsb)	ml	190
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	29.60
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m^3	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\ (mg/m^3) = ([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c)/(V_{mstd} \times MW_{cl} \times N_c)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Nc is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{std} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_c)	mg/m^3	53.16
Uncertainty (95% confidence limit)	mg/m^3	6.11
Uncertainty as a proportion of ELV	%	3.06
Discharge rate (D_c)	kg/h	0.072
Uncertainty (95% confidence limit)	kg/h	0.011
Detection limit	mg/m^3	0.180

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m^3	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_a)	%	5.0
Total for uncorrected measurement (U_c)	mg/m^3	3.12
Correction to reference conditions (m_{corr})	mg/m^3	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m^3	6.112

Based on Procedure 55 and Uncertainty Policies 11 & 16
(In accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-6.1.5)
Absorption efficiency not determined
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London
Site	Crematorium
Sample point	Cremator 1, run 1
Test carried out by	S Huntley & T Swannack

Date	7-Jan-10
Test Ref	crem 1 (a)
Time Start	09:54
Time End	11:03

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , dry			$mgCO/m^3$, ref. cond.		
09:54	09:58	20	9	<5	<5	22	<5	10
09:59	10:03	20	<5	<5	<5	10	<5	7
10:04	10:08	20	<5	<5	<5	8	<5	6
10:09	10:13	20	<5	<5	<5	6	<5	<5
10:14	10:18	20	<5	<5	<5	6	<5	<5
10:19	10:23	20	<5	<5	<5	5	<5	<5
10:24	10:28	20	<5	<5	<5	5	<5	<5
10:29	10:33	20	18	<5	7	78	<5	28
10:34	10:38	20	17	6	9	74	22	37
10:39	10:43	20	13	7	10	48	24	35
10:44	10:48	20	10	<5	6	35	15	22
10:49	10:53	20	<5	<5	<5	17	10	13
10:54	10:58	20	<5	<5	<5	14	8	11
10:59	11:03	20	<5	<5	<5	13	6	10
09:54	11:03	280	18	<5	<5	78	<5	14

Summary of measurements

Average concentration	14 $mgCO/m^3$
Uncertainty	14 $mgCO/m^3$
Discharge rate	0.019 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

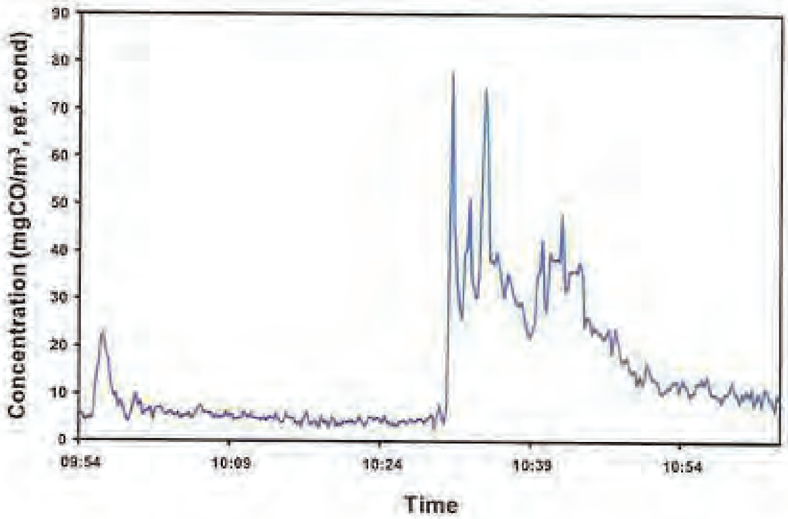
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.14
Gas into system before sampling	ppm	-0.20	25.12
Gas into system after sampling	ppm	-0.30	25.30
Drift	% span	0.40	0.72
Response time	s	26	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)		$x_{i,max}^2$
						ppm CO	$mgCO/m^3$	
Lack of fit	u(Corr)	-		2.00	% range	0.58	0.72	0.52
Zero drift	u(Corr)	-		0.26	% range	0.08	0.09	0.01
Span drift	u(Corr)	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	u(Corr)	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	u(Corr)	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	u(Corr)	1	K	0.50	% range/10K	0.01	0.01	0.00
Electric voltage	u(Corr)	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	u(Corr)	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	u(Corr)	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	u(Corr)	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	u(Corr)	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	u(Corr)	-		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr)	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr)	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$/ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 1, run 1



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London	Date	7-Jan-10
Site	Crematorium	Test Ref	crem 1 (a)
Sample point	Cremator 1, run 1	Time Start	09:50
Test carried out by	S Huntley & T Swannack	Time End	11:05

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , wet			mgCarbon/m3, ref cond.		
09:50	09:55	10	<1	<1	<1	3.5	<1	1.3
09:55	10:00	10	<1	<1	<1	1.8	<1	<1
10:00	10:05	10	<1	<1	<1	<1	<1	<1
10:05	10:10	10	<1	<1	<1	<1	<1	<1
10:10	10:15	10	<1	<1	<1	<1	<1	<1
10:15	10:20	10	<1	<1	<1	<1	<1	<1
10:20	10:25	10	<1	<1	<1	<1	<1	<1
10:25	10:30	10	<1	<1	<1	<1	<1	<1
10:30	10:35	10	<1	<1	<1	<1	<1	<1
10:35	10:40	10	<1	<1	<1	<1	<1	<1
10:40	10:45	10	<1	<1	<1	<1	<1	<1
10:45	10:50	10	<1	<1	<1	<1	<1	<1
10:50	10:55	10	<1	<1	<1	<1	<1	<1
10:55	11:00	10	<1	<1	<1	<1	<1	<1
11:00	11:05	10	<1	<1	<1	<1	<1	<1
09:50	11:05	150	<1	<1	<1	3.5	<1	<1

Summary of measurements

Average concentration	<1 mgCarbon/m3
Uncertainty	1 mgCarbon/m3
Discharge rate	<0.00134928 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

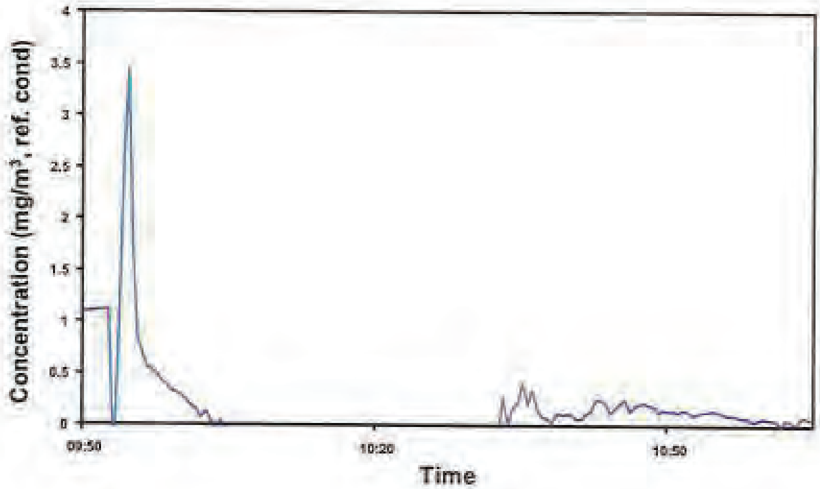
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1266		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.34	8.95
Gas into system before sampling	ppm	-0.35	8.92
Gas into system after sampling	ppm	-0.54	8.86
Drift	% span	2.13	0.67
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$) ppm	Partial uncertainty ($x_{i,max}$) mg/m^3	$x_{i,max}^2$
Lack of fit	u(Corr$_{fit}$)	–		2.00	% range	0.12	0.19	0.03
Zero drift	u(Corr$_{0,dr}$)	–		2.00	% range	0.12	0.19	0.03
Span drift	u(Corr$_{s,dr}$)	–		2.00	% range	0.12	0.19	0.03
Sample volume flow	u(Corr$_{spl}$)	–		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	u(Corr$_{press}$)	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	u(Corr$_{temp}$)	1	K	2.00	% range/10K	0.01	0.01	0.00
Electric voltage	u(Corr$_{volt}$)	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	u(Corr$_{int}$)	–		3.50	% range	0.20	0.32	0.11
Losses & leakage	u(Corr$_{leak}$)	–		0.00	% range	0.00	0.00	0.00
Repeatability at zero	u(Corr$_{r,zero}$)	–		1.00	% range	0.06	0.09	0.01
Repeatability at span	u(Corr$_{r,span}$)	–		2.00	% range	0.12	0.19	0.03
Converter efficiency	u(Corr$_{conv}$)	–		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr$_{resp}$)	–		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr$_{cal}$)	–		1.00	% value	0.06	0.10	0.01
Combined uncertainty	u(C$_{VOC}$)							0.63
Expanded uncertainty	U(C$_{VOC}$)							1.24
U(C$_{VOC}$)/ELV (%)								6.19

Measured concentration of Volatile Organic Compounds at Cremator 1, run 1



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London	Date	7-Jan-10
Site	Crematorium	Test Ref	crem 1 (a)
Sample point	Cremator 1, run 1	Time Start	09:54
Test carried out by	S Huntley & T Swannack	Time End	11:03

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
				% dry			% dry	
09:54	09:58	20	16.8	16.3	16.5	16.8	16.3	16.5
09:59	10:03	20	16.7	16.4	16.5	16.7	16.4	16.5
10:04	10:08	20	16.8	16.4	16.5	16.8	16.4	16.5
10:09	10:13	20	16.8	16.4	16.6	16.8	16.4	16.6
10:14	10:18	20	16.8	16.4	16.5	16.8	16.4	16.5
10:19	10:23	20	16.8	16.3	16.5	16.8	16.3	16.5
10:24	10:28	20	17.0	16.4	16.5	17.0	16.4	16.5
10:29	10:33	20	18.3	16.9	17.6	18.3	16.9	17.6
10:34	10:38	20	18.1	17.4	17.8	18.1	17.4	17.8
10:39	10:43	20	17.5	16.8	17.3	17.5	16.8	17.3
10:44	10:48	20	17.7	17.3	17.5	17.7	17.3	17.5
10:49	10:53	20	17.9	17.6	17.7	17.9	17.6	17.7
10:54	10:58	20	18.0	17.8	17.8	18.0	17.8	17.8
10:59	11:03	20	18.3	17.9	18.1	18.3	17.9	18.1
09:54	11:03	280	18.3	16.3	17.1	18.3	16.3	17.1

Summary of measurements

Average concentration	17.1 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

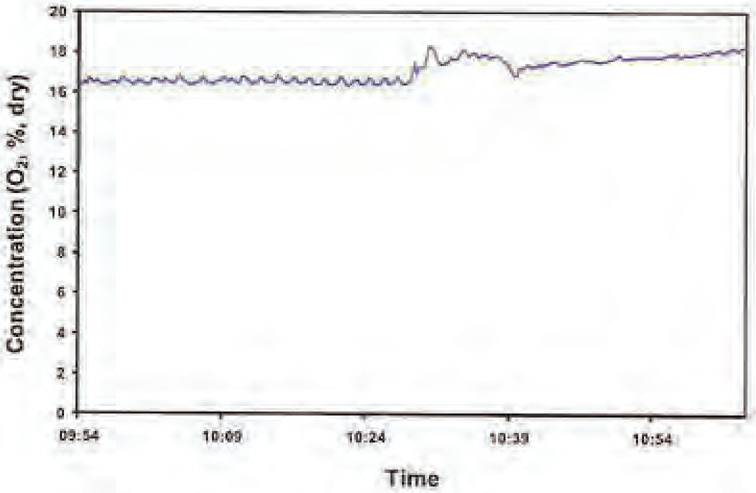
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.05
Gas into system before sampling	%	0.00	13.08
Gas into system after sampling	%	0.10	13.15
Drift	% span	0.76	0.54
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,res}$) %O_2	x_{res}^2
Lack of fit	$u(Corr_{lof})$	–		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{z,dr})$	–		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	–		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{spl})$	–		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{press})$	0	kPa	0.00	% range/2kPa	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.40	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	–		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	–		0.08	% range	0.01	0.00
Repeatability at zero	$u(Corr_{r,zero})$	–		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{r,span})$	–		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	–		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	–		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{cal})$	–		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})/C_{O2}$ (%)							3.63

Measured concentration of Oxygen at Cremator 1, run 1



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	7-Jan-10
Site	Crematorium	Test Ref	crem 1 (a)
Sample point	Cremator 1, run 1	Time Start	09:54
Test carried out by	S Huntley & T Swannack	Time End	11:03

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$ ref. cond.		
09:54	09:58	20	2.6	2.3	2.5	5.6	5.6	5.6
09:59	10:03	20	2.6	2.4	2.5	5.6	5.6	5.6
10:04	10:08	20	2.6	2.3	2.5	5.6	5.6	5.6
10:09	10:13	20	2.5	2.3	2.4	5.6	5.6	5.6
10:14	10:18	20	2.6	2.3	2.5	5.6	5.6	5.6
10:19	10:23	20	2.6	2.3	2.5	5.6	5.6	5.6
10:24	10:28	20	2.6	2.2	2.5	5.6	5.5	5.6
10:29	10:33	20	2.8	1.4	2.2	8.0	5.4	6.6
10:34	10:38	20	2.6	2.1	2.2	7.5	6.9	7.1
10:39	10:43	20	3.4	2.5	2.6	8.2	7.2	7.7
10:44	10:48	20	2.6	2.3	2.4	7.2	6.9	7.1
10:49	10:53	20	2.4	2.1	2.3	7.2	6.9	7.1
10:54	10:58	20	2.3	2.1	2.2	7.2	6.9	7.1
10:59	11:03	20	2.1	1.8	2.0	7.1	6.8	7.0
09:54	11:03	280	3.4	1.4	2.4	8.2	5.4	6.4

Summary of measurements

Average concentration	6.4 $\%CO_2$
Uncertainty	0.8 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.05	5.10
Gas into system after sampling	%	0.12	5.20
Drift	% span	1.38	1.96
Response time	s	27	

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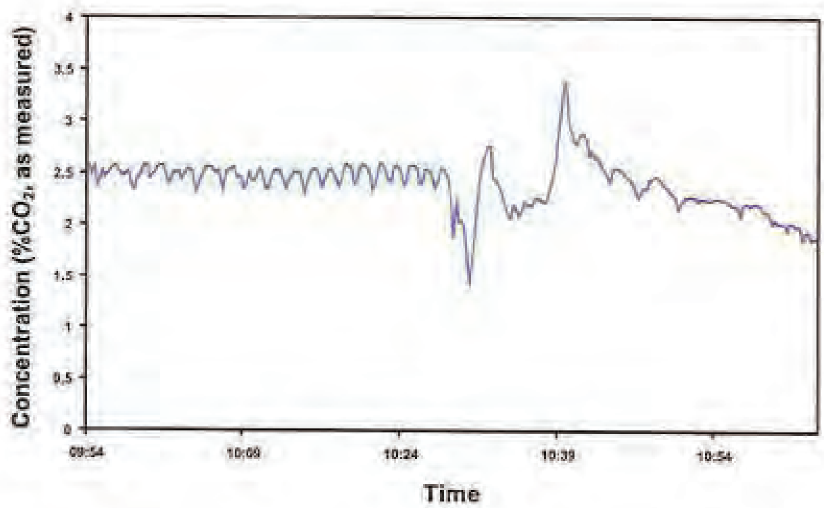
Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)	$x_{i,max}^2$
						$\%CO_2$	
Lack of fit	u($Corr_{fit}$)	–		2.00	% range	0.12	0.01
Zero drift	u($Corr_{0,dr}$)	–		0.25	% range	0.02	0.00
Span drift	u($Corr_{s,dr}$)	–		0.29	% range	0.02	0.00
Sample volume flow	u($Corr_{vol}$)	–		0.00	% range	0.00	0.00
Atmospheric pressure	u($Corr_{press}$)	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	1	K	0.50	% range/10K	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u($Corr_{int}$)	–		1.00	% range	0.09	0.01
Losses & leakage	u($Corr_{leak}$)	–		0.00	% range	0.00	0.00
Repeatability at zero	u($Corr_{r,zero}$)	–		0.14	% range	0.01	0.00
Repeatability at span	u($Corr_{r,span}$)	–		0.00	% range	0.00	0.00
Converter efficiency	u($Corr_{conv}$)	–		100.00	% reading	0.00	0.00
Response factor	u($Corr_{resp}$)	–		100.00	% reading	0.00	0.00
Calibration gas	u($Corr_{cal}$)	–		1.00	% value	0.05	0.00
Combined uncertainty	u(C_{CO2})						0.16
Expanded uncertainty	U(C_{CO2})						0.31
U(C_{CO2})/C_{CO2}(%)							12.94

Measured concentration of Carbon Dioxide at Cremator 1, run 1



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem1 (a)
Site	Crematorium	Date	07-Jan-10
Sample point	Cremator 1 run 1	Time start	9:50
Test carried out by	S Huntley & T Swanwick	Time End	11:05
		Duration (min)	75
		Data from	crem 1

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci,i) g	Final Mass (Mci,f) g	Mass gain (Mci) g
Container 1	788.96	804.88	15.92
Container 2	809.47	815.37	5.9
Container 3	617.17	617.86	0.69
Container 4	897.53	900.68	3.15
Total (M)	3113.13	3138.69	25.56

Calculation of dry gas sample volume at STP (SV_{STP})

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.8687

Calculation of water vapour content ($H_2O_{(w,v)}$)

$H_2O_{(w,v)}$ = 100 x (M x MV_{STP} /MW_{H_2O})/(SV_{STP} + (M x MV_{STP} /MW_{H_2O}))

where MV_{STP} molecular volume at STP (22.412 m³/kgmole)

MW_{H_2O} molecular weight of water (18 kg/kgmole)

Water vapour content ($H_2O_{(w,v)}$)	%	3.53	±	0.16

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.2)

Temperature at outlet is less than 4oC based on calculated dew point (Clause 6.4.2)

Leak rate is no more than 2% of sample flow rate

Sampling duration is within minimum of 30 minutes (Clause 6.1)

Sampling volume is within minimum of 30l (Clause 6.1)

Residual water content at outlet is below 1.25% (Clause 5.8)

Sampling temperature was within minimum of 120oC during sampling (Clause 6.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy µ25)

Volume of sampled gas	V	0.869 m^3
Average temperature of gas at meter	T	17.1 °C
Average barometric pressure at meter	P	990 mb
Sampling line leakage		0.000173 m^3/min
Duration of sampling	t	75 min
Total mass weighed	M	3138.69 g

Source of uncertainty		Value			Value of standard uncertainty			Relative standard uncertainty (%)	
Measurement of sample gas volume	$u_r V_m$	2.0 %		$u_s V_m$ =	[illegible]	0.0100 m^3		$u_r V_m$	1.15
Measurement of sample gas temperature	$u_r T_m$	1.0 %		$u_s T_m$ =	[illegible]	1.6701 K		$u_r T_m$	0.58
Measurement of absolute pressure	$u_r P_m$	1.0 %		$u_s P_m$ =	[illegible]	5.7158 mb		$u_r P_m$	0.58
Leakage in sampling line	$u_r L$	1.5 %		$u_s L$ =	[illegible]	0.0075 m^3		$u_r L$	0.87
Measurement of weight - balance uncertainty	$u_r W_m$	0.01 %		$u_s W_m$ =	[illegible]	0.1812 g			-
Measurement of weight - balance repeatability	$u_r W_r$	0.011 g		$u_s W_r$ =	[illegible]	0.0110 g			-
Total measurement of weight	$u_r W$	-	-	$u_s W$ =		0.1922 g		$u_r W$	0.75

Total standard relative uncertainty	$u_r = \sqrt{u_r V_m^2 + u_r T_m^2 + u_r P_m^2 + u_r L^2 + u_r W^2}$ + Corr	2.27 %
Total relative uncertainty	$U = 1.96u_r$	4.46 %

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 1 (b)
Site	Crematorium		
Sample point	Cremator 1 run 2		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		TPM
Date		07-Jan-10
Time Start		11:40
Time End		13:10
Duration (t)	min	90

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		TPM
Ambient temperature (T_{Amb})	°C	7.0
Average duct gas temperature (T_{duct})	°C	345.9
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	99.00
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.21
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_s)		0.55
Exhaust gas conditions measurements		crem 1 (b)

Reference conditions

Determination		TPM
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	345.9
Total pressure (P_{duct})	kPa	98.95
Oxygen (O_{2duct})	%vol,dry	18.30
Water vapour (H_2O_{duct})	%vol	3.74
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination				TPM
Nozzle diameter (d)	Ti24	Titanium	mm	6.280
Initial gas meter reading			m^3	630.168
Final gas meter reading			m^3	631.154
Sampled volume (SV_M)			m^3	0.986

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times Y \times$	$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
			$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		TPM
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.219

SAMPLING DATA TPM

Test Ref: [illegible]

Initial gas meter reading: 630160 Start Time: 11:40

Distance from Duct Wall Fraction of D	Port	Time of Day hours	Run time min	Gas meter reading l	Pitot Reading (Δ) mm w.g.	Orifice Desired (ΔH_d) $m \times K_c \times Cd^2$	Orifice Actual (ΔH)	Isokinetic difference ($\Delta H/\Delta H_d$) %	Temperatures: Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Meter (T_m) Outlet °C	Impinger (T_{imp}) °C	Oxygen Content % v/v, dry
0.500	A	11:40	0	630160	4.6	10.15	10.9	100	347	158	157	18.8		8	
		11:45	5	630227	7.2	15.81	17	107	346	159	159	18.8		8	
		11:50	10	630292	7.1	15.60	16.7	107	345	160	159	18.8		9	
		11:55	15	630361	3.8	8.35	9	108	344	160	160	18.8		11	
		12:00	20	630417	3.7	8.13	8.7	107	353	160	160	19.0		12	
		12:05	25	630466	5.2	11.42	12.2	108	347	160	159	19.8		12	
		12:10	30	630523	2.2	4.83	5.2	108	365	160	160	19.6		14	
		12:15	35	630564	3.3	7.25	7.8	108	366	161	160	19.8		14	
		12:20	40	630612	2.4	5.27	5.7	108	360	161	160	19.8		15	
		12:25	45	630655	2.8	6.15	6.6	107	351	161	160	19.8		16	
		12:30	50	630701	3.5	7.69	8.2	108	348	160	160	20.0		17	
		12:35	55	630752	3.1	6.81	7.3	107	347	160	160	20.0		18	
		12:40	60	630802	3.3	7.25	7.8	108	335	161	160	20.0		19	
		12:45	65	630851	6.6	14.34	16	107	338	160	160	20.2		7	
		12:50	70	630915	13.9	30.53	33	108	333	160	160	20.6		8	
		12:55	75	631006	7.8	17.13	18.4	107	332	160	160	21.0		9	
		13:00	80	631062	7.6	16.69	17.9	107	334	160	160	21.0		11	
		13:05	85	631117	4.6	10.34	11.2	107	336	160	160	21.0		11	
		13:10	90	631154											
	Averages								345.3	160.0	159.7	19.4		12.2	n/m

Final gas meter reading: 631154 End Time: 13:10

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (γ)	0.938
K factor, (K_c independent of C_p)	2.113
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple: Titanium	P1087
Duct gas thermocouple	P1611
Oven thermocouple	P1385
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		11:34	13:12
End Time		11:36	13:14
Initial meter reading	m^3	630.018	631.1538
Final meter reading	m^3	630.0183	631.1542
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.15	0.2
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	11.0 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	90 min
Theoretical isokinetic sample volume SV_t	1825.16 l
Actual sample volume (SV_a)	2000.63 l
Approach to isokinetic sampling (I)	109.5 %

where: V_{duct} is the average duct velocity based on the above measurements
$V_{duct} = C_p \times (1-\epsilon) \times \sqrt{2 \Delta p \, \rho} \ldots$ (Reference BS 1042 Section 2.1:1983 (ISO 3966), pages [illegible])
SV_t is the theoretical isokinetic sample volume based on V_{duct} & D_n
$SV_t = V_{duct} \times \pi \times (D_n/2000)^2 \times t \times 60 \times 1000$
SV_a is the sample volume at duct conditions
$SV_a = SV_m \times \gamma \times [(273 + T_{duct})/(273 + T_m)] \times (P_{atm}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.94 m^3/s
Flow rate at STP (Q_{STP})	0.83 m^3/s
Flow rate at reference conditions (Q_{Ref})	1.21 m^3/s

where:
$Q_{duct} = V_{duct} \times A$
$Q_{STP} = Q_{duct} \times [(T_{std} + 273)/(T_{duct} + 273)] \times (P_{duct}/P_{std})$
$Q_{Ref} = Q_{STP} \times [(20.9 - O_{2,duct})/(20.9 - O_{2,ref})] \times [(100 - H_2O_{duct})/(100 - H_2O_{ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 1 (b)

Filters

Determination		Method Blank	Field Blank	TPM
Filter No.		0	012376	012448
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7427	0.8245
after 2 min	g		0.7429	0.8245
after 3 min	g		0.7429	0.8245
Weight extrapolated to zero time (M_{fs})	g		0.7426	0.8245
Post-sampling weights				
after 1 min	g		0.7448	0.8243
after 2 min	g		0.7448	0.8243
after 3 min	g		0.7448	0.8244
Weight extrapolated to zero time (M_{fe})	g		0.7448	0.8242

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		74.2573	72.6034
after 2 min	g		74.2573	72.6033
after 3 min	g		74.2572	72.6033
Weight extrapolated to zero time (M_{rid})	g		74.2574	72.6034
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		74.2573	72.6088
after 2 min	g		74.2573	72.6087
after 3 min	g		74.2573	72.6085
Weight extrapolated to zero time (M_{rid})	g		74.2573	72.6090

Summary

Determination		Method Blank (M_{mb})	Field Blank	TPM
Mass collected on filter ($M_f = (M_{fe} - M_{fs} - M_{fmb})$)	g	0.0000	0.0022	-0.0003
Mass collected in rinsings ($M_r = (M_{rfc} - M_{ric} - M_{rmb})$)	g	0.0000	-0.0001	0.0055
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0021	0.0053

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS

Test Ref crem 1 (b)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = M x 1000/ SV_{Ref}

Discharge rate, kg/h = C x Q_{Ref} x 0.0036

Determination		Field Blank	TPM
Particulate concentration at reference conditions	mg/m^3	9.57	24.00
Uncertainty	mg/m^3	9.57	5.24
Particulate concentration at duct conditions (raw)	mg/m^3	1.05	2.62
Particulate discharge rate	kg/h	0.01	0.02
Uncertainty	kg/h	0.00	0.00

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	TPM
Volume measurement (m_{vol})	mg	0.06	0.15
Filter weighings (m_f)	mg	1.58	-0.27
Rinsings weighings (m_w)	mg	-0.07	0.50
Total for uncorrected measurement (U_u)	mg	1.58	0.59
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	1.58	0.59
Concentration at 95% confidence interval (U_{95c})	mg/m^3	9.57	5.24

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	EN 13284-1
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS EN 13284-1

Blank value is greater than 10% of ELV - measurement invalid (Clause 4f)
Nozzle diameter greater than 6 mm (Clause 6.2.4)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 8.4)
Leak rate is within 2% of sample rate (Clause 8.4)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	07-Jan-10
Sample point	Cremator 1 run 2	Time start	11:40
Test carried out by	S Huntley & T Swannack	Time End	13:10
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	90
		Sampling conditions	crem 1 (b)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	683
Volume of sampling solution in field blank (Vsb)	ml	190
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	0.25
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\ (mg/m^3) = (([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c)/(V_{mstd} \times MW_{cl} \times N_c)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Nc is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_r)	mg/m³	0.80
Uncertainty (95%confidence limit)	mg/m³	0.80
Uncertainty as a proportion of ELV	%	0.40
Discharge rate (D_g)	kg/h	0.001
Uncertainty (95%confidence limit)	kg/h	0.001
Detection limit	mg/m³	0.320

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	84.2
Total for uncorrected measurement (U_c)	mg/m³	0.67
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95})	mg/m³	0.800

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM)

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Absorption efficiency not determined
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London	Date	7-Jan-10
Site	Crematorium	Test Ref	crem 1 (b)
Sample point	Cremator 1, run 2	Time Start	11:43
Test carried out by	S Huntley & T Swannack	Time End	13:13

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm, dry			$mgCO/m^3$, ref. cond.		
11:43	11:48	20	<5	<5	<5	10	<5	6
11:48	11:53	20	<5	<5	<5	8	<5	<5
11:53	11:58	20	<5	<5	<5	10	<5	6
11:58	12:03	20	<5	<5	<5	9	<5	<5
12:03	12:08	20	<5	<5	<5	15	<5	7
12:08	12:13	20	<5	<5	<5	6	<5	<5
12:13	12:18	20	<5	<5	<5	5	<5	<5
12:18	12:23	20	<5	<5	<5	<5	<5	<5
12:23	12:28	20	<5	<5	<5	<5	<5	<5
12:28	12:33	20	<5	<5	<5	11	<5	<5
12:33	12:38	20	<5	<5	<5	8	<5	<5
12:38	12:43	20	10	<5	6	48	6	26
12:43	12:48	20	8	<5	<5	38	10	20
12:48	12:53	20	12	<5	6	52	12	33
12:53	12:58	20	<5	<5	<5	22	<5	11
12:58	13:03	20	<5	<5	<5	9	<5	6
13:03	13:08	20	<5	<5	<5	8	<5	5
13:08	13:13	20	<5	<5	<5	6	<5	<5
[redacted]								
11:43	13:13	360	12	<5	<5	52	<5	8

Summary of measurements

Average concentration	8 $mgCO/m^3$
Uncertainty	8 $mgCO/m^3$
Discharge rate	0.0062 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

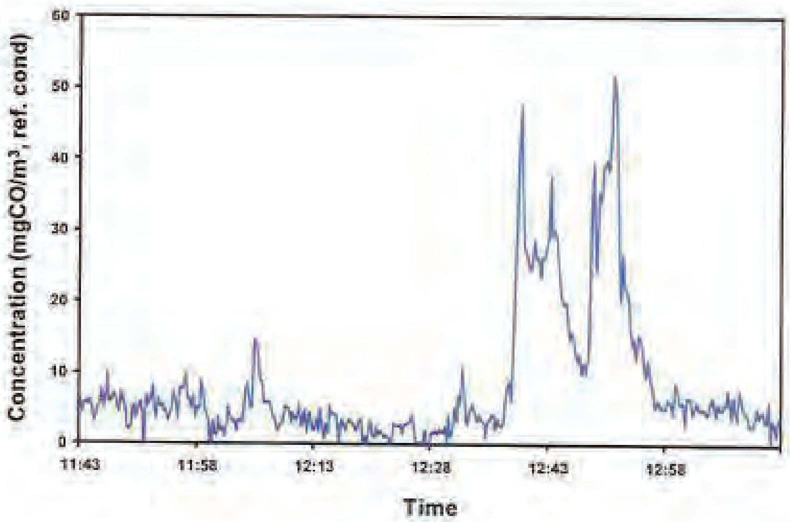
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.14
Gas into system before sampling	ppm	-0.20	25.12
Gas into system after sampling	ppm	-0.30	25.30
Drift	% span	0.40	0.72
Response time	s	26	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{[illegible]}$)		$x_{[illegible]}^2$
						ppm CO	mgCO/m³	
Lack of fit	u(Corr[illegible])	-		2.00	% range	0.58	0.72	0.52
Zero drift	u(Corr[illegible])	-		0.26	% range	0.08	0.09	0.01
Span drift	u(Corr[illegible])	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	u(Corr[illegible])	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	u(Corr[illegible])	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	u(Corr[illegible])	2	K	0.50	% range/10K	0.01	0.02	0.00
Electric voltage	u(Corr[illegible])	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	u(Corr[illegible])	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	u(Corr[illegible])	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	u(Corr[illegible])	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	u(Corr[illegible])	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	u(Corr[illegible])	-		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr[illegible])	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr[illegible])	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{[illegible]})$							1.06
Expanded uncertainty	$U(C_{[illegible]})$							2.08
$U(C_{[illegible]})$/ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 1, run 2



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London		Date	7-Jan-10
Site	Crematorium		Test Ref	crem 1 (b)
Sample point	Cremator 1, run 2		Time Start	11:40
Test carried out by	S Huntley & T Swannack		Time End	13:10

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , wet			mgCarbon/m3, ref cond.		
11:40	11:45	10	<1	<1	<1	2.8	2.7	2.7
11:45	11:50	10	<1	<1	<1	2.8	2.7	2.7
11:50	11:55	10	<1	<1	<1	2.7	2.4	2.6
11:55	12:00	10	<1	<1	<1	2.9	2.5	2.7
12:00	12:05	10	<1	<1	<1	2.7	2.4	2.6
12:05	12:10	10	<1	<1	<1	2.8	2.4	2.6
12:10	12:15	10	<1	<1	<1	2.5	2.1	2.3
12:15	12:20	10	<1	<1	<1	2.4	2.1	2.3
12:20	12:25	10	<1	<1	<1	2.4	2.0	2.2
12:25	12:30	10	<1	<1	<1	2.2	1.8	2.0
12:30	12:35	10	<1	<1	<1	2.3	1.7	2.0
12:35	12:40	10	<1	<1	<1	2.1	1.8	2.0
12:40	12:45	10	<1	<1	<1	2.4	1.9	2.2
12:45	12:50	10	<1	<1	<1	2.5	1.9	2.2
12:50	12:55	10	<1	<1	<1	2.6	1.8	2.3
12:55	13:00	10	<1	<1	<1	2.4	2.2	2.3
13:00	13:05	10	<1	<1	<1	2.2	2.1	2.2
13:05	13:10	10	<1	<1	<1	2.0	1.9	1.9
11:40	13:10	180	<1	<1	<1	2.9	1.7	2.3

Summary of measurements

Average concentration	2.3 mgCarbon/m3
Uncertainty	2.3 mgCarbon/m3
Discharge rate	0.0018 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

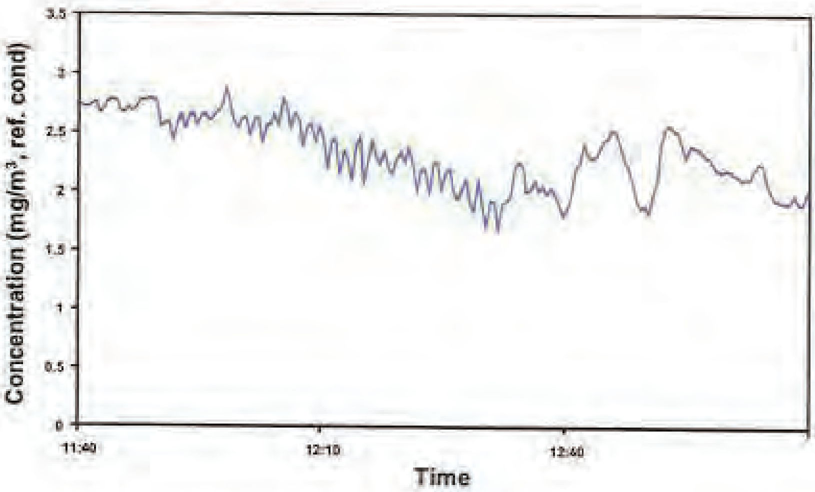
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.34	8.95
Gas into system before sampling	ppm	-0.54	8.86
Gas into system after sampling	ppm	-0.26	8.92
Drift	% span	3.14	0.68
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)		$x_{i,max}^2$
						ppm	mg/m³	
Lack of fit	$u(Corr_{lof})$	-		2.00	% range	0.12	0.19	0.03
Zero drift	$u(Corr_{z,dr})$	-		2.00	% range	0.12	0.19	0.03
Span drift	$u(Corr_{s,dr})$	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	$u(Corr_{s,f})$	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	$u(Corr_{atmos})$	0	kPa	0.50	% range/2kPa	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	2.00	% range/10K	0.01	0.02	0.00
Electric voltage	$u(Corr_{volt})$	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	$u(Corr_{int})$	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	$u(Corr_{leak})$	-		0.50	% range	0.03	0.06	0.00
Repeatability at zero	$u(Corr_{r,zero})$	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	$u(Corr_{r,sp})$	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	$u(C_{voc})$							0.63
Expanded uncertainty	$U(C_{voc})$							1.24
$U(C_{voc})$/ELV (%)								6.22

Measured concentration of Volatile Organic Compounds at Cremator 1, run 2



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London	Date	7-Jan-10
Site	Crematorium	Test Ref	crem 1 (b)
Sample point	Cremator 1, run 2	Time Start	11:43
Test carried out by	S Huntley & T Swannack	Time End	13:13

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			% dry		
11:43	11:48	20	18.9	18.4	18.8	18.9	18.4	18.8
11:48	11:53	20	18.7	18.2	18.5	18.7	18.2	18.5
11:53	11:58	20	19.1	18.3	18.7	19.1	18.3	18.7
11:58	12:03	20	18.8	18.2	18.5	18.8	18.2	18.5
12:03	12:08	20	18.7	18.1	18.4	18.7	18.1	18.4
12:08	12:13	20	18.3	17.9	18.1	18.3	17.9	18.1
12:13	12:18	20	18.4	17.8	18.1	18.4	17.8	18.1
12:18	12:23	20	18.3	17.8	18.1	18.3	17.8	18.1
12:23	12:28	20	18.3	17.5	17.9	18.3	17.5	17.9
12:28	12:33	20	19.3	17.7	18.2	19.3	17.7	18.2
12:33	12:38	20	18.7	17.7	18.0	18.7	17.7	18.0
12:38	12:43	20	19.4	17.5	18.3	19.4	17.5	18.3
12:43	12:48	20	18.9	17.3	18.0	18.9	17.3	18.0
12:48	12:53	20	19.2	17.1	18.4	19.2	17.1	18.4
12:53	12:58	20	18.8	17.9	18.3	18.8	17.9	18.3
12:58	13:03	20	18.3	17.8	18.1	18.3	17.8	18.1
13:03	13:08	20	18.6	17.8	18.2	18.6	17.8	18.2
13:08	13:13	20	18.2	17.9	18.1	18.2	17.9	18.1
11:43	13:13	360	19.4	17.1	18.3	19.4	17.1	18.3

Summary of measurements

Average concentration	18.3 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

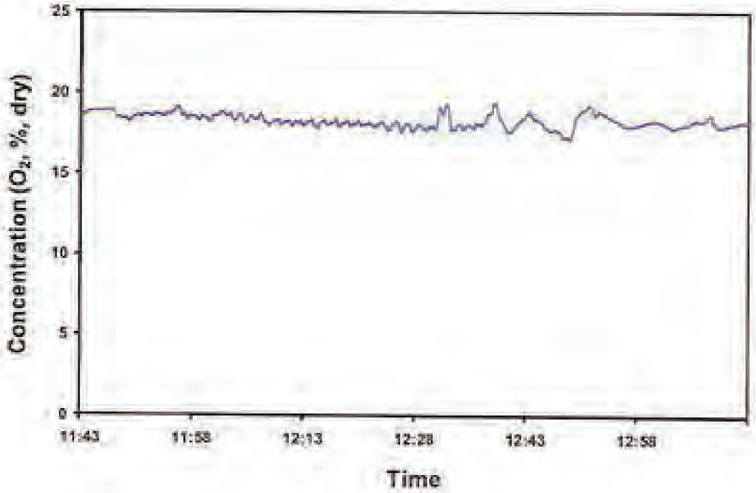
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.05
Gas into system before sampling	%	0.00	13.06
Gas into system after sampling	%	0.10	13.15
Drift	% span	0.76	0.54
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{max})	x_{max}^2
						$\%O_2$	
Lack of fit	u(Corr)	-		2.00	% range	0.29	0.08
Zero drift	u(Corr)	-		0.11	% range	0.02	0.00
Span drift	u(Corr)	-		0.24	% range	0.03	0.00
Sample volume flow	u(Corr)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u(Corr)	0	kPa	0.00	% range/2kPa	0.00	0.00
Ambient temperature	u(Corr)	2	K	0.40	% range/10K	0.01	0.00
Electric voltage	u(Corr)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u(Corr)	-		0.00	% range	0.00	0.00
Losses & leakage	u(Corr)	-		0.08	% range	0.01	0.00
Repeatability at zero	u(Corr)	-		0.00	% range	0.00	0.00
Repeatability at span	u(Corr)	-		0.00	% range	0.00	0.00
Converter efficiency	u(Corr)	-		100.00	% reading	0.00	0.00
Response factor	u(Corr)	-		100.00	% reading	0.00	0.00
Calibration gas	u(Corr)	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})/C_{O2}$(%)							3.40

Measured concentration of Oxygen at Cremator 1, run 2



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London		Date	7-Jan-10
Site	Crematorium		Test Ref	crem 1 (b)
Sample point	Cremator 1, run 2		Time Start	11:43
Test carried out by	S Huntley & T Swannack		Time End	13:13

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
11:43	11:48	20	1.4	1.1	1.2	5.7	5.3	5.5
11:48	11:53	20	1.6	1.2	1.3	5.6	5.3	5.5
11:53	11:58	20	1.4	0.9	1.2	5.4	5.1	5.3
11:58	12:03	20	1.5	1.1	1.3	5.5	5.1	5.3
12:03	12:08	20	1.5	1.1	1.3	5.4	5.2	5.3
12:08	12:13	20	1.7	1.4	1.5	5.5	5.3	5.4
12:13	12:18	20	1.7	1.3	1.5	5.5	5.3	5.4
12:18	12:23	20	1.7	1.4	1.5	5.4	5.3	5.4
12:23	12:28	20	1.9	1.4	1.6	5.5	5.3	5.4
12:28	12:33	20	1.8	0.8	1.4	5.5	4.9	5.3
12:33	12:38	20	1.8	1.2	1.6	5.7	5.2	5.5
12:38	12:43	20	2.8	0.7	1.9	8.3	4.7	7.2
12:43	12:48	20	3.1	1.6	2.3	8.4	7.2	7.8
12:48	12:53	20	3.2	1.1	1.8	8.6	6.1	7.2
12:53	12:58	20	2.1	1.3	1.8	7.1	6.2	6.8
12:58	13:03	20	2.2	1.8	2.0	7.1	6.9	7.0
13:03	13:08	20	2.2	1.5	2.0	7.3	6.7	7.1
13:08	13:13	20	2.0	1.8	1.9	6.7	6.5	6.6
11:43	13:13	360	3.2	0.7	1.6	8.6	4.7	6.0

Summary of measurements

Average concentration	6.0 $\%CO_2$
Uncertainty	1.2 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

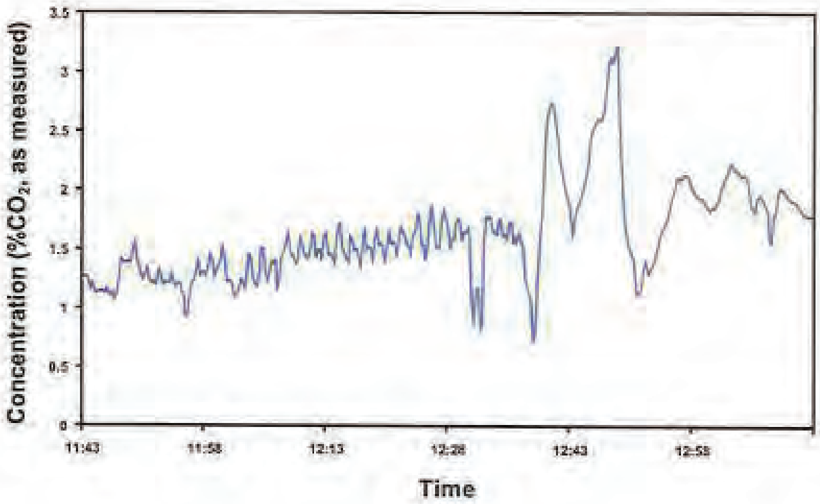
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.06
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.05	5.10
Gas into system after sampling	%	0.12	5.20
Drift	% span	1.38	1.96
Response time	s	27	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x)	x^2
						%CO_2	
Lack of fit	u(Corr)	-		2.00	% range	0.12	0.01
Zero drift	u(Corr)	-		0.26	% range	0.02	0.00
Span drift	u(Corr)	-		0.29	% range	0.02	0.00
Sample volume flow	u(Corr)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u(Corr)	0	kPa	0.00	% range/2kPa	0.00	0.00
Ambient temperature	u(Corr)	2	K	0.50	% range/10K	0.00	0.00
Electric voltage	u(Corr)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u(Corr)	-		1.60	% range	0.09	0.01
Losses & leakage	u(Corr)	-		0.00	% range	0.00	0.00
Repeatability at zero	u(Corr)	-		0.14	% range	0.01	0.00
Repeatability at span	u(Corr)	-		0.00	% range	0.00	0.00
Converter efficiency	u(Corr)	-		100.00	% reading	0.00	0.00
Response factor	u(Corr)	-		100.00	% reading	0.00	0.00
Calibration gas	u(Corr)	-		1.00	% value	0.05	0.00
Combined uncertainty	u(C)						0.16
Expanded uncertainty	U(C)						0.31
U(C)/C(%)							19.07

Measured concentration of Carbon Dioxide at Cremator 1, run 2



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 1 (b)
Site	Crematorium	Date	07-Jan-10
Sample point	Cremator 1 run 2	Time start	11:40
Test carried out by	S Huntley & T Swannack	Time End	13:10
		Duration (min)	90
		Data from	crem 1 (b)

Collection of water from gas

Collection Stage (c)	Initial Mass(M_{ci}) g	Final Mass (M_{cf}) g	Mass gain (M_{c}) g
Container 1	786.96	803.11	16.15
Container 2	809.47	813.89	4.42
Container 3	617.17	619.74	2.57
Container 4	897.53	902.36	4.83
Total (M)	3113.13	3139.1	25.97

Calculation of dry gas sample volume at STP (SV_{STP})

SV_{STP} = SV_a x (273/(273 + T_a) x (P_a/101.3)

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.8021

Calculation of water vapour content ($H_2O_{(cont)}$)

	$H_2O_{(cont)}$ =	100 x (M x MV_{STP}/MW_{H2O})/(SV_{STP} + (M x MV_{STP}/MW_{H2O}))
where:	MV_{STP}	molecular volume at STP (22.412 m^3/kgmole)
	MW_{H2O}	molecular weight of water (18 kg/kgmole)

Water vapour content ($H_2O_{(cont)}$)	%	3.74 ± 0.19

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is below 1.25% (Clause 5.6)
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U23)

Volume of sampled gas	V	0.835 m^3
Average temperature of gas at meter	T	15.4 °C
Average barometric pressure at meter	P	990 mb
Sampling line leakage		0.000175 m^3/min
Duration of sampling	t	90 min
Total mass weighed	M	3139.1 g

Source of uncertainty		Value		Value of standard uncertainty			Relative standard uncertainty (%)	
Measurement of sample gas volume	u_rV_m	2.0 %	u_r	u_rV_m =	[illegible]	0.0096 m^3	u_rV_m	1.15
Measurement of sample gas temperature	u_rT_m	1.0 %	u_r	u_rT_m =	[illegible]	1.6884 K	u_rT_m	0.58
Measurement of absolute pressure	u_rP_m	1.0 %	u_r	u_rP_m =	[illegible]	5.7158 mb	u_rP_m	0.58
Leakage in sampling line	u_rL	1.9 %	u_r	u_rL =	[illegible]	0.0091 m^3	u_rL	1.09
Measurement of weight - balance uncertainty	u_rW_m	0.01 %	u_{bal}	u_rW_m =	[illegible]	0.1812 g		–
Measurement of weight - balance repeatability	u_rW_r	0.011 g	u_{rep}	u_rW_r =	[illegible]	0.0110 g		–
Total measurement of weight	u_rW	-	-	u_rW =		0.1922 g	u_rW	0.74

Total standard relative uncertainty	$u_c = \sqrt{u_rV_m^2 + u_rT_m^2 + u_rP_m^2 + u_rL^2 + u_rW^2} - Corr$	2.65 %
Total relative uncertainty	$U = 1.96u_c$	5.10 %

scientifics

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 1 (c)
Site	Crematorium		
Sample point	Cremator 1 run 3		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		07-Jan-10
Time Start		13:41
Time End		15:21
Duration (t)	min	100

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	7.0
Average duct gas temperature (T_{duct})	°C	340.0
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	99.00
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.19
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_s)		0.55
Exhaust gas conditions measurements		crem 1 (c)

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	340.0
Total pressure (P_{duct})	kPa	98.95
Oxygen (O_{2duct})	% vol,dry	18.40
Water vapour (H_2O_{duct})	% vol	3.22
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	% vol, dry	11
Water vapour (H_2O_{Ref})	% vol	0

Sampling conditions

Determination		tpm
Nozzle diameter (d) TI 24 Titanium	mm	6.280
Initial gas meter reading	m^3	631.397
Final gas meter reading	m^3	632.401
Sampled volume (SV_M)	m^3	1.004

Calculation of sample gas volume at reference conditions, SV_{Ref}

SV_{Ref} = SV_{Meter} x γ x

	Corrections
$[273+T_{Ref}]/[273+T_{Meter}]$	Temperature
P_{Baro}/P_{Ref}	Pressure
$[100-H_2O_{Meter}]/[100-H_2O_{Ref}]$	Water vapour
$[20.9-O_{2Duct}]/[20.9-O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.213

SAMPLING DATA (pm) Test Ref: crem 6 (2)

Initial gas meter reading: 631397 | Start Time: 13:41

Distance from Duct Wall Fraction of D	Port	Time of Day (time)	Run time (min)	Gas meter reading (l)	Pitot Reading (h) mm w.g.	Orifice (H) mm w.g. Desired (H_d) $= h \times K_s \times Cp^2$	Orifice (H) mm w.g. Actual (H_a)	Isokinetic difference (H_a/H_d) %	Temperatures: Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Meter (T_m) Outlet °C	Impinger (T_{imp}) °C	Oxygen Content % v/v, dry
0.500	A	13:41	0	631397	3.6	7.47	8	107	340	160	157	22.0		7	
		13:46	5	631434	4.8	10.34	11.3	107	338	161	158	22.0		8	
		13:51	10	631468	2.4	5.27	5.7	108	349	160	158	22.0		9	
		13:56	15	631526	2.1	4.61	5	108	348	160	160	22.0		10	
		14:01	20	631571	2.2	4.82	5.2	108	347	160	158	22.0		11	
		14:06	25	631611	2.1	4.61	5	108	346	160	160	22.0		12	
		14:11	30	631661	2.1	4.61	5	108	345	161	161	22.0		14	
		14:16	35	631691	2.6	5.71	6.1	107	344	161	161	22.0		14	
		14:21	40	631736	2.3	5.05	5.4	107	346	161	158	22.0		15	
		14:26	45	631777	2.8	6.15	6.6	107	343	161	160	22.0		15	
		14:31	50	631822	1.6	3.51	3.8	108	341	160	158	23.0		16	
		14:36	55	631863	1.4	3.06	3.3	107	336	160	160	22.0		16	
		14:41	60	631894	1.4	3.06	3.3	107	335	161	160	22.0		17	
		14:46	65	631927	8.2	18.01	19.3	107	340	160	160	22.0		18	
		14:51	70	631985	4.8	10.34	11.3	107	333	160	160	22.0		18	
		14:56	75	632054	11.2	26.09	31.1	107	335	160	158	22.0		19	
		15:01	80	632135	11	24.16	26	108	335	160	160	22.0		7	
		15:06	85	632220	9.5	20.87	22.4	107	338	160	158	22.0		8	
		15:11	90	632303	7.8	17.13	18.4	107	328	161	161	22.0		9	
		15:16	95	632371	3.3	7.83	7.5	107	324	161	161	22.0		11	
		15:21	100	632401											
	Averages								340.8	160.3	160.0	22.1		12.7	[illegible]

Final gas meter reading: 632401 | End Time: 15:21

Equipment used

Item	Rig No.
Control box	P1382
Meter coefficient (y)	1.028
K factor (K_s independent of C_p)	2.112
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1087
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		13:36	15:22
End Time		13:38	15:23
Initial meter reading	m^3	631.2040	632.4013
Final meter reading	m^3	631.2060	632.4016
Duration of leak test	min	2	2
Pump vacuum	"Hg	-13	-15
Leak rate	l/min	0.2	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	5.6 m/s
Nozzle diameter (D_n)	5.285 mm
Sampling time (t)	100 min
Theoretical isokinetic sample volume SV_t	1627.81 l
Actual sample volume (SV_a)	1595.66 l
Approach to isokinetic sampling (I)	98.3 %

where: V_{duct} is the average duct velocity based on the above measurements
$V_{duct} = C_p \times (T \times a) \times \sqrt{2g_c \times h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)
SV_t is the theoretical isokinetic sample volume based on V_{duct} & D_n
$SV_t = V_{duct} \times \pi \times (D_n/2000)^2 \times t \times 60 \times 1000$
SV_a is the sample volume at duct conditions
$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{atm}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate
based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.72 m^3/s
Flow rate at STP (Q_{STP})	0.75 m^3/s
Flow rate at reference conditions (Q_{ref})	2.16 m^3/s

where:
$Q_{duct} = V_{duct} \times A$
$Q_{STP} = Q_{duct} \times [(T_{ref} + 273)/(T_{duct} + 273)] \times (P_{duct}/P_{ref})$
$Q_{ref} = Q_{STP} \times [(20.9 - O_{2 ref})/(20.9 - O_{2 duct})] \times [(100 - H_2O_{ref})/(100 - H_2O_{duct})]$

PARTICULATE WEIGHINGS

Test Ref crem 1 (c)

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012376	012451
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7427	0.8400
after 2 min	g		0.7429	0.8400
after 3 min	g		0.7429	0.8400
Weight extrapolated to zero time (M_{fs})	g		0.7426	0.8400
Post-sampling weights				
after 1 min	g		0.7448	0.8399
after 2 min	g		0.7448	0.8400
after 3 min	g		0.7448	0.8400
Weight extrapolated to zero time (M_{f0})	g		0.7448	0.8399

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		74.2573	67.8624
after 2 min	g		74.2573	67.8624
after 3 min	g		74.2572	67.8623
Weight extrapolated to zero time (M_{rs})	g		74.2574	67.8625
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		74.2573	67.8650
after 2 min	g		74.2573	67.8648
after 3 min	g		74.2573	67.8647
Weight extrapolated to zero time (M_{r0})	g		74.2573	67.8651

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{f0} - M_{fs} - M_{fmb})$)	g	0.0000	0.0022	-0.0001
Mass collected in rinsings ($M_r = (M_{r0} - M_{rs} - M_{rmb})$)	g	0.0000	-0.0001	0.0027
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0021	0.0025

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS Test Ref crem 1 (c)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = $M \times 1000/ SV_{Ref}$

Discharge rate, kg/h = $C \times Q_{Ref} \times 0.0036$

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m^3	9.86	11.90
Uncertainty	mg/m^3	9.86	11.90
Particulate concentration at duct conditions (raw)	mg/m^3	1.05	1.27
Particulate discharge rate	kg/h	0.01	0.01
Uncertainty	kg/h	0.00	0.00

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.06	0.07
Filter weighings (m_f)	mg	1.58	-0.13
Rinsings weighings (m_w)	mg	-0.07	1.62
Total for uncorrected measurement (U_u)	mg	1.58	1.63
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	1.58	1.63
Concentration at 95% confidence interval (U_{95c})	mg/m^3	9.86	11.90

Based on Procedure 55 and Uncertainty Policies 11 & 17
(In accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	EN 13284-1
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS EN 13284-1

Blank value is greater than 10% of ELV - measurement invalid (Clause 4f)
Nozzle diameter greater than 6 mm (Clause 6.2.4)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 8.4)
Leak rate is within 2% of sample rate (Clause 8.4)

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SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	07-Jan-10
Sample point	Cremator 1 run 3	Time start	13:41
Test carried out by	S Huntley & T Swannack	Time End	15:21
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	100
		Sampling conditions	crem 1 (c)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	550
Volume of sampling solution in field blank (Vsb)	ml	150
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	10.30
Chloride in field blank sampling solution (ocb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

C_g (mg/m³) = $[((V_{s1} \times q_{s1})+(V_{s2} \times q_{s2})) \times MW_c] / (V_{m,ref} \times MW_{cl} \times N_c)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Nc is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	35.79
Uncertainty (95% confidence limit)	mg/m³	4.12
Uncertainty as a proportion of ELV	%	2.06
Discharge rate (D_g)	kg/h	0.024
Uncertainty (95% confidence limit)	kg/h	0.004
Detection limit	mg/m³	0.328

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	%	0.0

*assuming same sample volume as for sample

Determination		HCl
Chloride in first stage absorber (m1)	mg	7.41
Chloride in final stage absorber (m2)	mg	0.00
Absorption efficiency	%	n.d.

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_a)	%	5.0
Total for uncorrected measurement (U_c)	mg/m³	2.10
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95})	mg/m³	4.115

Based on Procedure 55 and Uncertainty Policies 11 & 16
(In accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-6.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Absorption efficiency not determined
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London	Date	7-Jan-10
Site	Crematorium	Test Ref	crem 1 (c)
Sample point	Cremator 1, run 3	Time Start	13:43
Test carried out by	S Huntley & T Swannack	Time End	15:23

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , dry			$mgCO/m^3$, ref. cond.		
13:43	13:48	20	<5	<5	<5	9	<5	<5
13:48	13:53	20	<5	<5	<5	5	<5	<5
13:53	13:58	20	<5	<5	<5	5	<5	<5
13:58	14:03	20	<5	<5	<5	6	<5	<5
14:03	14:08	20	<5	<5	<5	6	<5	<5
14:08	14:13	20	<5	<5	<5	6	<5	<5
14:13	14:18	20	<5	<5	<5	6	<5	<5
14:18	14:23	20	<5	<5	<5	8	<5	5
14:23	14:28	20	<5	<5	<5	9	<5	6
14:28	14:33	20	<5	<5	<5	18	<5	9
14:33	14:38	20	<5	<5	<5	9	<5	6
14:38	14:43	20	<5	<5	<5	7	<5	5
14:43	14:48	20	5	<5	<5	28	<5	14
14:48	14:53	20	205	<5	37	597	<5	112
14:53	14:58	20	256	7	62	744	43	232
14:58	15:03	20	7	<5	5	41	25	33
15:03	15:08	20	<5	<5	<5	26	18	21
15:08	15:13	20	115	<5	12	387	<5	47
15:13	15:18	20	227	<5	102	769	30	354
15:18	15:23	20	<5	<5	<5	39	9	20
13:43	15:23	400	256	<5	12	769	<5	44

Summary of measurements

Average concentration	44 $mgCO/m^3$
Uncertainty	6 $mgCO/m^3$
Discharge rate	0.030 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

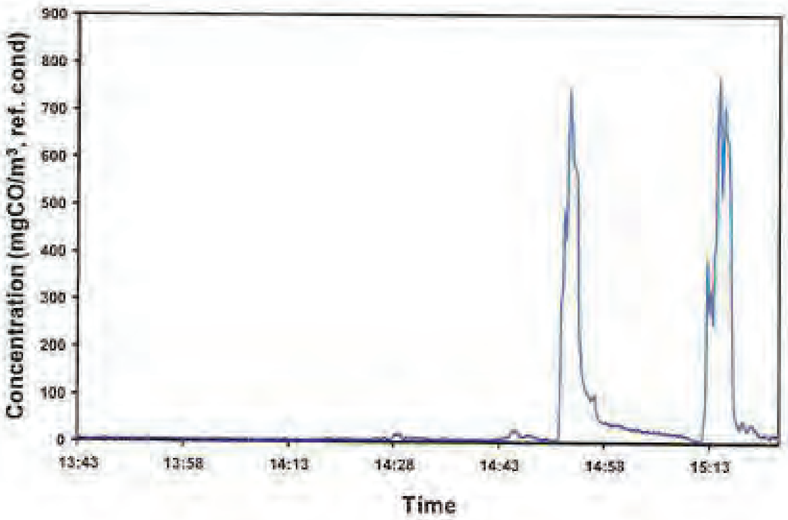
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.14
Gas into system before sampling	ppm	-0.20	25.12
Gas into system after sampling	ppm	-0.30	25.30
Drift	% span	0.40	0.72
Response time	s	26	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)		x_{max}^2
						ppm CO	mgCO/m³	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,f})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{press})$	0	kPa	0.00	% range/2kPa	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.50	% range/10K	0.01	0.02	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{r,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$/ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 1, run 3



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London		Date	7-Jan-10
Site	Crematorium		Test Ref	crem 1 (c)
Sample point	Cremator 1, run 3		Time Start	13:41
Test carried out by	S Huntley & T Swannack		Time End	15:21

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm, wet			mgCarbon/m3, ref cond.		
13:41	13:46	10	<1	<1	<1	1.9	1.7	1.8
13:46	13:51	10	<1	<1	<1	1.8	1.6	1.7
13:51	13:56	10	<1	<1	<1	1.7	1.4	1.6
13:56	14:01	10	<1	<1	<1	1.4	1.3	1.3
14:01	14:06	10	<1	<1	<1	1.4	1.2	1.3
14:06	14:11	10	<1	<1	<1	1.3	1.2	1.2
14:11	14:16	10	<1	<1	<1	1.4	1.2	1.2
14:16	14:21	10	<1	<1	<1	1.2	1.1	1.1
14:21	14:26	10	<1	<1	<1	1.3	1.2	1.2
14:26	14:31	10	<1	<1	<1	1.3	1.0	1.2
14:31	14:36	10	<1	<1	<1	1.3	1.1	1.1
14:36	14:41	10	<1	<1	<1	1.3	1.0	1.1
14:41	14:46	10	<1	<1	<1	1.2	<1	1.0
14:46	14:51	10	<1	<1	<1	1.3	<1	1.1
14:51	14:56	10	10.3	<1	3.8	67.9	<1	25.2
14:56	15:01	10	9.9	<1	1.9	64.8	2.9	12.6
15:01	15:06	10	<1	<1	<1	2.8	1.8	2.3
15:06	15:11	10	<1	<1	<1	1.9	1.5	1.7
15:11	15:16	10	1.1	<1	<1	7.4	<1	2.2
15:16	15:21	10	4.0	<1	1.1	26.2	1.5	7.4
13:41	15:21	200	10	<1	<1	68	<1	3

Summary of measurements

Average concentration	3.5 mgCarbon/m3
Uncertainty	3.5 mgCarbon/m3
Discharge rate	0.002 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

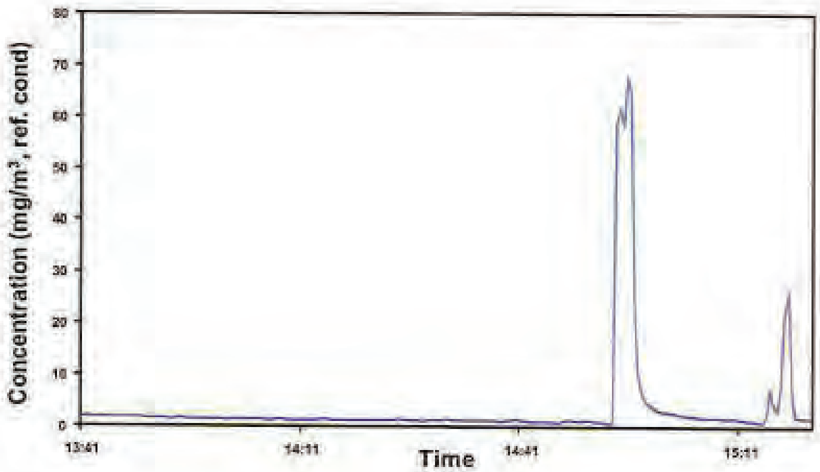
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1368		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH4	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.34	8.95
Gas into system before sampling	ppm	-0.26	8.92
Gas into system after sampling	ppm	0.03	8.78
Drift	% span	3.25	1.57
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$) ppm	mg/m^3	$x_{i,max}^2$
Lack of fit	u(Corr$_{fit}$)	–		2.00	% range	0.12	0.19	0.03
Zero drift	u(Corr$_{0,dr}$)	–		2.00	% range	0.12	0.19	0.03
Span drift	u(Corr$_{s,dr}$)	–		2.00	% range	0.12	0.19	0.03
Sample volume flow	u(Corr$_{v,f}$)	–		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	u(Corr$_{press}$)	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	u(Corr$_{temp}$)	2	K	2.00	% range/10K	0.01	0.02	0.00
Electric voltage	u(Corr$_{volt}$)	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	u(Corr$_{int}$)	–		3.50	% range	0.20	0.32	0.11
Losses & leakage	u(Corr$_{leak}$)	–		0.00	% range	0.00	0.00	0.00
Repeatability at zero	u(Corr$_{r,zero}$)	–		1.00	% range	0.06	0.09	0.01
Repeatability at span	u(Corr$_{r,span}$)	–		2.00	% range	0.12	0.19	0.03
Converter efficiency	u(Corr$_{conv}$)	–		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr$_{resp}$)	–		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr$_{cal}$)	–		1.00	% value	0.06	0.10	0.01
Combined uncertainty	u(C$_{VOC}$)							0.63
Expanded uncertainty	U(C$_{VOC}$)							1.24
U(C$_{VOC}$):ELV (%)								6.19

Measured concentration of Volatile Organic Compounds at Cremator 1, run 3



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London		Date	7-Jan-10
Site	Crematorium		Test Ref	crem 1 (c)
Sample point	Cremator 1, run 3		Time Start	13:43
Test carried out by	S Huntley & T Swannack		Time End	15:23

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			% dry		
13:43	13:48	20	18.8	18.3	18.4	18.8	18.3	18.4
13:48	13:53	20	18.6	17.7	18.2	18.6	17.7	18.2
13:53	13:58	20	18.0	17.8	17.9	18.0	17.8	17.9
13:58	14:03	20	18.6	17.9	18.1	18.6	17.9	18.1
14:03	14:08	20	18.2	17.9	18.0	18.2	17.9	18.0
14:08	14:13	20	18.6	18.0	18.2	18.6	18.0	18.2
14:13	14:18	20	18.3	18.0	18.1	18.3	18.0	18.1
14:18	14:23	20	18.7	18.0	18.3	18.7	18.0	18.3
14:23	14:28	20	19.2	18.0	18.3	19.2	18.0	18.3
14:28	14:33	20	19.6	18.4	18.8	19.6	18.4	18.8
14:33	14:38	20	18.7	18.6	18.7	18.7	18.6	18.7
14:38	14:43	20	18.8	18.7	18.7	18.8	18.7	18.7
14:43	14:48	20	19.6	18.0	18.5	19.6	18.0	18.5
14:48	14:53	20	18.2	16.6	17.7	18.2	16.6	17.7
14:53	14:58	20	19.2	16.7	18.5	19.2	16.7	18.5
14:58	15:03	20	19.3	18.9	19.0	19.3	18.9	19.0
15:03	15:08	20	19.1	19.0	19.0	19.1	19.0	19.0
15:08	15:13	20	19.0	17.2	18.2	19.0	17.2	18.2
15:13	15:18	20	19.7	17.1	17.9	19.7	17.1	17.9
15:18	15:23	20	19.6	19.2	19.4	19.6	19.2	19.4
13:43	15:23	400	19.7	16.6	18.4	19.7	16.6	18.4

Summary of measurements

Average concentration	18.4 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

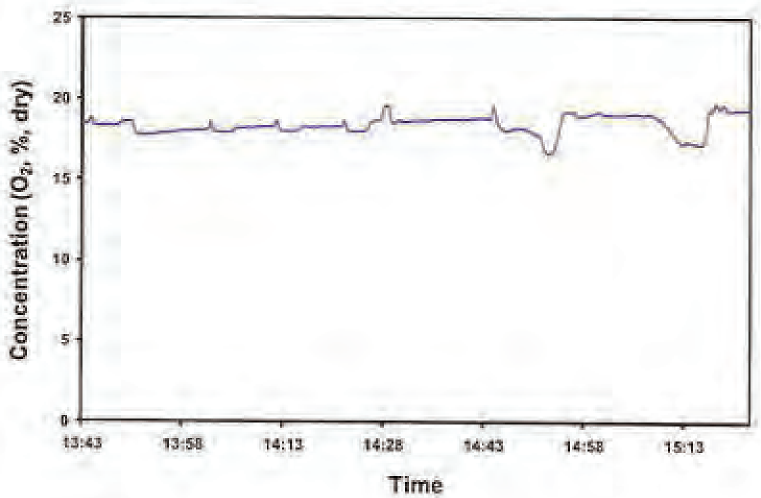
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.05
Gas into system before sampling	%	0.00	13.08
Gas into system after sampling	%	0.10	13.15
Drift	% span	0.76	0.54
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$) %O_2	$x_{i,max}^2$
Lack of fit	$u(Corr_{fit})$	–		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	–		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	–		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{v,sf})$	–		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{press})$	0	kPa	0.00	% range/2kPa	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.40	% range/10K	0.01	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	–		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	–		0.08	% range	0.01	0.00
Repeatability at zero	$u(Corr_{0,rep})$	–		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	–		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	–		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	–		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{cal})$	–		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})/C_{O2}$(%)							3.38

Measured concentration of Oxygen at Cremator 1, run 3



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London
Site	Crematorium
Sample point	Cremator 1, run 3
Test carried out by	S Huntley & T Swannack

Date	7-Jan-10
Test Ref	crem 1 (c)
Time Start	13:43
Time End	15:23

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
13:43	13:48	20	1.4	1.2	1.4	5.6	5.4	5.5
13:48	13:53	20	1.8	1.3	1.5	5.7	5.4	5.5
13:53	13:58	20	1.8	1.6	1.7	5.6	5.5	5.6
13:58	14:03	20	1.6	1.2	1.6	5.5	5.2	5.4
14:03	14:08	20	1.7	1.4	1.6	5.4	5.3	5.4
14:08	14:13	20	1.6	1.2	1.4	5.4	5.1	5.3
14:13	14:18	20	1.6	1.4	1.5	5.4	5.3	5.3
14:18	14:23	20	1.5	1.1	1.4	5.3	5.1	5.3
14:23	14:28	20	1.6	0.8	1.4	5.3	4.7	5.2
14:28	14:33	20	1.3	0.6	1.1	5.3	4.7	5.2
14:33	14:38	20	1.2	1.1	1.1	5.2	5.1	5.1
14:38	14:43	20	1.1	1.1	1.1	5.1	5.0	5.0
14:43	14:48	20	2.5	0.6	1.8	8.4	4.4	7.1
14:48	14:53	20	3.5	2.3	2.8	8.7	8.2	8.4
14:53	14:58	20	3.5	1.2	1.8	8.5	6.9	7.5
14:58	15:03	20	1.4	1.1	1.2	6.9	6.2	6.5
15:03	15:08	20	1.2	1.2	1.2	6.4	6.2	6.3
15:08	15:13	20	2.8	1.2	1.9	7.5	6.3	6.9
15:13	15:18	20	2.9	0.8	2.2	7.8	6.2	7.3
15:18	15:23	20	1.0	0.8	0.9	6.0	5.6	5.8
13:43	15:23	400	3.5	0.6	1.5	8.7	4.4	6.0

Summary of measurements

Average concentration	6.0 $\%CO_2$
Uncertainty	1.2 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

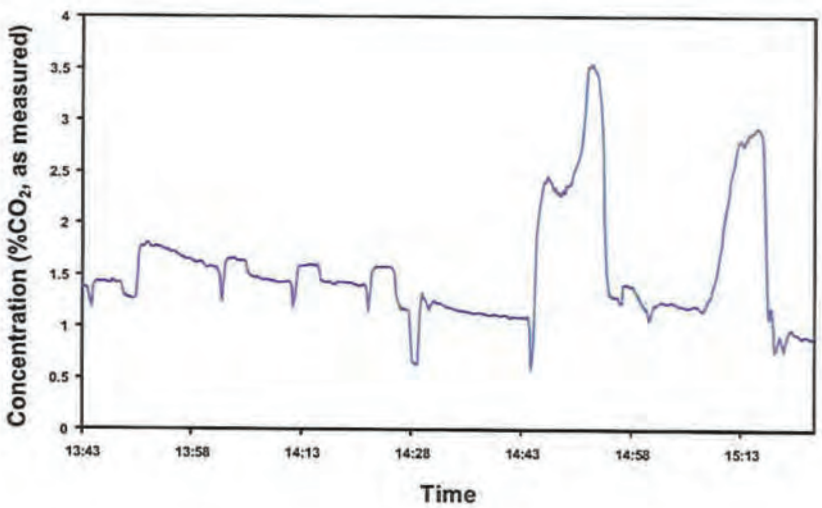
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.05	5.10
Gas into system after sampling	%	0.12	5.20
Drift	% span	1.38	1.96
Response time	s	27	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%CO_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.01
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.02	0.00
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{atmos})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.50	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.09	0.01
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{r,rep})$	-		0.14	% range	0.01	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.05	0.00
Combined uncertainty	$u(C_{CO2})$						0.16
Expanded uncertainty	$U(C_{CO2})$						0.31
$U(C_{CO2})$:C_{CO2}(%)							20.15

Measured concentration of Carbon Dioxide at Cremator 1, run 3



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem I (c)
Site	Crematorium	Date	07-Jan-10
Sample point	Cremator 1 run 3	Time start	13:41
Test carried out by	S Huntley & T Swannack	Time End	15:21
		Duration (min)	100
		Data from	crem 1 (c)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	788.96	800.54	11.58
Container 2	809.47	818.32	8.85
Container 3	617.17	617.38	0.21
Container 4	897.53	899.34	1.81
Total (M)	3113.13	3135.58	22.45

Calculation of dry gas sample volume at STP (SV_{STP})

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.8406

Calculation of water vapour content (H_2O_{duct})

	H_2O_{duct} =	100 x (M x MV_{STP} /MW_{H2O})/[SV_{STP} + (M x MV_{STP} /MW_{H2O})]
where	MV_{STP}	molecular volume at STP (22.412 m^3/kgmole)
	MW_{H2O}	molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	3.22 ± 0.15

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature at outlet is less than 4oC based on calculated dew point (Clause 6.4.2)
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is below 1.25% (Clause 5.8)
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.841 m^3
Average temperature of gas at meter	T	22.1 °C
Average barometric pressure at meter	P	990 mb
Sampling line leakage		0.000175 m^3/min
Duration of sampling	t	100 min
Total mass weighed	M	3135.58 g

Source of uncertainty		Value		Value of standard uncertainty		Relative standard uncertainty (%)	
Measurement of sample gas volume	u_rV_m	2.0 %	u_V	$u_{s,}V_m$ =	0.0097 m^3	$u_{r,}V_m$	1.15
Measurement of sample gas temperature	u_rT_m	1.0 %	u_t	$u_{s,}T_m$ =	1.7036 K	$u_{r,}T_m$	0.58
Measurement of absolute pressure	u_rP_m	1.0 %	u_p	$u_{s,}P_m$ =	5.7158 mb	$u_{r,}P_m$	0.58
Leakage in sampling line	u_rL	2.1 %	u_L	$u_{s,}L$ =	0.0101 m^3	$u_{r,}L$	1.20
Measurement of weight - balance uncertainty	u_rW_m	0.01 %	u_{wm}	$u_{s,}W_m$ =	0.1810 g		-
Measurement of weight - balance repeatability	u_rW_r	0.011 g	u_{wr}	$u_{s,}W_r$ =	0.0110 g		-
Total measurement of weight	u_rW	-	-	$u_{s,}W$ =	0.1920 g	$u_{r,}W$	0.86

Total standard relative uncertainty	$u_r = \sqrt{u_rV_m^2 + u_rT_m^2 + u_rP_m^2 + u_rL^2 + u_rW^2 + Corr_r}$	2.31 %
Total relative uncertainty	$U_r = 1.96u_r$	4.53 %

SCIENTIFICS MONITORING REPORT FORM
PITOT TRAVERSE (BS EN 13284-1)

Company	City of London	Date	12-Jan-10
Site	Crematorium	Test Ref	crem 1 flow
Sample point	Cremator 1	Time Start	x
Test carried out by	S Huntley & T Swannack	Time End	x

SAMPLING PLANE GEOMETRY

Geometry of duct		Rectangular
Dimension traversed by sampling probe (D)	m	0.42
Other dimension (if applicable)	m	0.4200
Cross sectional area of sampling plane (A)	m^2	0.1764

MOLECULAR WEIGHT & DENSITY DETERMINATION

Duct gas conditions

Ambient temperature (T_a)	°C	8.00
Duct static gas pressure	kPa	-0.05
Average duct gas temperature (T_{duct})	°C	75.00
Barometric pressure (P_m)	kPa	98.90

Calculation of molecular weight from assumed gas composition

Gas	Vol% Dry gas	Vol% Wet gas	Dry Mol Wt g/gmole	Wet Mol Wt g/gmole
CO_2	2.00	1.93	0.88	0.85
O_2	18.00	17.37	5.76	5.56
CO	0.00	0.00	0.00	0.00
N_2	80.00	77.20	22.40	21.62
H_2O	———	3.50	———	0.63
		Total	29.04	28.65

Calculation of dry and wet gas density from molecular weight results

Dry density	kg/m^3	1.30	At STP
Wet density	kg/m^3	1.28	(0°C & 101.3 kPa)
Dry density	kg/m^3	0.99	At Duct Conditions
Wet density (ρ_a)	kg/m^3	0.98	(see above)
Wet specific gravity (sg)		0.99	

CALCULATION OF NOZZLE SIZE & K FACTOR

Exhaust & sample gas conditions

Desired sampling rate at orifice (SR_o)	10 l/min	0.353 ft^3/min
Expected meter outlet temperature (T_m)	20 °C	

(guide is a sampling rate of 0.75 ft^3/min or 21.2 l/min at the orifice)

Conditions at nozzle		Conditions at orifice/meter	
Sampling rate (SR_n)	12.31 l/min	Sampling rate (SR_o)	10.00 l/min
Temperature (T_{duct})	75.00 °C	Temperature (T_a)	20.00 °C
Pressure (P_{duct})	98.85 kPa	Pressure (P_m)	98.90 kPa
Water vapour (H_2O_{duct}	3.50 %	Water vapour (H_2O_m)	0 %
Molecular weight (M_{duct})	28.65	Molecular weight (M_m)	29.04

Orifice Parameters

Orifice plate coefficient ($\Delta H_@$)	2.1935 " w.g.

Determination of nozzle diameter

based on isokinetic sampling and the average gas velocity

$D_{nr} = 2000 \times \sqrt{[SR_n / V_{duct} \times \pi \times 60000]}$

where D_{nr} is the recommended nozzle diameter (mm)

Recommended nozzle diameter (D_{nr} = 5.775 mm

Diameter of nozzle selected (D_n) = 6.28 mm

Determination of K Factor

based on preliminary exhaust gas conditions

K Factor is a proportionality factor relating the pressure drop measured with the Pitot tube in the duct (h) with the corresponding pressure drop at the orifice (ΔH), i.e.

$\Delta H = K * h$

$K = 8.038 \times 10^{-5} \times C_p^2 \times \Delta H_@ \times D_n^4 \times (M_m/M_{duct}) \times [(100-H_2O_{duct})/(100-H_2O_m)]^2 . (T_m+273/T_{duct}+273).(P_{duct}/P_m)$

where $\Delta H_@$ is the orifice plate coefficient (mm w.g.)

K Factor = 5.5322

K Factor$_i$ (independent of C_p) = 5.5322

SCIENTIFICS MONITORING REPORT FORM
TRACE HYDROCARBONS TO BS EN 1948:2006 (Filter/Condenser Method)

Company	City of London	Test Ref	Dioxin 1
Site	Crematorium		
Sample point	Cremator 1		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		THC 1
Date		12-Jan-10
Time Start		09:02
Time End		16:09
Duration (t)	min	375

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		THC 1
Ambient temperature (T_{Amb})	°C	8.0
Average duct gas temperature (T_{duct})	°C	55.8
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.90
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.41
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_s)		0.98
Exhaust gas conditions measurements		Dioxin 1

Reference conditions

Determination		THC 1
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	55.8
Total pressure (P_{duct})	kPa	98.85
Oxygen (O_{2duct})	%vol,dry	18.00
Water vapour (H_2O_{duct})	%vol	3.50
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		THC 1
Nozzle diameter (d) TI 24 Titanium	mm	6.280
Initial gas meter reading	m^3	633.514
Final gas meter reading	m^3	640.055
Sampled volume (SV_M)	m^3	6.541

Calculation of sample gas volume at reference conditions, SV_{Ref}

$$SV_{Ref} = SV_{Meter} \times \gamma \times \begin{array}{ll} [273 + T_{Ref}]/[273 + T_{Meter}] & \text{Corrections: Temperature} \\ P_{Baro}/P_{Ref} & \text{Pressure} \\ [100 - H_2O_{Meter}]/[100 - H_2O_{Ref}] & \text{Water vapour} \\ [20.9 - O_{2Duct}]/[20.9 - O_{2Ref}] & \text{Oxygen} \end{array}$$

Determination		THC 1
Sampled volume @ ref. conditions (SV_{Ref})	m^3	1.600

SAMPLING DATA THC 1

Test Ref Dioxin 1

Initial gas meter reading: 633514 l   Start Time: 09:02

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time min	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH_d) ΔH x K_i x Cp²	Orifice ΔH mm w.g. Actual (ΔH_a)	Isokinetic difference (ΔH_a/ΔH_d) %	Temperatures Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Meter (T_m) Outlet °C	Condenser (T_{cond}) °C	Oxygen Content % v/v, dry
0.500	A (1)	09:02	0	633514	7.50	29.28	29	99	75	119	121	19.8		7	
		09:17	15	633722	7.80	30.45	30.5	100	74	122	123	21.0		9	
		09:32	30	633911	8.00	31.23	31.2	100	71	122	124	22.0		12	
		09:47	45	634275	8.20	32.01	32	100	69	123	123	23.0		15	
		10:02	60	634555	8.10	31.62	31.6	100	67	122	123	24.0		18	
		10:17	75	634831	8.00	31.23	31.2	100	66	121	123	24.0		8	
		10:32	90	635121	6.90	26.93	27	100	66	121	122	23.0		11	
	A(2)	0:47/10:5	105	635369	7.00	27.32	27.3	100	63	121	122	23.0		8	
		11:11	120	635628	8.00	31.23	31.2	100	61	120	122	23.0		12	
		11:26	135	635894	7.90	30.84	30.8	100	60	121	124	24.0		16	
		11:41	150	636160	8.10	31.62	31.6	100	59	123	122	24.0		7	
		11:56	165	636433	7.40	28.89	28.9	100	57	122	121	23.0		9	
	A(3)	2:11/12:2	180	636692	6.90	26.93	26.9	100	53	124	124	23.0		7	
		13:09	195	636962	7.10	27.72	27.7	100	52	121	123	23.0		10	
		13:24	210	637227	7.00	27.32	27.3	100	52	122	124	23.0		14	
		13:39	225	637487	7.40	28.89	28.9	100	49	123	123	24.0		16	
		13:54	240	637761	6.80	26.54	26.5	100	48	123	123	24.0		17	
		14:09	255	638024	7.40	28.89	28.9	100	48	122	123	24.0		19	
	A(4)	4:24/14:3	270	638279	8.00	31.23	31.2	100	46	121	122	24.0		8	
		14:45	285	638548	7.20	28.11	28.1	100	45	122	122	24.0		11	
		15:00	300	638818	7.8	30.45	30.5	100	44	123	124	24.0		14	
		15:15	315	639092	7.6	29.67	29.7	100	44	122	124	24.0		15	
		15:30	330	639366	6.7	26.15	26.2	100	42	123	124	24.0		17	
		15:45	345	639632	6.8	26.54	26.5	100	42	123	122	24.0		18	
		16:00	360	639894	6.7	26.15	26.2	100	41	124	124	24.0		19	
		16:09	375	640055											
	Averages								55.8	122.0	122.9	23.3		12.7	n.m

Final gas meter reading: 640055 l   End Time: 16:09

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.926
K factor, (K_i independent of C_p)	5.532
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Condenser thermocouple	P1333
Timer	P1187

Leak check

	Start	End		
Start Time	08:27	16:11		
End Time	08:29	16:13		
Initial meter reading m^3	633.5141	640.0548		
Final meter reading m^3	633.5144	640.0552		
Duration of leak test min	2	2		
Pump vacuum "Hg	-15	-15		
Leak rate l/min	0.15	0.2		
Less than 2% of normal sampling rate?	Yes	Yes		

Approach to isokinetic sampling

Average gas velocity (V_{duct})	18.2 m/s
Nozzle diameter (D_n)	6.288 mm
Sampling time (t)	375 min
Theoretical isokinetic sample volume SV_t	7113.65 l
Actual sample volume (SV_a)	6969.81 l
Approach to isokinetic sampling (AI)	98.0 %

where Vduct is the average duct velocity based on the above measurements

$V_{duct} = C_p \times (1-\epsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1 1983 (ISO 3966), pages 8&9)

SV_t is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_t = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

SV_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measumments at sample points only

Flow rate at duct conditions (Q_{duct})	1.80 m^3/s
Flow rate at STP (Q_{STP})	1.46 m^3/s
Flow rate at reference conditions (Q_{Ref})	0.41 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{Ref} + 273)/(T_{duct} + 273)] \times (P_{baro}/P_{Ref})$

$Q_{Ref} = Q_{STP} \times [(20.9 - O_{2Ref})/(20.9 - O_{2duct})] \times [(100 - H_2O_{duct})/(100 - H_2O_{Ref})]$

MEASUREMENT OF PCDD & PCDF CONCENTRATIONS Test Ref Dioxin 1

Congener (i)	PCDD & PCDF Content (ng)			
	Field Blank 7721956,7721957,7721286		Sample 7721287,7721288,7721289	
	Content	Detection Limit	Content (q_i)	Detection Limit
Dioxin 2,3,7,8 Isomers				
2,3,7,8-TCDD	0.0000	0.0020	0.0000	0.0020
1,2,3,7,8-PeCDD	0.0000	0.0020	0.0030	0.0020
1,2,3,4,7,8-HxCDD	0.0000	0.0200	0.0000	0.0200
1,2,3,6,7,8-HxCDD	0.0000	0.0200	0.0000	0.0200
1,2,3,7,8,9-HxCDD	0.0000	0.0200	0.0000	0.0200
1,2,3,4,6,7,8-HpCDD	0.0000	0.0200	0.0000	0.0200
OCDD	0.0000	0.0200	0.0310	0.0200
Furan 2,3,7,8 Isomers				
2,3,7,8-TCDF	0.0000	0.0020	0.0073	0.0020
1,2,3,7,8-PeCDF	0.0000	0.0020	0.0160	0.0020
2,3,4,7,8-PeCDF	0.0000	0.0020	0.0025	0.0020
1,2,3,4,7,8-HxCDF	0.0000	0.0020	0.0000	0.0020
1,2,3,6,7,8-HxCDF	0.0000	0.0020	0.0000	0.0020
2,3,4,6,7,8-HxCDF	0.0000	0.0020	0.0000	0.0020
1,2,3,7,8,9-HxCDF	0.0000	0.0020	0.0000	0.0020
1,2,3,4,6,7,8-HpCDF	0.0000	0.0020	0.0000	0.0020
1,2,3,4,7,8,9-HpCDF	0.0000	0.0020	0.0000	0.0020
OCDF	0.0000	0.0020	0.0000	0.0020

In the case where congeners are not detected the regulatory authority will normally specify a procec generally assuming non-detects to be present at a proportion of their respective detection limit.
Specify below the proportion of the detection limit to be assumed for non-detects:

Proportion of detection limit to be assumed for non-detects (0-1)	1.0

Emission Limit value (ELV)	ng/m³	0.1

Calculation of total dioxin & furan concentration in duct gas, C_g

$C_g\ (ng/m^3) = \sum q_i \cdot TEF_i / SV_{Ref}$

where TEFi is the toxic equivalent factor for congener i

Calculation of dioxin & furan discharge rate, D_g

$D_g = C_g \cdot Q_{Ref} \cdot 0.0036$

Recovery of Spikes on Sample

Spike Recoveries - Sampling spike (added to adsorbent)

Recovery of $^{13}C_{12}$(%)	Field Blank	Sample	Limit
1,2,3,7,8-PeCDF	75	110	>50
1,2,3,7,8,9-HxCDF	88	87	>50
1,2,3,4,7,8,9-HpCDF	82	87	>50

Spike Recoveries - Spikes added during sample extraction

Recovery of $^{13}C_{12}$ Dioxins (%)	Field Blank	Sample	Limit
2,3,7,8-TCDD	71	76	50 - 130
1,2,3,7,8-PeCDD	70	59	50 - 130
1,2,3,4,7,8-HxCDD	79	56	50 - 130
1,2,3,6,7,8-HxCDD	84	90	50 - 130
1,2,3,4,6,7,8-HpCDD	61	83	40 - 130
OCDD	48	52	40 - 130
$^{13}C_{12}$ Furans			
2,3,7,8-TCDF	70	69	50 - 130
2,3,4,7,8-PeCDF	65	56	50 - 130
1,2,3,4,7,8-HxCDF	83	98	50 - 130
1,2,3,6,7,8-HxCDF	67	99	50 - 130
2,3,4,6,7,8-HxCDF	69	92	50 - 130
1,2,3,4,6,7,8-HpCDF	69	81	40 - 130
OCDF	52	54	40 - 130

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6	2.9 %
Analytical uncertainty at X times LOD (U15)	10 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

SUMMARY OF MEASUREMENT OF PCDDs & PCDFs Test Ref Dioxin 1

Gas concentration ng/m³ at reference conditions	Upper Limit			Lower Limit	Field Blank
NATO/CCMS ITEQ	0.0083	±	0.0083	0.0027	0.0000
WHO 1997 Humans & mammals	0.0088	±	0.0088	0.0031	0.0000
WHO 1997 Fish	0.0117	±	0.0117	0.0034	0.0000
WHO 1997 Birds	0.0128	±	0.0128	0.0090	0.0000

Discharge rate ng/h	Upper Limit			Lower Limit	Field Blank
NATO/CCMS ITEQ	12	±	12	4	0
WHO 1997 Humans & mammals	13	±	13	5	0
WHO 1997 Fish	17	±	17	5	0
WHO 1997 Birds	19	±	19	13	0

Measured congener profile (upper limit values) 5 of 17 toxicologically significant congeners were detected

"*" indicates congener below limit of detection		PCDD & PCDF Content ng	PCDD & PCDF Concentration ng/m³, ref cond. NATO ITEQ	WHO Humans & mammals	WHO Fish	WHO Birds	% of total ITEQ
Dioxin 2,3,7,8 Isomers							
2,3,7,8-TCDD	*	0.0020	0.0012	0.0012	0.0000	0.0000	15.0
1,2,3,7,8-PeCDD		0.0030	0.0009	0.0019	0.0019	0.0019	11.2
1,2,3,4,7,8-HxCDD	*	0.0200	0.0012	0.0012	0.0000	0.0000	15.0
1,2,3,6,7,8-HxCDD	*	0.0200	0.0012	0.0012	0.0000	0.0000	15.0
1,2,3,7,8,9-HxCDD	*	0.0200	0.0012	0.0012	0.0000	0.0000	15.0
1,2,3,4,6,7,8-HpCDD	*	0.0200	0.0001	0.0001	0.0000	0.0000	1.5
OCDD		0.0310	0.0000	0.0000	0.0000	0.0000	0.2
Furan 2,3,7,8 Isomers							
2,3,7,8-TCDF		0.0073	0.0005	0.0005	0.0002	0.0046	5.5
1,2,3,7,8-PeCDF		0.0160	0.0005	0.0003	0.0005	0.0010	6.0
2,3,4,7,8-PeCDF		0.0025	0.0008	0.0005	0.0008	0.0016	9.4
1,2,3,4,7,8-HxCDF	*	0.0020	0.0001	0.0001	0.0000	0.0000	1.5
1,2,3,6,7,8-HxCDF	*	0.0020	0.0001	0.0001	0.0000	0.0000	1.5
2,3,4,6,7,8-HxCDF	*	0.0020	0.0001	0.0001	0.0000	0.0000	1.5
1,2,3,7,8,9-HxCDF	*	0.0020	0.0001	0.0001	0.0000	0.0000	1.5
1,2,3,4,6,7,8-HpCDF	*	0.0020	0.0000	0.0000	0.0000	0.0000	0.1
1,2,3,4,7,8,9-HpCDF	*	0.0020	0.0000	0.0000	0.0000	0.0000	0.1
OCDF	*	0.0020	0.0000	0.0000	0.0000	0.0000	0.0

COMPLIANCE WITH BS EN 1948-1,2,3:2006

Filter temperature was less than 125oC during sampling (Clause 1-5.1.2)
Condenser temperature was below 20oC during sampling (Clause 1-5.1.2)
Nozzle diameter is at least 6 mm (Clause 1-7.2)
Leak rate is less than 2% of sampling rate (MID 1948-1, 7.2)
Sampling rate is within required isokinetic range of 95-115% (Clause 1-7.2)
Sampling spike recoveries on sample are within specification (Clause 1-7.2)
Extraction spike recoveries on sample are within specification (Clause 3-8.3)
Sampling spike recoveries on field blank are within specification (Clause 1-7.2)
Extraction spike recoveries on field blank are within specification (Clause 3-8.3)
Field blank concentration is greater than 10% of the ELV (Clause 1-7.3) - outside standard
Sample concentration is greater than the field blank concentration
The limit of quantification for at least one congener is does not meet specification (Clause 1-7.2) - outside standard

Uncertainty budget

Uncertainties (basis ITEQ group)		
Sample gas volume measurement (m_{vol})	%	2.9
Sample analysis for group total (m_{an})	%	93.5
Total for uncorrected group measurement (Ut,	%	93.6
Correction to reference conditions (m_{corr})	%	0.0
Total for corrected group measurement (Ut,)	%	93.6
Group concentration at 95% confidence interv	%	100.0

Based on Procedure 55 and Uncertainty Policy 8
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))
for each component(i):

scientifics

SCIENTIFICS MONITORING REPORT FORM
PITOT TRAVERSE (BS EN 13284-1)

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 flow
Sample point	Cremator 6	Time Start	08:00
Test carried out by	S Huntley & T Swannack	Time End	08:10

SAMPLING PLANE GEOMETRY

Geometry of duct		Rectangular
Dimension traversed by sampling probe (D)	m	0.42
Other dimension (if applicable)	m	0.4200
Cross sectional area of sampling plane (A)	m^2	0.1764

MOLECULAR WEIGHT & DENSITY DETERMINATION

Duct gas conditions

Ambient temperature (T_a)	°C	9.00
Duct static gas pressure	kPa	-0.05
Average duct gas temperature (T_{duct})	°C	378.50
Barometric pressure (P_m)	kPa	98.60

Calculation of molecular weight from assumed gas composition

Gas	Vol% Dry gas	Vol% Wet gas	Dry Mol Wt g/gmole	Wet Mol Wt g/gmole
CO_2	2.70	2.60	1.19	1.15
O_2	17.10	16.48	5.47	5.28
CO	0.00	0.00	0.00	0.00
N_2	80.20	77.31	22.46	21.65
H_2O	--------	3.60	--------	0.65
		Total	29.12	28.72

Calculation of dry and wet gas density from molecular weight results

Dry density	kg/m^3	1.30	At STP
Wet density	kg/m^3	1.28	(0°C & 101.3 kPa)
Dry density	kg/m^3	0.53	At Duct Conditions
Wet density (ρ_a)	kg/m^3	0.52	(see above)
Wet specific gravity (sg)		0.99	

CALCULATION OF NOZZLE SIZE & K FACTOR

Exhaust & sample gas conditions

Desired sampling rate at orifice (SR_o)	10 l/min	0.353 ft^3/min
Expected meter outlet temperature (T_m)	20 °C	

(guide is a sampling rate of 0.75 ft^3/min or 21.2 l/min at the orifice)

Conditions at nozzle		Conditions at orifice/meter	
Sampling rate (SR_n)	23.08 l/min	Sampling rate (SR_o)	10.00 l/min
Temperature (T_{duct})	378.50 °C	Temperature (T_o)	20.00 °C
Pressure (P_{duct})	98.55 kPa	Pressure (P_m)	98.60 kPa
Water vapour (H_2O_{duct}	3.60 %	Water vapour (H_2O_m)	0 %
Molecular weight (M_{duct})	28.72	Molecular weight (M_m)	29.12

Orifice Parameters

Orifice plate coefficient ($\Delta H_@$)	2.1935 " w.g.

Determination of nozzle diameter

based on isokinetic sampling and the average gas velocity

$D_{nr} = 2000 \times \sqrt{[SR_n / V_{duct} \times \pi \times 60000]}$

where D_{nr} is the recommended nozzle diameter (mm)

Recommended nozzle diameter (D_{nr} = 6.758 mm

Diameter of nozzle selected (D_n) = 6.28 mm

Determination of K Factor

based on preliminary exhaust gas conditions

K Factor is a proportionality factor relating the pressure drop measured with the Pitot tube in the duct (h) with the corresponding pressure drop at the orifice (ΔH), i.e.

$\Delta H = K * h$

$K = 8.038 \times 10^{-5} \times C_p^2 \times \Delta H_@ \times D_n^4 \times (M_m/M_{duct}) \times [(100-H_2O_{duct})/(100-H_2O_m)]^2 . (T_m+273/T_{duct}+273).(P_{duct}/P_m)$

where $\Delta H_@$ is the orifice plate coefficient (mm w.g.)

K Factor = 2.9502

K Factor$_i$ (independent of C_p) = 2.9502

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 6 (a)
Site	Crematorium		
Sample point	Cremator 6 run 1		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		13-Jan-10
Time Start		09:22
Time End		10:42
Duration (t)	min	80

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	368.2
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.30
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_s)		0.52
Exhaust gas conditions measurements		crem 6 (a)

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	368.2
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	17.00
Water vapour (H_2O_{duct})	%vol	2.18
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		tpm
Nozzle diameter (d) Ti24 Titanium	mm	6.280
Initial gas meter reading	m^3	640.266
Final gas meter reading	m^3	641.136
Sampled volume (SV_M)	m^3	0.870

Calculation of sample gas volume at reference conditions, SV_{Ref}

SV_{Ref} = $SV_{Meter} \times Y \times$

	Corrections
$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
P_{Baro}/P_{Ref}	Pressure
$[100-H_2O_{Meter}]/[100-H_2O_{Ref}]$	Water vapour
$[20.9-O_{2Duct}]/[20.9-O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.288

SAMPLING DATA tpm

Test Ref crem 6 (a)

Initial gas meter reading 640266 l   Start Time 09:22

Distance from Duct Wall Fraction of D	Port	Time of Day h.mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH$_r$) = h x K$_i$ x Cp^2	Actual (ΔH$_a$)	Isokinetic difference (ΔH$_a$/ΔH$_r$) %	Temperatures Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Outlet °C	Impinger (T_{imp}) °C	Oxygen Content %, v/v, dry
0.500	A	09:22	0	640266	5	10.41	10.4	100	367	156	157	19.0		8	
		09:27	5	640322	3.6	7.49	7.5	100	363	158	158	19.0		7	
		09:32	10	640381	5.8	12.07	12.1	100	382	160	160	20.0		8	
		09:37	15	640443	8.7	18.11	18.1	100	397	160	160	20.0		9	
		09:42	20	640516	8.8	18.32	18.4	100	398	160	160	20.0		11	
		09:47	25	640593	8.2	17.07	17.1	100	399	160	160	20.0		11	
		09:52	30	640667	8.5	17.69	17.7	100	393	160	160	21.0		12	
		09:57	35	640741	6.2	12.91	12.9	100	361	160	160	21.0		12	
		10:02	40	640802	3.9	8.12	8.1	100	369	160	160	21.0		14	
		10:07	45	640853	3.1	6.45	6.5	101	360	160	160	21.0		15	
		10:12	50	640898	2.7	5.62	5.6	100	349	160	160	21.0		17	
		10:17	55	640941	1.8	3.75	3.8	101	333	160	160	21.0		19	
		10:22	60	640979	4	8.33	8.3	100	336	160	160	21.0		8	
		10:27	65	641030	2.1	4.37	4.4	101	351	160	160	21.0		9	
		10:32	70	641070	2	4.16	4.2	101	356	160	160	21.0		10	
		10:37	75	641106	2	4.16	4.2	101	357	160	160	21.0		11	
		10:42	80	641136											
	Averages								368.2	159.6	159.7	20.5		11.3	n.m

Final gas meter reading 641136 l   End Time 10:42

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.926
K factor, (K$_i$ independent of C$_p$)	2.958
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C$_p$)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1011
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Approach to isokinetic sampling

Average gas velocity (V_{duct})	10.6 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	80 min
Theoretical isokinetic sample volume SV_i	1604.89 l
Actual sample volume (SV_a)	1800.23 l
Approach to isokinetic sampling (AI)	112.2 %

where Vduct is the average duct velocity based on the above measurements
$V_{duct} = C_p \times (1-\epsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)
SV_i is the theoretical isokinetic sample volume based on V_{duct} & D_n
$SV_i = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$
SV_a is the sample volume at duct conditions
$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{baro}/P_{duct}) \times (100 - H_2O_m)/(100-H_2O_{duct})$

Leak check

		Start	End
Start Time		08:43	10:36
End Time		08:45	10:38
Initial meter reading	m^3	640.2658	641.1362
Final meter reading	m^3	640.266	641.1364
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.1	0.1
Less than 2% of normal sampling rate?		Yes	Yes

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.30 m^3/s
Flow rate at STP (Q_{STP})	0.79 m^3/s
Flow rate at reference conditions (Q_{ref})	0.38 m^3/s

where

$Q_{duct} = V_{duct} \times A$
$Q_{STP} = Q_{duct} \times [(T_{ref} + 273)/(T_{duct} + 273)] \times (P_{duct}/P_{ref})$
$Q_{ref} = Q_{STP} \times [(20.9-O_{2,ref})/(20.9-O_{2,duct})] \times [(100-H_2O_{duct})/(100-H_2O_{ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 6 (a)

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012467	012450
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.8014	0.8196
after 2 min	g		0.8014	0.8196
after 3 min	g		0.8014	0.8196
Weight extrapolated to zero time (M_{fi0})	g		0.8014	0.8196
Post-sampling weights				
after 1 min	g		0.8005	0.8359
after 2 min	g		0.8005	0.8359
after 3 min	g		0.8006	0.8358
Weight extrapolated to zero time (M_{ff0})	g		0.8004	0.8360

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		68.6805	72.0110
after 2 min	g		68.6805	72.0109
after 3 min	g		68.6805	72.0109
Weight extrapolated to zero time (M_{ri0})	g		68.6805	72.0110
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		68.6820	72.0145
after 2 min	g		68.6819	72.0143
after 3 min	g		68.6818	72.0142
Weight extrapolated to zero time (M_{rf0})	g		68.6821	72.0146

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0010	0.0164
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	0.0016	0.0036
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0006	0.0200

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS Test Ref crem 6 (a)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = M x 1000/ SV_{Ref}

Discharge rate, kg/h = C x Q_{Ref} x 0.0036

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m^3	2.20	69.38
Uncertainty	mg/m^3	2.20	11.41
Particulate concentration at duct conditions (raw)	mg/m^3	0.35	11.09
Particulate discharge rate	kg/h	0.00	0.08
Uncertainty	kg/h	0.00	0.01

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.02	0.58
Filter weighings (m_f)	mg	-0.97	0.57
Rinsings weighings (m_w)	mg	1.33	1.46
Total for uncorrected measurement (U_u)	mg	1.65	1.67
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	1.65	1.67
Concentration at 95% confidence interval (U_{95c})	mg/m^3	2.20	11.41

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is greater than limit of 2 mg/m3 - outside standard (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	13-Jan-10
Sample point	Cremator 6 run 1	Time start	09:22
Test carried out by	S Huntley & T Swannack	Time End	10:42
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	80
		Sampling conditions	crem 6 (a)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	560
Volume of sampling solution in final stage (Vs2)	ml	0
Volume of sampling solution in field blank (Vsb)	ml	400
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	4.75
Chloride in final stage sampling solution (qs2)	mg/l	
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\ (mg/m^3) = (([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c).(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	9.50
Uncertainty (95% confidence limit)	mg/m³	1.09
Uncertainty as a proportion of ELV	%	0.55
Discharge rate (D_g)	kg/h	0.010
Uncertainty (95% confidence limit)	kg/h	0.002
Detection limit	mg/m³	0.200

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

ABSORPTION EFFICIENCY (where determined)

Calculation of Absorption Efficicency, e

$e = m_s \times 100 / (m_{s1} + m_{s2})$

Determination		HCl
Chloride in first stage absorber (m1)	mg	2.66
Chloride in final stage absorber (m2)	mg	0.00
Absorption efficiency	%	n.d.

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_c)	mg/m³	0.56
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval ($U_{95\%}$)	mg/m³	1.093

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling outside 10% of isokinetic conditions - outside standard (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (a)
Sample point	Cremator 6, run 1	Time Start	09:30
Test carried out by	S Huntley, T Swannack	Time End	10:49

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm, dry			mgCO/m³, ref. cond.		
09:30	09:34	20	29	<5	9	65	9	25
09:35	09:39	20	15	6	9	36	14	20
09:40	09:44	20	8	6	7	17	14	16
09:45	09:49	20	7	6	7	18	15	16
09:50	09:54	20	7	<5	6	18	11	14
09:55	09:59	20	6	<5	5	17	13	15
10:00	10:04	20	9	<5	6	25	14	16
10:05	10:09	20	6	<5	5	17	13	15
10:10	10:14	20	6	<5	5	21	15	17
10:15	10:19	20	5	<5	<5	22	16	19
10:20	10:24	20	11	<5	7	48	20	36
10:25	10:29	20	10	<5	6	38	17	25
10:30	10:34	20	6	<5	<5	20	15	17
10:35	10:39	20	5	<5	<5	25	14	18
10:40	10:44	20	5	<5	<5	27	15	18
10:45	10:49	20	<5	<5	<5	32	18	23
09:30	10:49	320	29	<5	6	65	9	19

Summary of measurements

Average concentration	19.4 mgCO/m³
Uncertainty	5.5 mgCO/m³
Discharge rate	0.021 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

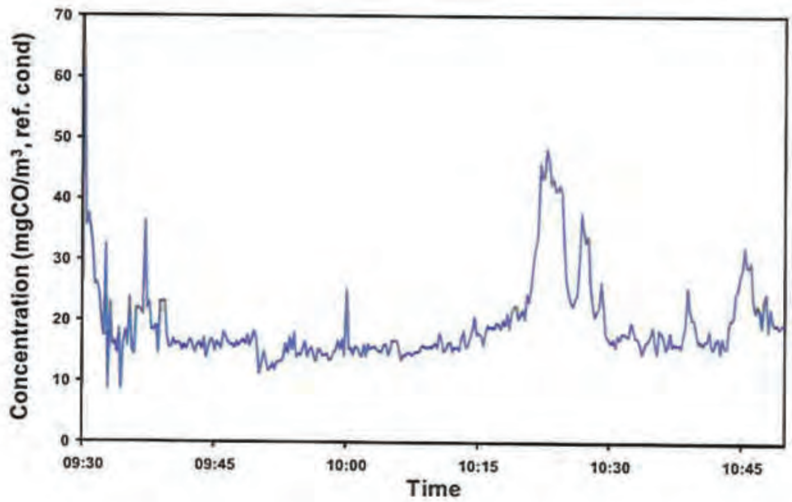
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.20
Gas into system before sampling	ppm	0.40	25.30
Gas into system after sampling	ppm	0.30	25.50
Drift	% span	0.40	0.79
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)		$x_{i,max}^2$
						ppm CO	mgCO/m³	
Lack of fit	$u(Corr_{lof})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{atmos})$	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.50	% range/10K	0.01	0.01	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 6, run 1



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London		Date	13-Jan-10
Site	Crematorium		Test Ref	crem 6 (a)
Sample point	Cremator 6, run 1		Time Start	09:24
Test carried out by	S Huntley, T Swannack		Time End	10:48

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , wet			mgCarbon/m3, ref cond.		
09:24	09:28	5	<1	<1	<1	2.5	2.1	2.3
09:29	09:33	5	7.8	<1	1.9	32.5	1.5	8.0
09:34	09:38	5	<1	<1	<1	4.0	2.3	2.9
09:39	09:43	5	1.0	<1	<1	4.2	3.1	3.7
09:44	09:48	5	<1	<1	<1	2.9	2.5	2.8
09:49	09:53	5	<1	<1	<1	2.3	1.3	1.7
09:54	09:58	5	<1	<1	<1	1.0	<1	<1
09:59	10:03	5	<1	<1	<1	<1	<1	<1
10:04	10:08	5	<1	<1	<1	<1	<1	<1
10:09	10:13	5	<1	<1	<1	<1	<1	<1
10:14	10:18	5	<1	<1	<1	<1	<1	<1
10:19	10:23	5	<1	<1	<1	<1	<1	<1
10:24	10:28	5	<1	<1	<1	<1	<1	<1
10:29	10:33	5	<1	<1	<1	<1	<1	<1
10:34	10:38	5	<1	<1	<1	<1	<1	<1
10:39	10:43	5	<1	<1	<1	<1	<1	<1
10:44	10:48	5	<1	<1	<1	2.7	<1	1.1
09:24	10:48	85	7.8	<1	<1	32.5	<1	1.4

Summary of measurements

Average concentration	1.4 mgCarbon/m3
Uncertainty	1.4 mgCarbon/m3
Discharge rate	0.002 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

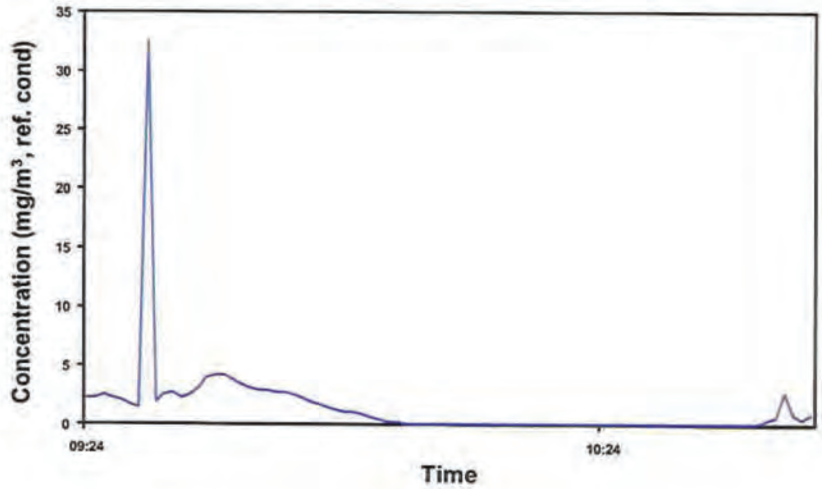
Type Bernath 3006 **Range** 0 to 10 ppm
Equipment No. P1366
Measurement method Flame ionisation detection

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	0.02	8.90
Gas into system before sampling	ppm	0.04	8.90
Gas into system after sampling	ppm	-0.04	8.80
Drift	% span	0.90	1.12
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax}) ppm	Partial uncertainty (x_{imax}) mg/m³	x_{imax}^2
Lack of fit	u(Corr$_{fit}$)	-		2.00	% range	0.12	0.19	0.03
Zero drift	u(Corr$_{0,dr}$)	-		2.00	% range	0.12	0.19	0.03
Span drift	u(Corr$_{s,dr}$)	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	u(Corr$_{s,v}$)	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	u(Corr$_{adpress}$)	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	u(Corr$_{temp}$)	1	K	2.00	% range/10K	0.01	0.01	0.00
Electric voltage	u(Corr$_{volt}$)	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	u(Corr$_{int}$)	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	u(Corr$_{leak}$)	-		0.20	% range	0.01	0.02	0.00
Repeatability at zero	u(Corr$_{z,rep}$)	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	u(Corr$_{s,rep}$)	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	u(Corr$_{conv}$)	-		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr$_{resp}$)	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr$_{adj}$)	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	u(C_{VOC})							0.63
Expanded uncertainty	U(C_{VOC})							1.24
U(C_{VOC}):ELV (%)								6.19

Measured concentration of Volatile Organic Compounds at Cremator 6, run 1



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (a)
Sample point	Cremator 6, run 1	Time Start	09:30
Test carried out by	S Huntley, T Swannack	Time End	10:49

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum (%, dry)	Minimum (%, dry)	Average (%, dry)	Maximum (% dry)	Minimum (% dry)	Average (% dry)
09:30	09:34	20	16.8	15.3	16.1	16.8	15.3	16.1
09:35	09:39	20	15.8	15.2	15.5	15.8	15.2	15.5
09:40	09:44	20	15.7	15.3	15.4	15.7	15.3	15.4
09:45	09:49	20	16.5	15.5	16.0	16.5	15.5	16.0
09:50	09:54	20	16.3	15.4	15.9	16.3	15.4	15.9
09:55	09:59	20	16.6	16.1	16.3	16.6	16.1	16.3
10:00	10:04	20	16.7	16.2	16.5	16.7	16.2	16.5
10:05	10:09	20	17.0	16.2	16.7	17.0	16.2	16.7
10:10	10:14	20	17.4	16.6	17.0	17.4	16.6	17.0
10:15	10:19	20	18.4	17.4	17.9	18.4	17.4	17.9
10:20	10:24	20	18.8	18.1	18.5	18.8	18.1	18.5
10:25	10:29	20	18.4	17.0	17.8	18.4	17.0	17.8
10:30	10:34	20	17.5	17.2	17.4	17.5	17.2	17.4
10:35	10:39	20	19.0	17.5	17.8	19.0	17.5	17.8
10:40	10:44	20	19.3	17.6	17.9	19.3	17.6	17.9
10:45	10:49	20	19.7	18.3	18.8	19.7	18.3	18.8
09:30	10:49	320	19.7	15.2	17.0	19.7	15.2	17.0

Summary of measurements

Average concentration	17.0 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

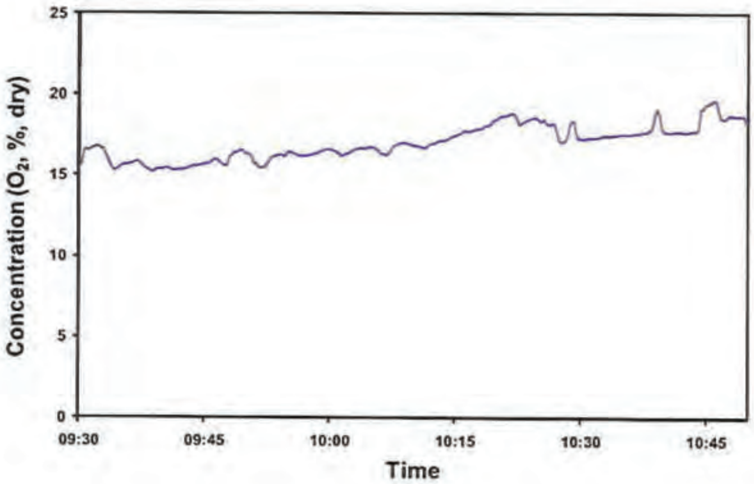
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.15
Gas into system after sampling	%	0.10	13.18
Drift	% span	0.76	0.23
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)	$x_{i,max}^2$
						$\%O_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	-		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{s,d})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{adpress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.40	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})$:C_{O2}(%)							3.66

Measured concentration of Oxygen at Cremator 6, run 1



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (a)
Sample point	Cremator 6, run 1	Time Start	09:30
Test carried out by	S Huntley, T Swannack	Time End	10:49

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum (%, dry)	Minimum (%, dry)	Average (%, dry)	Maximum (%CO_2, ref. cond.)	Minimum (%CO_2, ref. cond.)	Average (%CO_2, ref. cond.)
09:30	09:34	20	4.9	3.6	4.1	9.0	7.8	8.5
09:35	09:39	20	4.4	4.0	4.2	7.9	7.6	7.7
09:40	09:44	20	4.4	4.1	4.3	7.8	7.8	7.8
09:45	09:49	20	4.2	3.4	3.9	7.8	7.4	7.8
09:50	09:54	20	4.2	3.4	3.8	7.8	7.4	7.5
09:55	09:59	20	3.9	3.5	3.8	8.2	8.1	8.1
10:00	10:04	20	3.9	3.5	3.7	8.2	8.2	8.2
10:05	10:09	20	3.9	3.3	3.5	8.3	8.2	8.2
10:10	10:14	20	3.6	2.9	3.3	8.3	8.2	8.3
10:15	10:19	20	2.9	2.1	2.5	8.3	8.2	8.3
10:20	10:24	20	2.2	1.7	1.9	8.3	7.1	7.9
10:25	10:29	20	2.4	1.6	1.9	6.6	6.0	6.3
10:30	10:34	20	2.2	2.0	2.1	6.0	5.8	5.9
10:35	10:39	20	2.0	0.9	1.7	5.8	4.9	5.5
10:40	10:44	20	1.9	0.8	1.7	5.6	4.7	5.4
10:45	10:49	20	1.5	0.6	1.1	5.7	4.5	5.3
09:30	10:49	320	4.9	0.6	3.0	9.0	4.5	7.3

Summary of measurements

Average concentration	7.3 %CO_2
Uncertainty	0.8 %CO_2

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

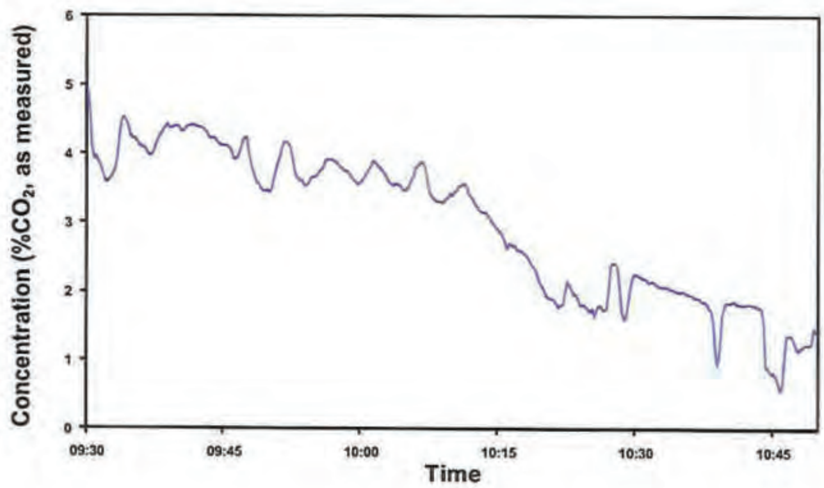
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.08	5.15
Gas into system after sampling	%	0.15	5.19
Drift	% span	1.38	0.78
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)	$x_{i,max}^2$
						$\%CO_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.01
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.02	0.00
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{atmos})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.50	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.09	0.01
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{0,rep})$	-		0.14	% range	0.01	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.05	0.00
Combined uncertainty	$u(C_{CO2})$						0.16
Expanded uncertainty	$U(C_{CO2})$						0.31
$U(C_{CO2})$:C_{CO2}(%)							10.44

Measured concentration of Carbon Dioxide at Cremator 6, run 1



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	h2o 6 (a)
Site	Crematorium	Date	13-Jan-10
Sample point	Cremator 6 run 1	Time start	09:22
Test carried out by	S Huntley & T Swannack	Time End	10:42
		Duration (min)	80
		Data from	crem 6 (a)

Collection of water from gas

Collection Stage (cl)	Initial Mass(Mcl_i) g	Final Mass (Mcl_f) g	Mass gain (Mcl) g
Container 1	766.63	768.78	2.15
Container 2	743.42	744.03	0.61
Container 3	504.66	505.56	0.9
Container 4	908.82	918.19	9.37
Total (M)	2923.53	2936.56	13.03

Calculation of dry gas sample volume at STP (SV_{STP})

$$SV_{STP} = SV_M \times (273/(273 + T_M)) \times (P_M/101.3)$$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.7295

Calculation of water vapour content (H_2O_{duct})

$$H_2O_{duct} = 100 \times (M \times MV_{STP}/MW_{H2O})/(SV_{STP} + (M \times MV_{STP}/MW_{H2O}))$$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)
MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	2.18 ± 0.16

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is above 1.25% (Clause 5.8) - outside standard
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.729 m^3
Average temperature of gas at meter	T	20.5 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		1E-04 m^3/min
Duration of sampling	t	80 min
Total mass weighed	M	2936.56 g

Source of uncertainty		Value		Value of standard uncertainty		Relative standard uncertainty (%)	
Measurement of sample gas volume	u_iV_m	2.0 %	u_v	$u_{vi}V_m$ =	0.0084 m^3	$u_{ri}V_m$	1.15
Measurement of sample gas temperature	u_iT_m	1.0 %	u_t	$u_{ti}T_m$ =	1.6945 K	$u_{ri}T_m$	0.58
Measurement of absolute pressure	u_iP_m	1.0 %	u_p	$u_{pi}P_m$ =	5.6927 mb	$u_{ri}P_m$	0.58
Leakage in sampling line	u_iL	1.1 %	u_l	$u_{li}L$ =	0.0046 m^3	$u_{ri}L$	0.63
Measurement of weight - balance uncertainty	u_iW_m	0.01 %	u_{wm}	$u_{wi}W_m$ =	0.1695 g		-
Measurement of weight - balance repeatability	u_iW_r	0.011 g	u_{wr}	$u_{wi}W_r$ =	0.0110 g		-
Total measurement of weight	u_iW	-	-	$u_{wi}W$ =	0.1805 g	$u_{ri}W$	1.39

Total standard relative uncertainty	$u_c = \sqrt{u_r V_m^2 + u_r T_m^2 + u_r P_m^2 + u_r L^2 + u_r W^2} + Corr_r$	3.65 %
Total relative uncertainty	$U = 1.96u_c$	7.16 %

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 6 (b)
Site	Crematorium		
Sample point	Cremator 6 run 2		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		TPM
Date		13-Jan-10
Time Start		11:12
Time End		12:27
Duration (t)	min	75

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		TPM
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	354.0
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.24
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_A)		0.52
Exhaust gas conditions measurements		crem 6 (b)

Reference conditions

Determination		TPM
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	354.0
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	17.40
Water vapour (H_2O_{duct})	%vol	2.80
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	% vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination				TPM
Nozzle diameter (d)	T124	Titanium	mm	6.280
Initial gas meter reading			m^3	641.151
Final gas meter reading			m^3	641.844
Sampled volume (SV_M)			m^3	0.693

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times \gamma \times$	$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
			$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		TPM
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.205

SAMPLING DATA TPM

Test Ref crem 6 (b)

Initial gas meter reading 641151 l Start Time 11:12

Distance from Duct Wall Fraction of D	Port	Time of Day h.mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH$_d$) h x K x Cp²	Actual (ΔH$_a$)	Isokinetic difference (ΔH$_a$/ΔH$_d$) %	Temperatures Gas (T_{duct}) (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Outlet °C	Impinger (T_{imp}) °C	Oxygen Content % v/v, dry
0.500	A	11:12	0	641151	3.8	7.91	7.9	100	357	157	156	22.0		9	
		11:17	5	641201	4	6.33	6.3	100	359	158	156	22.0		10	
		11:22	10	641251	5.2	10.82	10.8	100	362	160	160	22.0		11	
		11:27	15	641308	7.1	14.78	14.8	100	374	160	160	22.0		12	
		11:32	20	641392	8.5	17.69	17.7	100	377	160	160	22.0		13	
		11:37	25	641444	5.9	12.28	12.3	100	366	160	160	22.0		14	
		11:42	30	641518	3.2	6.66	6.6	99	359	160	160	22.0		15	
		11:47	35	641557	2.5	5.20	5.2	100	352	160	160	22.0		16	
		11:52	40	641600	1.9	3.96	3.9	99	351	160	160	23.0		17	
		11:57	45	641638	1.3	2.71	2.7	100	350	160	160	23.0		17	
		12:02	50	641666	2	4.16	4.2	101	349	160	160	23.0		18	
		12:07	55	641701	1.3	2.71	2.7	100	337	160	160	22.0		19	
		12:12	60	641734	1.9	3.96	4	101	336	160	160	22.0		8	
		12:17	65	641764	1.9	3.96	4	101	332	160	160	22.0		8	
		12:22	70	641807	1.8	3.75	3.7	99	329	160	160	22.0		9	
		12:27	75	641844											
	Averages								354.8	159.7	159.5	22.2		13.1	n/m

Final gas meter reading 641844 l End Time 12:27

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.020
K factor, (K_i independent of C_p)	2.959
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		11:02	12:31
End Time		11:04	12:33
Initial meter reading	m³	641.1507	641.8438
Final meter reading	m³	641.151	641.8441
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.15	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	9.1 m/s
Nozzle diameter (D_n)	6.200 mm
Sampling time (t)	75 min
Theoretical isokinetic sample volume SV_i	1274.42 l
Actual sample volume (SV_a)	1403.11 l
Approach to isokinetic sampling (AI)	110.1 %

where Vduct is the average duct velocity based on the above measurements

$V_{duct} = C_p \times (1-\varepsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV_i is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_i = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

SV_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.61 m³/s
Flow rate at STP (Q_{STP})	0.60 m³/s
Flow rate at reference conditions (Q_{ref})	0.24 m³/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{ref} + 273)/(T_{duct} + 273)] \times (P_{baro}/P_{ref})$

$Q_{ref} = Q_{STP} \times [(20.9 - O_{ref})/(20.9 - O_{2duct})] \times [(100 - H_2O_{duct})/(100 - H_2O_{ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 6 (b)

Filters

Determination		Method Blank	Field Blank	TPM
Filter No.		0	012467	012468
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.8014	0.7979
after 2 min	g		0.8014	0.7979
after 3 min	g		0.8014	0.7980
Weight extrapolated to zero time (M_{fi0})	g		0.8014	0.7978
Post-sampling weights				
after 1 min	g		0.8005	0.8333
after 2 min	g		0.8005	0.8333
after 3 min	g		0.8006	0.8334
Weight extrapolated to zero time (M_{ff0})	g		0.8004	0.8332

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		68.6805	69.0011
after 2 min	g		68.6805	69.0011
after 3 min	g		68.6805	69.0011
Weight extrapolated to zero time (M_{ri0})	g		68.6805	69.0011
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		68.6820	69.0055
after 2 min	g		68.6819	69.0054
after 3 min	g		68.6818	69.0053
Weight extrapolated to zero time (M_{rf0})	g		68.6821	69.0056

Summary

Determination		Method Blank (M_{mb})	Field Blank	TPM
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0010	0.0354
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	0.0016	0.0045
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0006	0.0399

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m^3

SUMMARY OF MEASUREMENTS Test Ref crem 6 (b)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = $M \times 1000/ SV_{Ref}$

Discharge rate, kg/h = $C \times Q_{Ref} \times 0.0036$

Determination		Field Blank	TPM
Particulate concentration at reference conditions	mg/m^3	3.10	195.00
Uncertainty	mg/m^3	3.10	15.31
Particulate concentration at duct conditions (raw)	mg/m^3	0.45	28.44
Particulate discharge rate	kg/h	0.00	0.17
Uncertainty	kg/h	0.00	0.02

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	TPM
Volume measurement (m_{vol})	mg	0.02	1.16
Filter weighings (m_f)	mg	-0.97	0.57
Rinsings weighings (m_w)	mg	1.33	0.94
Total for uncorrected measurement (U_u)	mg	1.65	1.60
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	1.65	1.60
Concentration at 95% confidence interval (U_{95c})	mg/m^3	3.10	15.31

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is greater than limit of 2 mg/m3 - outside standard (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	13-Jan-10
Sample point	Cremator 6 run 2	Time start	11:12
Test carried out by	S Huntley & T Swannack	Time End	12:27
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	75
		Sampling conditions	crem 6 (b)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	590
Volume of sampling solution in final stage (Vs2)	ml	0
Volume of sampling solution in field blank (Vsb)	ml	400
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	19.70
Chloride in final stage sampling solution (qs2)	mg/l	
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\,(mg/m^3) = (([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c)/(V_{sample} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	58.40
Uncertainty (95% confidence limit)	mg/m³	6.71
Uncertainty as a proportion of ELV	%	3.36
Discharge rate (D_g)	kg/h	0.049
Uncertainty (95% confidence limit)	kg/h	0.008
Detection limit	mg/m³	0.296

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

ABSORPTION EFFICIENCY (where determined)

Calculation of Absorption Efficiency, e

$e = m_s \times 100 / (m_{s1} + m_{s2})$

Determination		HCl
Chloride in first stage absorber (m1)	mg	11.62
Chloride in final stage absorber (m2)	mg	0.00
Absorption efficiency	%	n.d.

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_{an})	%	5.0
Total for uncorrected measurement (U_u)	mg/m³	3.43
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m³	6.715

Based on Procedure 55 and Uncertainty Policies 11 & 16
(In accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_{sol}^2 + m_{an}^2} / SV_{ref}$
$U_{95c} = 1.95 \times \sqrt{U_u^2 + m_{corr}^2}$

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling outside 10% of isokinetic conditions - outside standard (Clause 1-5.1.5)
Absorption efficiency not determined
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London
Site	Crematorium
Sample point	Cremator 6, run 2
Test carried out by	S Huntley, T Swannack

Date	13-Jan-10
Test Ref	crem 6 (b)
Time Start	11:14
Time End	12:29

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum (ppm, dry)	Minimum (ppm, dry)	Average (ppm, dry)	Maximum ($mgCO/m^3$, ref. cond.)	Minimum ($mgCO/m^3$, ref. cond.)	Average ($mgCO/m^3$, ref. cond.)
11:14	11:19	20	101	5	12	227	15	33
11:19	11:24	20	42	5	8	97	15	24
11:24	11:29	20	21	6	13	52	14	31
11:29	11:34	20	13	7	9	35	17	23
11:34	11:39	20	8	6	7	23	15	18
11:39	11:44	20	7	6	6	20	15	17
11:44	11:49	20	7	5	6	20	16	18
11:49	11:54	20	6	<5	5	21	16	19
11:54	11:59	20	6	<5	5	26	19	23
11:59	12:04	20	6	<5	<5	27	20	23
12:04	12:09	20	<5	<5	<5	26	15	21
12:09	12:14	20	<5	<5	<5	20	15	17
12:14	12:19	20	6	<5	<5	28	16	21
12:19	12:24	20	<5	<5	<5	23	15	20
12:24	12:29	20	<5	<5	<5	28	19	24
11:14	12:29	300	101	<5	6	227	14	22

Summary of measurements

Average concentration	22.0 $mgCO/m^3$
Uncertainty	5.7 $mgCO/m^3$
Discharge rate	0.019 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

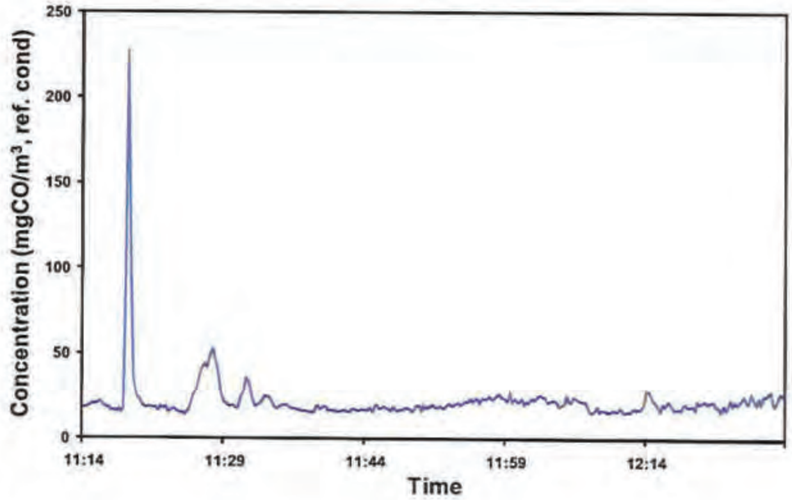
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.20
Gas into system before sampling	ppm	0.40	25.30
Gas into system after sampling	ppm	0.30	25.50
Drift	% span	0.40	0.79
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)		$x_{i,max}^2$
						ppm CO	mgCO/m^3	
Lack of fit	u(Corr$_{fit}$)	-		2.00	% range	0.58	0.72	0.52
Zero drift	u(Corr$_{0,dr}$)	-		0.26	% range	0.08	0.09	0.01
Span drift	u(Corr$_{s,dr}$)	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	u(Corr$_{s,vf}$)	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	u(Corr$_{atmos}$)	0	kPa	0.00	% range/2kPa	0.00	0.00	0.00
Ambient temperature	u(Corr$_{temp}$)	1	K	0.50	% range/10K	0.01	0.01	0.00
Electric voltage	u(Corr$_{volt}$)	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	u(Corr$_{int}$)	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	u(Corr$_{leak}$)	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	u(Corr$_{z,rep}$)	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	u(Corr$_{s,rep}$)	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	u(Corr$_{conv}$)	-		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr$_{resp}$)	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr$_{cal}$)	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	u(C_{CO})							1.06
Expanded uncertainty	U(C_{CO})							2.08
U(C_{CO}):ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 6, run 2



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (b)
Sample point	Cremator 6, run 2	Time Start	11:13
Test carried out by	S Huntley, T Swannack	Time End	12:27

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum (ppm, wet)	Minimum (ppm, wet)	Average (ppm, wet)	Maximum (mgCarbon/m3, ref cond.)	Minimum (mgCarbon/m3, ref cond.)	Average (mgCarbon/m3, ref cond.)
11:13	11:17	5	<1	<1	<1	<1	<1	<1
11:18	11:22	5	2.5	<1	<1	11.5	<1	2.3
11:23	11:27	5	<1	<1	<1	<1	<1	<1
11:28	11:32	5	<1	<1	<1	<1	<1	<1
11:33	11:37	5	<1	<1	<1	<1	<1	<1
11:38	11:42	5	<1	<1	<1	<1	<1	<1
11:43	11:47	5	<1	<1	<1	<1	<1	<1
11:48	11:52	5	<1	<1	<1	<1	<1	<1
11:53	11:57	5	<1	<1	<1	<1	<1	<1
11:58	12:02	5	<1	<1	<1	<1	<1	<1
12:03	12:07	5	<1	<1	<1	<1	<1	<1
12:08	12:12	5	<1	<1	<1	<1	<1	<1
12:13	12:17	5	<1	<1	<1	2.3	<1	<1
12:18	12:22	5	<1	<1	<1	<1	<1	<1
12:23	12:27	5	<1	<1	<1	<1	<1	<1
11:13	12:27	75	2.5	<1	<1	11.5	<1	<1

Summary of measurements

Average concentration	<1 mgCarbon/m3
Uncertainty	1 mgCarbon/m3
Discharge rate	<0.00084708 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

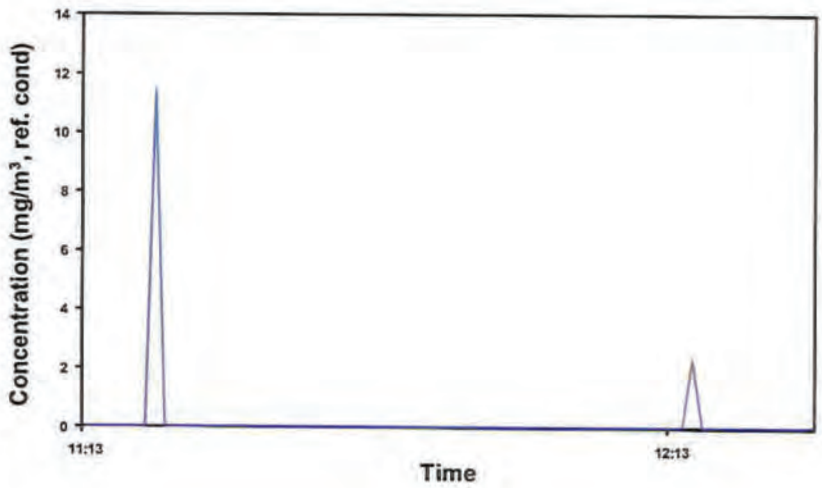
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	0.02	8.90
Gas into system before sampling	ppm	-0.04	8.80
Gas into system after sampling	ppm	0.03	8.85
Drift	% span	0.78	0.57
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$) ppm	Partial uncertainty ($x_{i,max}$) mg/m³	$x_{i,max}^2$
Lack of fit	u(Corr$_{lof}$)	-		2.00	% range	0.12	0.19	0.03
Zero drift	u(Corr$_{0,dr}$)	-		2.00	% range	0.12	0.19	0.03
Span drift	u(Corr$_{s,dr}$)	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	u(Corr$_{s,v}$)	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	u(Corr$_{press}$)	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	u(Corr$_{temp}$)	1	K	2.00	% range/10K	0.01	0.01	0.00
Electric voltage	u(Corr$_{volt}$)	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	u(Corr$_{int}$)	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	u(Corr$_{leak}$)	-		1.20	% range	0.07	0.11	0.01
Repeatability at zero	u(Corr$_{z,rep}$)	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	u(Corr$_{s,rep}$)	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	u(Corr$_{conv}$)	-		100.00	% reading	0.00	0.00	0.00
Response factor	u(Corr$_{resp}$)	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u(Corr$_{cal}$)	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	u(C_{VOC})							0.64
Expanded uncertainty	U(C_{VOC})							1.26
U(C_{VOC}):ELV (%)								6.29

Measured concentration of Volatile Organic Compounds at Cremator 6, run 2



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London		Date	13-Jan-10
Site	Crematorium		Test Ref	crem 6 (b)
Sample point	Cremator 6, run 2		Time Start	11:14
Test carried out by	S Huntley, T Swannack		Time End	12:29

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
				%, dry			% dry	
11:14	11:19	20	17.7	15.4	16.8	17.7	15.4	16.8
11:19	11:24	20	17.3	15.6	16.8	17.3	15.6	16.8
11:24	11:29	20	16.1	15.5	15.8	16.1	15.5	15.8
11:29	11:34	20	16.3	16.0	16.2	16.3	16.0	16.2
11:34	11:39	20	16.6	16.0	16.3	16.6	16.0	16.3
11:39	11:44	20	16.8	16.2	16.5	16.8	16.2	16.5
11:44	11:49	20	17.1	16.6	16.8	17.1	16.6	16.8
11:49	11:54	20	17.7	17.2	17.5	17.7	17.2	17.5
11:54	11:59	20	18.3	17.7	18.0	18.3	17.7	18.0
11:59	12:04	20	18.7	18.1	18.3	18.7	18.1	18.3
12:04	12:09	20	18.7	17.5	18.3	18.7	17.5	18.3
12:09	12:14	20	18.1	17.6	17.8	18.1	17.6	17.8
12:14	12:19	20	18.3	18.1	18.2	18.3	18.1	18.2
12:19	12:24	20	18.8	18.3	18.5	18.8	18.3	18.5
12:24	12:29	20	19.0	18.9	19.0	19.0	18.9	19.0
11:14	12:29	300	19.0	15.4	17.4	19.0	15.4	17.4

Summary of measurements

Average concentration	17.4 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

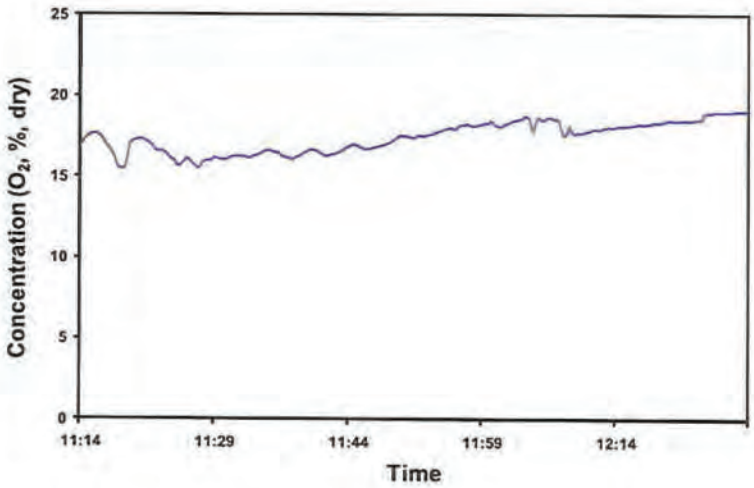
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.15
Gas into system after sampling	%	0.10	13.18
Drift	% span	0.76	0.23
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%O_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	-		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{adpress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.40	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})$:C_{O2}(%)							3.57

Measured concentration of Oxygen at Cremator 6, run 2



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (b)
Sample point	Cremator 6, run 2	Time Start	11:14
Test carried out by	S Huntley, T Swannack	Time End	12:29

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$ ref. cond.		
11:14	11:19	20	5.1	2.9	3.7	9.2	8.9	9.0
11:19	11:24	20	5.0	3.1	3.6	9.3	8.3	8.6
11:24	11:29	20	4.3	3.9	4.1	8.2	7.8	7.9
11:29	11:34	20	3.9	3.7	3.8	7.9	7.9	7.9
11:34	11:39	20	3.9	3.5	3.7	8.0	7.9	8.0
11:39	11:44	20	3.8	3.4	3.6	8.1	8.0	8.1
11:44	11:49	20	3.5	3.1	3.3	8.2	8.1	8.2
11:49	11:54	20	3.0	2.7	2.8	8.2	8.1	8.2
11:54	11:59	20	2.7	2.2	2.4	8.2	8.1	8.2
11:59	12:04	20	2.3	1.7	2.1	8.2	7.7	7.9
12:04	12:09	20	2.2	1.5	1.8	7.8	6.3	6.9
12:09	12:14	20	2.1	1.7	1.9	6.4	5.9	6.1
12:14	12:19	20	1.7	1.4	1.5	5.8	5.5	5.7
12:19	12:24	20	1.4	1.2	1.3	5.9	5.2	5.4
12:24	12:29	20	1.2	1.1	1.1	6.1	5.9	6.0
11:14	12:29	300	5.1	1.1	2.7	9.3	5.2	7.5

Summary of measurements

Average concentration	7.5 $\%CO_2$
Uncertainty	0.9 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

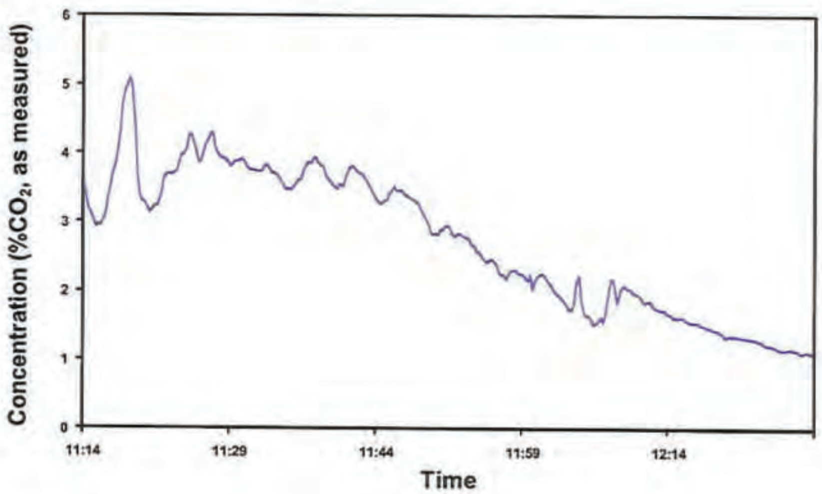
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.08	5.15
Gas into system after sampling	%	0.15	5.19
Drift	% span	1.38	0.78
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						%CO_2	
Lack of fit	$u(Corr_{lof})$	-		2.00	% range	0.12	0.01
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.02	0.00
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.50	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.09	0.01
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{0,rep})$	-		0.14	% range	0.01	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.05	0.00
Combined uncertainty	$u(C_{CO2})$						0.16
Expanded uncertainty	$U(C_{CO2})$						0.31
$U(C_{CO2})$:C_{CO2}(%)							11.41

Measured concentration of Carbon Dioxide at Cremator 6, run 2



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 6 (b) h2o
Site	Crematorium	Date	13-Jan-10
Sample point	Cremator 6 run 2	Time start	11:12
Test carried out by	S Huntley & T Swannack	Time End	12:27
		Duration (min)	75
		Data from	crem 6 (b)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	748.78	756.22	7.44
Container 2	724.03	728.29	4.26
Container 3	505.56	507.17	1.61
Container 4	918.19	918.24	0.05
Total (M)	2896.56	2909.92	13.36

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i)....(Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

$SV_{STP} =$ $SV_M \times (273/(273 + T_M) \times (P_M/101.3)$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.5777

Calculation of water vapour content (H_2O_{duct})

$H_2O_{duct} =$ $100 \times (M \times MV_{STP}/MW_{H2O})/[SV_{STP} + (M \times MV_{STP}/MW_{H2O})]$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)
MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	2.80 ± 0.12

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature at outlet is less than 4oC based on calculated dew point (Clause 6.4.2)
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is below 1.25% (Clause 5.8)
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.578 m^3
Average temperature of gas at meter	T	22.2 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.00015 m^3/min
Duration of sampling	t	75 min
Total mass weighed	M	2909.92 g

Source of uncertainty		Value		Value of standard uncertainty			Relative standard uncertainty (%)	
Measurement of sample gas volume	u_rV_m	2.0 %	u_v	$u_c V_m =$	[illegible]	0.0067 m^3	$u_c V_m$	1.15
Measurement of sample gas temperature	u_rT_m	1.0 %	u_t	$u_c T_m =$	[illegible]	1.7043 K	$u_c T_m$	0.58
Measurement of absolute pressure	u_rP_m	1.0 %	u_p	$u_c P_m =$	[illegible]	5.6927 mb	$u_c P_m$	0.58
Leakage in sampling line	u_rL	1.9 %	u_l	$u_c L =$	[illegible]	0.0065 m^3	$u_c L$	1.12
Measurement of weight - balance uncertainty	u_rW_m	0.01 %	u_{wm}	$u_c W_m =$	[illegible]	0.1680 g		-
Measurement of weight - balance repeatability	u_rW_r	0.011 g	u_{wr}	$u_c W_r =$	[illegible]	0.0110 g		-
Total measurement of weight	u_rW	-	-	$u_c W =$		0.1790 g	$u_c W$	1.34

Total standard relative uncertainty	$u_c = \sqrt{u_c V_m^2 + u_c T_m^2 + u_c P_m^2 + u_c L^2 + u_c W^2} + Corr.$	2.26 %
Total relative uncertainty	$U_c = 1.96 u_c$	4.43 %

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 6 (c)
Site	Crematorium		
Sample point	Cremator 6 run 3		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		13-Jan-10
Time Start		14:18
Time End		15:23
Duration (t)	min	65

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	353.8
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.17
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_e)		0.52
Exhaust gas conditions measurements		crem 6 (c)

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	353.8
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	18.40
Water vapour (H_2O_{duct})	%vol	3.00
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		tpm
Nozzle diameter (d) Ti24 Titanium	mm	6.280
Initial gas meter reading	m^3	642.158
Final gas meter reading	m^3	642.778
Sampled volume (SV_M)	m^3	0.620

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times \gamma \times$	$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
			$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.131

SAMPLING DATA tpm Test Ref crem 6 (c)

Initial gas meter reading 642158 l Start Time 14:18

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH$_d$) =h x K$_s$ x Cp^2	Actual (ΔH$_a$)	Isokinetic difference (ΔH$_a$/ΔH$_d$) %	Temperatures Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Outlet °C	Impinger (T_{imp}) °C	Oxygen Content % v/v, dry
0.500	A	14:18	0	642158	5.5	11.45	11.4	100	364	158	159	23.8		7	
		14:23	5	642216	5.2	10.82	10.8	100	361	159	159	23.8		8	
		14:28	10	642275	4.9	10.20	10.2	100	357	160	160	23.8		9	
		14:33	15	642332	5	10.41	10.4	100	355	160	160	23.8		11	
		14:38	20	642390	7.2	14.99	15	100	362	160	160	23.8		12	
		14:43	25	642458	4.8	9.99	10	100	366	160	160	23.8		14	
		14:48	30	642513	2.4	5.00	5	100	359	160	160	23.8		15	
		14:53	35	642555	2.2	4.58	4.6	100	352	160	160	23.8		16	
		14:58	40	642594	1.8	3.75	3.8	101	351	160	160	23.8		16	
		15:03	45	642630	1.8	3.75	3.8	101	350	160	160	23.8		17	
		15:08	50	642666	2.2	4.58	4.6	100	349	160	160	23.8		18	
		15:13	55	642702	2	4.16	4.2	101	337	160	160	23.8		18	
		15:18	60	642741	2.1	4.37	4.4	101	336	160	160	23.8		19	
		15:23	65	642778											
	Averages								353.8	159.8	159.8	23.8		13.8	n.m

Final gas meter reading 642778 l End Time 15:23

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.926
K factor, (K$_s$ independent of C$_p$)	2.958
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C$_p$)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		14:13	15:25
End Time		14:15	15:27
Initial meter reading	m^3	642.1578	642.7782
Final meter reading	m^3	642.158	642.7785
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.1	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	9.5 m/s
Nozzle diameter (D_n)	6.288 mm
Sampling time (t)	65 min
Theoretical isokinetic sample volume SV_t	1142.67 l
Actual sample volume (SV_a)	1254.85 l
Approach to isokinetic sampling (AI)	109.7 %

where Vduct is the average duct velocity based on the above measurements

$V_{duct} = C_p \times (1-\varepsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_t = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

SV_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{baro}/P_{duct}) \times (100 - H_2O_m)/(100-H_2O_{duct})$

Determination of exhaust gas flow rate
based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.67 m^3/s
Flow rate at STP (Q_{STP})	0.71 m^3/s
Flow rate at reference conditions (Q_{ref})	0.17 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{Ref} + 273)/(T_{duct} + 273)] \times (P_{baro}/P_{Ref})$

$Q_{Ref} = Q_{STP} \times [(20.9-O_{2Ref})/(20.9-O_{2duct})] \times [(100-H_2O_{duct})/(100-H_2O_{Ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 6 (c)

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012467	012466
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.8014	0.8267
after 2 min	g		0.8014	0.8267
after 3 min	g		0.8014	0.8267
Weight extrapolated to zero time (M_{fi0})	g		0.8014	0.8267
Post-sampling weights				
after 1 min	g		0.8005	0.8372
after 2 min	g		0.8005	0.8372
after 3 min	g		0.8006	0.8372
Weight extrapolated to zero time (M_{ff0})	g		0.8004	0.8372

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		68.6805	66.1992
after 2 min	g		68.6805	66.1992
after 3 min	g		68.6805	66.1991
Weight extrapolated to zero time (M_{ri0})	g		68.6805	66.1993
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		68.6820	66.2025
after 2 min	g		68.6819	66.2023
after 3 min	g		68.6818	66.2022
Weight extrapolated to zero time (M_{rf0})	g		68.6821	66.2026

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0010	0.0105
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	0.0016	0.0034
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0006	0.0139

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS Test Ref crem 6 (c)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = M x 1000/ SV_{Ref}

Discharge rate, kg/h = C x Q_{Ref} x 0.0036

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m^3	4.85	106.21
Uncertainty	mg/m^3	4.85	25.39
Particulate concentration at duct conditions (raw)	mg/m^3	0.51	11.06
Particulate discharge rate	kg/h	0.00	0.07
Uncertainty	kg/h	0.00	0.01

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.02	0.40
Filter weighings (m_f)	mg	-0.97	0.57
Rinsings weighings (m_w)	mg	1.33	1.54
Total for uncorrected measurement (U_u)	mg	1.65	1.69
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	1.65	1.69
Concentration at 95% confidence interval (U_{95c})	mg/m^3	4.85	25.39

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is greater than limit of 2 mg/m3 - outside standard (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	13-Jan-10
Sample point	Cremator 6 run 3	Time start	14:18
Test carried out by	S Huntley & T Swannack	Time End	15:23
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	65
		Sampling conditions	crem 6 (c)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	720
Volume of sampling solution in field blank (Vsb)	ml	400
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	6.29
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\ (mg/m^3) = (([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c),(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	35.67
Uncertainty (95% confidence limit)	mg/m³	4.10
Uncertainty as a proportion of ELV	%	2.05
Discharge rate (D_g)	kg/h	0.022
Uncertainty (95% confidence limit)	kg/h	0.004
Detection limit	mg/m³	0.567

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_c)	mg/m³	2.09
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m³	4.101

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (c)
Sample point	Cremator 6, run 3	Time Start	14:24
Test carried out by	S Huntley, T Swannack	Time End	15:24

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum ppm, dry	Minimum ppm, dry	Average ppm, dry	Maximum $mgCO/m^3$, ref. cond.	Minimum $mgCO/m^3$, ref. cond.	Average $mgCO/m^3$, ref. cond.
14:24	14:29	20	6	<5	5	38	17	25
14:29	14:34	20	182	<5	21	637	21	86
14:34	14:39	20	6	<5	5	21	16	18
14:39	14:44	20	6	<5	5	22	16	18
14:44	14:49	20	6	<5	<5	22	18	20
14:49	14:54	20	5	<5	<5	25	18	21
14:54	14:59	20	11	<5	<5	68	21	28
14:59	15:04	20	5	<5	<5	35	22	28
15:04	15:09	20	<5	<5	<5	30	15	22
15:09	15:14	20	<5	<5	<5	24	13	19
15:14	15:19	20	<5	<5	<5	25	15	21
15:19	15:24	20	<5	<5	<5	26	17	20
14:24	15:24	240	182	<5	6	637	13	27

Summary of measurements

Average concentration	27.0 $mgCO/m^3$
Uncertainty	7.9 $mgCO/m^3$
Discharge rate	0.017 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

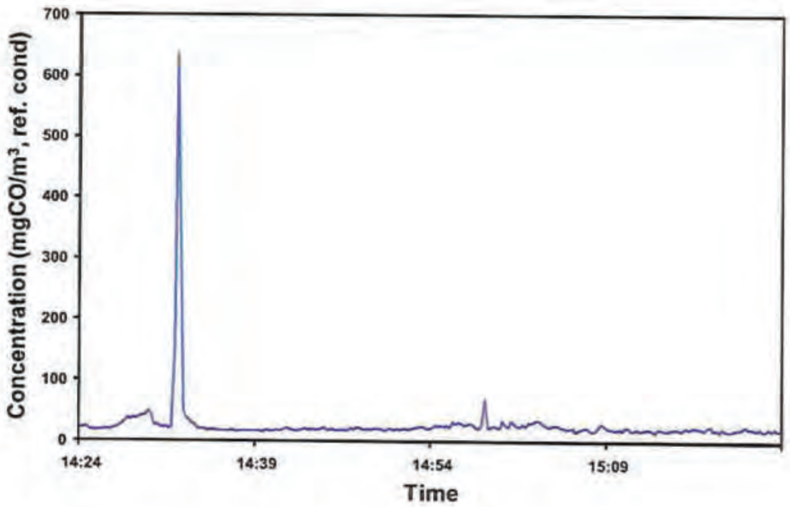
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.20
Gas into system before sampling	ppm	0.40	25.30
Gas into system after sampling	ppm	0.30	25.50
Drift	% span	0.40	0.79
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$) ppm CO	Partial uncertainty ($x_{i,max}$) $mgCO/m^3$	$x_{i,max}^2$
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.50	% range/10K	0.01	0.01	0.00
Electric voltage	$u(Corr_{vol})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 6, run 3



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SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (c)
Sample point	Cremator 6, run 3	Time Start	14:20
Test carried out by	S Huntley, T Swannack	Time End	15:24

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , wet			mgCarbon/m3, ref cond.		
14:20	14:24	5	<1	<1	<1	2.6	<1	<1
14:25	14:29	5	<1	<1	<1	<1	<1	<1
14:30	14:34	5	<1	<1	<1	2.0	<1	<1
14:35	14:39	5	<1	<1	<1	<1	<1	<1
14:40	14:44	5	<1	<1	<1	<1	<1	<1
14:45	14:49	5	<1	<1	<1	<1	<1	<1
14:50	14:54	5	<1	<1	<1	<1	<1	<1
14:55	14:59	5	<1	<1	<1	<1	<1	<1
15:00	15:04	5	<1	<1	<1	<1	<1	<1
15:05	15:09	5	<1	<1	<1	<1	<1	<1
15:10	15:14	5	<1	<1	<1	<1	<1	<1
15:15	15:19	5	<1	<1	<1	<1	<1	<1
15:20	15:24	5	<1	<1	<1	<1	<1	<1
14:20	15:24	65	<1	<1	<1	3	<1	<1

Summary of measurements

Average concentration	<1 mgCarbon/m3
Uncertainty	1 mgCarbon/m3
Discharge rate	<0.00062568 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

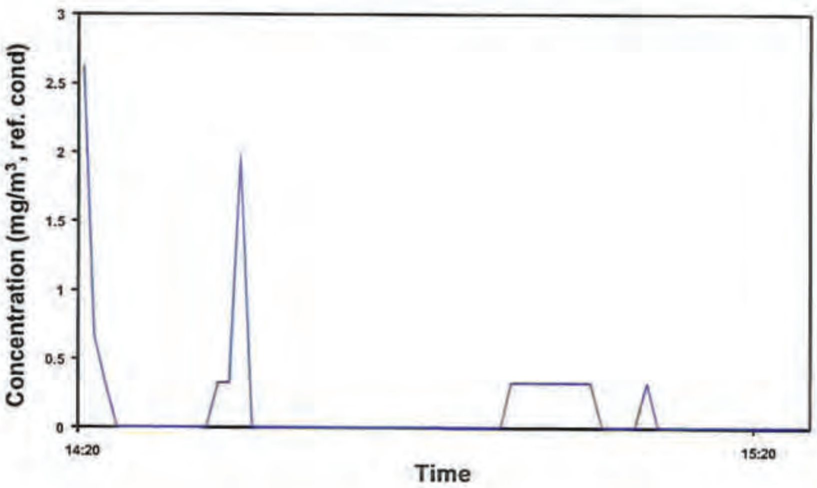
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	0.02	8.90
Gas into system before sampling	ppm	0.03	8.85
Gas into system after sampling	ppm	-0.05	8.93
Drift	% span	0.90	0.90
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax}) ppm	Partial uncertainty (x_{imax}) mg/m^3	x_{imax}^2
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.19	0.03
Zero drift	$u(Corr_{0,dr})$	-		2.00	% range	0.12	0.19	0.03
Span drift	$u(Corr_{s,dr})$	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	$u(Corr_{s,vf})$	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	$u(Corr_{press})$	0	kPa	0.50	% range/2kPa	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	2.00	% range/10K	0.01	0.01	0.00
Electric voltage	$u(Corr_{volt})$	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	$u(Corr_{int})$	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	$u(Corr_{leak})$	-		0.70	% range	0.04	0.06	0.00
Repeatability at zero	$u(Corr_{r,rep})$	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	$u(Corr_{s,rep})$	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	$u(C_{VOC})$							0.64
Expanded uncertainty	$U(C_{VOC})$							1.24
$U(C_{VOC})$:ELV (%)								6.22

Measured concentration of Volatile Organic Compounds at Cremator 6, run 3



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London
Site	Crematorium
Sample point	Cremator 6, run 3
Test carried out by	S Huntley, T Swannack

Date	13-Jan-10
Test Ref	crem 6 (c)
Time Start	14:24
Time End	15:24

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			% dry		
14:24	14:29	20	19.3	16.7	18.1	19.3	16.7	18.1
14:29	14:34	20	19.4	17.2	18.5	19.4	17.2	18.5
14:34	14:39	20	17.9	16.6	17.1	17.9	16.6	17.1
14:39	14:44	20	17.5	17.1	17.3	17.5	17.1	17.3
14:44	14:49	20	17.9	17.6	17.7	17.9	17.6	17.7
14:49	14:54	20	18.5	17.9	18.2	18.5	17.9	18.2
14:54	14:59	20	19.1	18.6	18.9	19.1	18.6	18.9
14:59	15:04	20	19.4	19.0	19.1	19.4	19.0	19.1
15:04	15:09	20	19.4	18.5	18.8	19.4	18.5	18.8
15:09	15:14	20	19.0	18.6	18.7	19.0	18.6	18.7
15:14	15:19	20	19.1	18.8	19.0	19.1	18.8	19.0
15:19	15:24	20	19.1	19.1	19.1	19.1	19.1	19.1
14:24	15:24	240	19.4	16.6	18.4	19.4	16.6	18.4

Summary of measurements

Average concentration	18.4 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

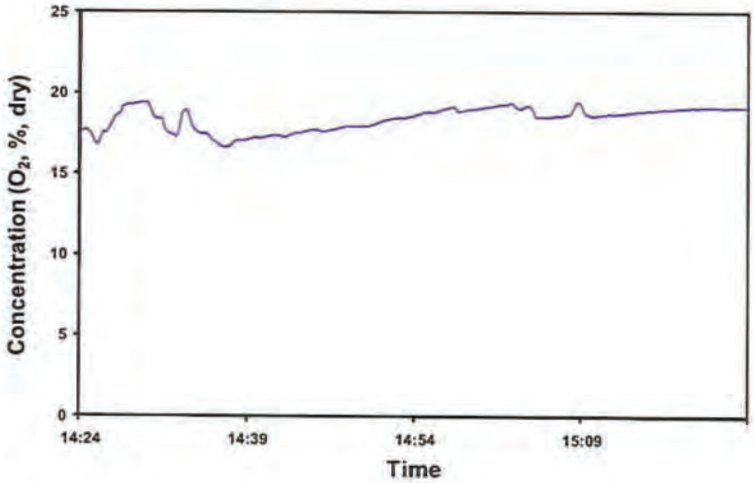
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.15
Gas into system after sampling	%	0.10	13.18
Drift	% span	0.76	0.23
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%O_2$	
Lack of fit	u($Corr_{fit}$)	-		2.00	% range	0.29	0.08
Zero drift	u($Corr_{0,dr}$)	-		0.11	% range	0.02	0.00
Span drift	u($Corr_{s,dr}$)	-		0.24	% range	0.03	0.00
Sample volume flow	u($Corr_{s,v}$)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u($Corr_{adjpress}$)	0	kPa	0.00	% range/2kPa	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	1	K	0.40	% range/10K	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u($Corr_{int}$)	-		0.00	% range	0.00	0.00
Losses & leakage	u($Corr_{leak}$)	-		0.00	% range	0.00	0.00
Repeatability at zero	u($Corr_{0,rep}$)	-		0.00	% range	0.00	0.00
Repeatability at span	u($Corr_{s,rep}$)	-		0.00	% range	0.00	0.00
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00
Calibration gas	u($Corr_{cal}$)	-		1.00	% value	0.13	0.02
Combined uncertainty	u(C_{O2})						0.32
Expanded uncertainty	U(C_{O2})						0.62
U(C_{O2}):C_{O2}(%)							3.38

Measured concentration of Oxygen at Cremator 6, run 3



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	13-Jan-10
Site	Crematorium	Test Ref	crem 6 (c)
Sample point	Cremator 6, run 3	Time Start	14:24
Test carried out by	S Huntley, T Swannack	Time End	15:24

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
14:24	14:29	20	3.6	1.4	2.3	8.5	7.2	8.1
14:29	14:34	20	3.0	1.2	2.0	8.3	7.9	8.1
14:34	14:39	20	3.5	2.5	3.1	8.1	8.0	8.1
14:39	14:44	20	3.1	2.9	3.0	8.4	8.1	8.2
14:44	14:49	20	2.8	2.5	2.7	8.5	8.4	8.4
14:49	14:54	20	2.6	2.0	2.3	8.5	8.3	8.4
14:54	14:59	20	1.9	1.3	1.6	8.3	6.8	7.9
14:59	15:04	20	1.3	1.0	1.1	6.8	6.1	6.5
15:04	15:09	20	1.4	0.8	1.2	6.1	5.5	5.7
15:09	15:14	20	1.3	1.1	1.2	5.6	5.2	5.4
15:14	15:19	20	1.1	0.9	1.0	5.2	4.8	5.0
15:19	15:24	20	0.9	0.8	0.9	4.8	4.7	4.7
14:24	15:24	240	3.6	0.8	1.9	8.5	4.7	7.1

Summary of measurements

Average concentration	7.1 $\%CO_2$
Uncertainty	1.2 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

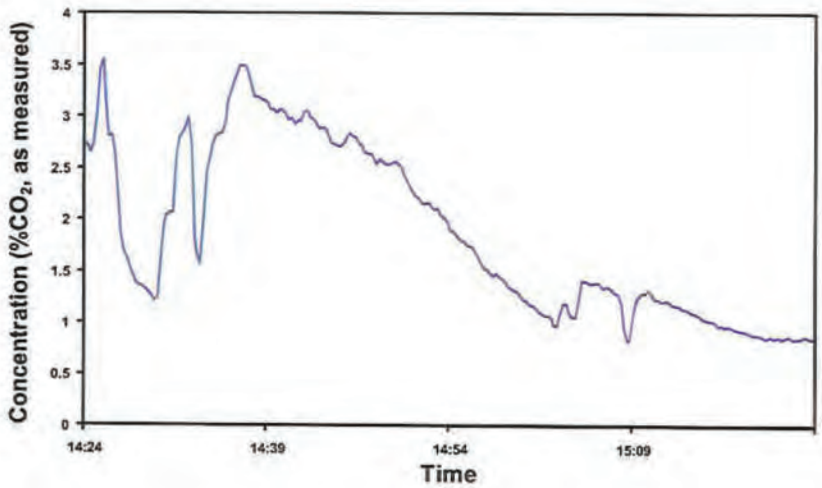
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.08	5.15
Gas into system after sampling	%	0.15	5.19
Drift	% span	1.38	0.78
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%CO_2$	
Lack of fit	u($Corr_{fit}$)	-		2.00	% range	0.12	0.01
Zero drift	u($Corr_{0,dr}$)	-		0.26	% range	0.02	0.00
Span drift	u($Corr_{s,dr}$)	-		0.29	% range	0.02	0.00
Sample volume flow	u($Corr_{s,v}$)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u($Corr_{airpress}$)	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	1	K	0.50	% range/10K	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u($Corr_{int}$)	-		1.60	% range	0.09	0.01
Losses & leakage	u($Corr_{leak}$)	-		0.00	% range	0.00	0.00
Repeatability at zero	u($Corr_{z,rep}$)	-		0.14	% range	0.01	0.00
Repeatability at span	u($Corr_{s,rep}$)	-		0.00	% range	0.00	0.00
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00
Calibration gas	u($Corr_{cal}$)	-		1.00	% value	0.05	0.00
Combined uncertainty	u(C_{CO2})						0.16
Expanded uncertainty	U(C_{CO2})						0.31
U(C_{CO2}):C_{CO2}(%)							16.56

Measured concentration of Carbon Dioxide at Cremator 6, run 3



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SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 6 (c) h2o
Site	Crematorium	Date	13-Jan-10
Sample point	Cremator 6 run 3	Time start	14:18
Test carried out by	S Huntley & T Swannack	Time End	15:23
		Duration (min)	65
		Data from	crem 6 (c)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	776.63	783.56	6.93
Container 2	748.38	752.18	3.8
Container 3	507.44	508.21	0.77
Container 4	918.31	919.53	1.22
Total (M)	2950.76	2963.48	12.72

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i)....(Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

$$SV_{STP} = SV_M \times (273/(273 + T_M) \times (P_M/101.3)$$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.5155

Calculation of water vapour content (H_2O_{duct})

$$H_2O_{duct} = 100 \times (M \times MV_{STP}/MW_{H2O})/[SV_{STP} + (M \times MV_{STP}/MW_{H2O})]$$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)
MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	2.98 ± 0.15

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature at outlet is less than 4oC based on calculated dew point (Clause 6.4.2)
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is below 1.25% (Clause 5.8)
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.515 m^3
Average temperature of gas at meter	T	23.0 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.000125 m^3/min
Duration of sampling	t	65 min
Total mass weighed	M	2963.48 g

Source of uncertainty		Value		Value of standard uncertainty		Relative standard uncertainty (%)	
Measurement of sample gas volume	u_rV_m	2.0 %	u_v	$u_{st}V_m$ =	0.0060 m^3	$u_{st}V_m$	1.15
Measurement of sample gas temperature	u_rT_m	1.0 %	u_t	$u_{st}T_m$ =	1.7090 K	$u_{st}T_m$	0.58
Measurement of absolute pressure	u_rP_m	1.0 %	u_p	$u_{st}P_m$ =	5.6027 mb	$u_{st}P_m$	0.58
Leakage in sampling line	u_rL	1.6 %	u_l	$u_{st}L$ =	0.0047 m^3	$u_{st}L$	0.01
Measurement of weight - balance uncertainty	u_rW_m	0.01 %	u_{wm}	$u_{st}W_m$ =	0.1711 g		-
Measurement of weight - balance repeatability	u_rW_r	0.011 g	u_{wr}	$u_{st}W_r$ =	0.0110 g		-
Total measurement of weight	u_rW	-	-	$u_{st}W$ =	0.1821 g	$u_{st}W$	1.43

Total standard relative uncertainty	$u_c = \sqrt{u_rV_m^2 + u_rT_m^2 + u_rP_m^2 + u_rL^2 + u_rW^2 + Corr_{..}}$	2.50 %
Total relative uncertainty	$U_c = 1.96u_c$	4.90 %

SCIENTIFICS MONITORING REPORT FORM
PITOT TRAVERSE (BS EN 13284-1)

Company	City of London	Date	05-Jan-10
Site	Crematorium	Test Ref	crem 7 flow
Sample point	Cremator 7	Time Start	11:45
Test carried out by	S Huntley & T Swannack	Time End	11:55

SAMPLING PLANE GEOMETRY

Geometry of duct		Rectangular
Dimension traversed by sampling probe (D)	m	0.42
Other dimension (if applicable)	m	0.4200
Cross sectional area of sampling plane (A)	m^2	0.1764

MOLECULAR WEIGHT & DENSITY DETERMINATION

Duct gas conditions

Ambient temperature (T_a)	°C	9.00
Duct static gas pressure	kPa	-0.05
Average duct gas temperature (T_{duct})	°C	327.05
Barometric pressure (P_m)	kPa	98.60

Calculation of molecular weight from assumed gas composition

Gas	Vol% Dry gas	Vol% Wet gas	Dry Mol Wt g/gmole	Wet Mol Wt g/gmole
CO_2	2.70	2.60	1.19	1.15
O_2	17.10	16.48	5.47	5.28
CO	0.20	0.19	0.06	0.05
N_2	80.00	77.12	22.40	21.59
H_2O	———	3.60	———	0.65
		Total	29.12	28.72

Calculation of dry and wet gas density from molecular weight results

Dry density	kg/m^3	1.30	At STP
Wet density	kg/m^3	1.28	(0°C & 101.3 kPa)
Dry density	kg/m^3	0.58	At Duct Conditions
Wet density (ρ_a)	kg/m^3	0.57	(see above)
Wet specific gravity (sg)		0.99	

CALCULATION OF NOZZLE SIZE & K FACTOR

Exhaust & sample gas conditions

Desired sampling rate at orifice (SR_o)	10 l/min	0.353 ft^3/min
Expected meter outlet temperature (T_m)	50 °C	

(guide is a sampling rate of 0.75 ft^3/min or 21.2 l/min at the orifice)

Conditions at nozzle		Conditions at orifice/meter	
Sampling rate (SR_n)	19.28 l/min	Sampling rate (SR_o)	10.00 l/min
Temperature (T_{duct})	327.05 °C	Temperature (T_o)	50.00 °C
Pressure (P_{duct})	98.55 kPa	Pressure (P_m)	98.60 kPa
Water vapour (H_2O_{duct}	3.60 %	Water vapour (H_2O_m)	0 %
Molecular weight (M_{duct})	28.72	Molecular weight (M_m)	29.12

Orifice Parameters

Orifice plate coefficient ($\Delta H_@$)	2.1935	" w.g.

Determination of nozzle diameter

based on isokinetic sampling and the average gas velocity

$D_{nr} = 2000 \times \sqrt{[SR_n / V_{duct} \times \pi \times 60000]}$

where D_{nr} is the recommended nozzle diameter (mm)

Recommended nozzle diameter (D_{nr} = 6.306 mm

Diameter of nozzle selected (D_n) = 6.28 mm

Determination of K Factor

based on preliminary exhaust gas conditions

K Factor is a proportionality factor relating the pressure drop measured with the Pitot tube in the duct (h) with the corresponding pressure drop at the orifice (ΔH), i.e.

$\Delta H = K * h$

$K = 8.038 \times 10^{-5} \times C_p^2 \times \Delta H_@ \times D_n^4 \times (M_m/M_{duct}) \times [(100\text{-}H_2O_{duct})/(100\text{-}H_2O_m)]^2 . (T_m+273/T_{duct}+273).(P_{duct}/P_m)$

where $\Delta H_@$ is the orifice plate coefficient (mm w.g.)

K Factor = *3.5312*

K Factor $_I$ (independent of C_p) = 3.5312

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 7
Site	Crematorium		
Sample point	Cremator 7 run 1		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		05-Jan-10
Time Start		12:00
Time End		13:40
Duration (t)	min	100

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	324.4
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.21
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_s)		0.57
Exhaust gas conditions measurements		crem 7

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	324.4
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	18.10
Water vapour (H_2O_{duct})	%vol	4.87
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	% vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		tpm
Nozzle diameter (d) T124 Titanium	mm	6.280
Initial gas meter reading	m^3	621.870
Final gas meter reading	m^3	622.948
Sampled volume (SV_M)	m^3	1.078

Calculation of sample gas volume at reference conditions, SV_{Ref}

SV_{Ref} = SV_{Meter} x γ x

	Corrections
$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
P_{Baro}/P_{Ref}	Pressure
$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.233

SAMPLING DATA tpm

Test Ref crem 7

Initial gas meter reading: 621870 l Start Time: 12:00

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time min	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH_d) =h x K_s x Cp^2	Orifice ΔH mm w.g. Actual (ΔH_a)	Isokinetic difference (ΔH_a/ΔH_d) %	Temperatures: Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Meter (T_m) Outlet °C	Impinger (T_{imp}) °C	Oxygen Content % v/v, dry
0.500	A	12:00	0	621870	8	19.93	18.4	92	325	156	155	48.0		11	
		12:05	5	621954	4.8	11.96	11	92	324	158	158	50.0		12	
		12:10	10	622018	8.2	20.43	19	93	326	160	160	51.0		14	
		12:15	15	622070	4.5	11.21	10.4	93	325	160	160	51.0		14	
		12:20	20	622125	7.2	17.94	16.6	93	325	160	160	51.0		15	
		12:25	25	622193	3.1	7.72	7.1	92	325	160	160	51.0		17	
		12:30	30	622230	7.2	17.94	16.6	93	325	160	160	51.0		18	
		12:35	35	622314	2.3	5.73	5.3	92	325	160	160	50.0		19	
		12:40	40	622354	5	12.46	11.5	92	327	160	160	51.0		9	
		12:45	45	622419	2.2	5.48	5	91	324	160	160	51.0		9	
		12:50	50	622452	2.1	5.23	4.9	94	326	160	160	51.0		11	
		12:55	55	622498	4.4	10.96	10.1	92	323	160	160	51.0		12	
		13:00	60	622542	4.1	10.22	9.4	92	324	160	160	51.0		14	
		13:05	65	622597	3.5	8.72	8.1	93	325	160	160	50.0		15	
		13:10	70	622656	3.2	7.97	7.4	93	327	160	160	50.0		15	
		13:15	75	622712	2.8	6.98	6.5	93	326	160	160	50.0		17	
		13:20	80	622738	4.1	10.22	9.4	92	323	160	160	50.0		9	
		13:25	85	622809	4	9.97	9.2	92	321	160	160	50.0		9	
		13:30	90	622887	2.7	6.73	6.2	92	320	160	160	50.0		11	
		13:35	95	622913	1.4	3.49	3.2	92	322	160	160	50.0		12	
		13:40	100	622948											
	Averages								324.4	159.7	159.6	50.4		13.2	n.m

Final gas meter reading: 622948 l End Time: 13:40

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.926
K factor, (K_s independent of C_p)	3.531
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Approach to isokinetic sampling

Average gas velocity (V_{duct})	9.5 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	100 min
Theoretical isokinetic sample volume SV_t	1832.44 l
Actual sample volume (SV_a)	1939.60 l
Approach to isokinetic sampling (AI)	105.8 %

where Vduct is the average duct velocity based on the above measurements

$V_{duct} = C_p \times (1-x) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV_t is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_t = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

SV_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Leak check

		Start	End
Start Time		11:52	13:42
End Time		11:54	13:44
Initial meter reading	m^3	621.8696	622.9481
Final meter reading	m^3	621.8699	622.9484
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.15	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.74 m^3/s
Flow rate at STP (Q_{STP})	0.77 m^3/s
Flow rate at reference conditions (Q_{ref})	0.21 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{ref} + 273)/(T_{duct} + 273)] \times (P_{duct}/P_{ref})$

$Q_{ref} = Q_{STP} \times [(20.9 - O_{2ref})/(20.9 - O_{2duct})] \times [(100 - H_2O_{duct})/(100 - H_2O_{ref})]$

PARTICULATE WEIGHINGS Test Ref crem 7

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012446	012443
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7349	0.7394
after 2 min	g		0.7350	0.7394
after 3 min	g		0.7350	0.7394
Weight extrapolated to zero time (M_{fi0})	g		0.7349	0.7394
Post-sampling weights				
after 1 min	g		0.7346	0.7799
after 2 min	g		0.7346	0.7799
after 3 min	g		0.7346	0.7800
Weight extrapolated to zero time (M_{ff0})	g		0.7346	0.7798

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		64.8242	72.3952
after 2 min	g		64.8241	72.3952
after 3 min	g		64.8240	72.3951
Weight extrapolated to zero time (M_{ri0})	g		64.8243	72.3953
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		64.8241	72.4087
after 2 min	g		64.8241	72.4086
after 3 min	g		64.8240	72.4086
Weight extrapolated to zero time (M_{rf0})	g		64.8242	72.4087

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0003	0.0404
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	-0.0001	0.0135
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0000	0.0539

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS Test Ref crem 7

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), $mg/m^3 = M \times 1000/ SV_{Ref}$

Discharge rate, $kg/h = C \times Q_{Ref} \times 0.0036$

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m^3	0.00	231.73
Uncertainty	mg/m^3	0.00	14.64
Particulate concentration at duct conditions (raw)	mg/m^3	0.00	27.79
Particulate discharge rate	kg/h	0.00	0.17
Uncertainty	kg/h	#DIV/0!	0.02

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.00	1.56
Filter weighings (m_f)	mg	-0.27	0.57
Rinsings weighings (m_w)	mg	-0.13	0.50
Total for uncorrected measurement (U_u)	mg	0.30	1.74
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	0.30	1.74
Concentration at 95% confidence interval (U_{95c})	mg/m^3	0.00	14.64

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is less than 2 mg/m3 (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	05-Jan-10
Sample point	Cremator 7 run 1	Time start	12:00
Test carried out by	S Huntley & T Swannack	Time End	13:40
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	100
		Sampling conditions	crem 7

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	575
Volume of sampling solution in field blank (Vsb)	ml	190
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	35.10
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

C_g (mg/m³) = $(([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c).(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	89.22
Uncertainty (95% confidence limit)	mg/m³	10.26
Uncertainty as a proportion of ELV	%	5.13
Discharge rate (D_g)	kg/h	0.067
Uncertainty (95% confidence limit)	kg/h	0.011
Detection limit	mg/m³	0.254

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_c)	mg/m³	5.23
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m³	10.257

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London
Site	Crematorium
Sample point	Cremator 7, run 1
Test carried out by	S Huntley & T Swannack

Date	5-Jan-10
Test Ref	CREM 7
Time Start	12:06
Time End	13:46

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm , dry			$mgCO/m^3$, ref. cond.		
12:06	12:11	20	10	<5	6	45	17	27
12:11	12:16	20	9	<5	<5	39	<5	19
12:16	12:21	20	7	<5	<5	33	13	19
12:21	12:26	20	8	<5	6	35	16	24
12:26	12:31	20	10	<5	<5	43	12	20
12:31	12:36	20	8	<5	<5	34	14	21
12:36	12:41	20	6	<5	<5	26	11	17
12:41	12:46	20	6	<5	<5	24	12	16
12:46	12:51	20	<5	<5	<5	22	12	17
12:51	12:56	20	5	<5	<5	23	12	16
12:56	13:01	20	<5	<5	<5	12	6	9
13:01	13:06	20	6	<5	<5	25	5	11
13:06	13:11	20	14	<5	9	62	17	42
13:11	13:16	20	225	7	58	994	29	256
13:16	13:21	20	17	5	11	75	23	48
13:21	13:26	20	12	<5	8	55	21	34
13:26	13:31	20	9	<5	<5	38	15	22
13:31	13:36	20	10	<5	7	43	17	31
13:36	13:41	20	27	9	15	119	41	66
13:41	13:46	20	74	25	49	328	109	219
12:06	13:46	400	225	<5	11	994	<5	47

Summary of measurements

Average concentration	46.6 $mgCO/m^3$
Uncertainty	7.4 $mgCO/m^3$
Discharge rate	0.035 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

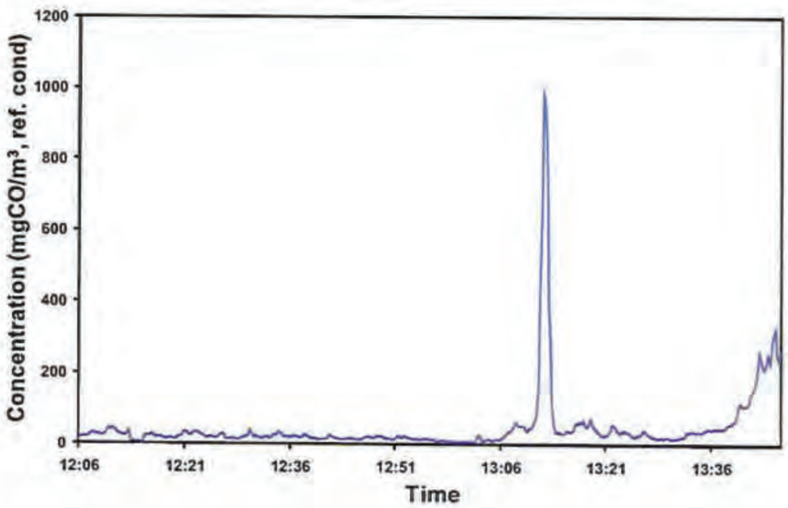
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.10
Gas into system before sampling	ppm	0.30	25.15
Gas into system after sampling	ppm	0.40	25.20
Drift	% span	0.40	0.20
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax}) ppm CO	Partial uncertainty (x_{imax}) mgCO/m³	x_{imax}^2
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{press})$	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.50	% range/10K	0.01	0.02	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 7, run 1



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London
Site	Crematorium
Sample point	Cremator 7, run 1
Test carried out by	S Huntley & T Swannack

Date	5-Jan-10
Test Ref	CREM 7
Time Start	12:06
Time End	13:46

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum (%, dry)	Minimum (%, dry)	Average (%, dry)	Maximum (% dry)	Minimum (% dry)	Average (% dry)
12:06	12:11	20	17.9	16.9	17.5	17.9	16.9	17.5
12:11	12:16	20	20.9	16.8	18.8	20.9	16.8	18.8
12:16	12:21	20	17.7	17.2	17.4	17.7	17.2	17.4
12:21	12:26	20	18.2	16.8	17.4	18.2	16.8	17.4
12:26	12:31	20	20.9	17.3	19.4	20.9	17.3	19.4
12:31	12:36	20	17.7	16.8	17.3	17.7	16.8	17.3
12:36	12:41	20	17.4	16.9	17.1	17.4	16.9	17.1
12:41	12:46	20	17.4	16.6	17.0	17.4	16.6	17.0
12:46	12:51	20	17.8	16.9	17.3	17.8	16.9	17.3
12:51	12:56	20	20.9	17.0	17.4	20.9	17.0	17.4
12:56	13:01	20	20.9	20.9	20.9	20.9	20.9	20.9
13:01	13:06	20	20.9	17.6	19.1	20.9	17.6	19.1
13:06	13:11	20	18.9	18.0	18.3	18.9	18.0	18.3
13:11	13:16	20	19.1	18.3	18.5	19.1	18.3	18.5
13:16	13:21	20	18.8	17.9	18.3	18.8	17.9	18.3
13:21	13:26	20	18.8	18.1	18.2	18.8	18.1	18.2
13:26	13:31	20	18.4	18.2	18.3	18.4	18.2	18.3
13:31	13:36	20	18.4	17.5	17.8	18.4	17.5	17.8
13:36	13:41	20	19.2	17.5	17.8	19.2	17.5	17.8
13:41	13:46	20	17.6	17.5	17.6	17.6	17.5	17.6
12:06	13:46	400	20.9	16.6	18.1	20.9	16.6	18.1

Summary of measurements

Average concentration	18.1 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

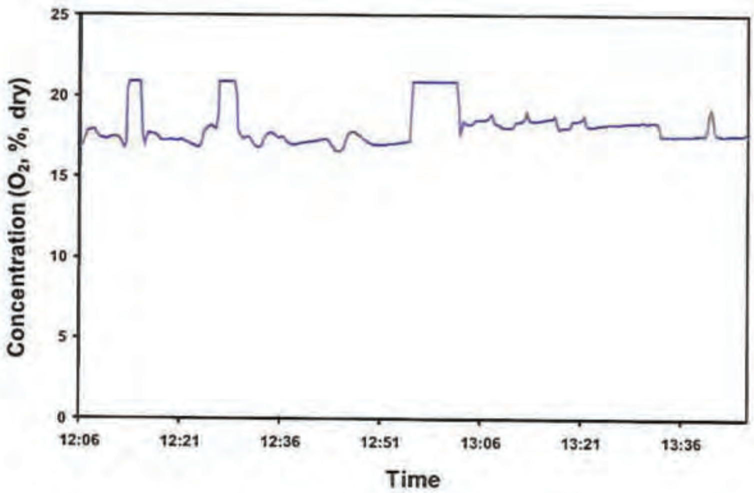
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.10
Gas into system after sampling	%	0.10	13.20
Drift	% span	0.76	0.76
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)	$x_{i,max}^2$
						%O_2	
Lack of fit	u($Corr_{lof}$)	-		2.00	% range	0.29	0.08
Zero drift	u($Corr_{0,dr}$)	-		0.11	% range	0.02	0.00
Span drift	u($Corr_{s,dr}$)	-		0.24	% range	0.03	0.00
Sample volume flow	u($Corr_{s,fl}$)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u($Corr_{atmos}$)	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	2	K	0.40	% range/10K	0.01	0.00
Electric voltage	u($Corr_{volt}$)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u($Corr_{int}$)	-		0.00	% range	0.00	0.00
Losses & leakage	u($Corr_{leak}$)	-		0.00	% range	0.00	0.00
Repeatability at zero	u($Corr_{z,rep}$)	-		0.00	% range	0.00	0.00
Repeatability at span	u($Corr_{s,rep}$)	-		0.00	% range	0.00	0.00
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00
Calibration gas	u($Corr_{adj}$)	-		1.00	% value	0.13	0.02
Combined uncertainty	u(C_{O2})						0.32
Expanded uncertainty	U(C_{O2})						0.62
U(C_{O2}):C_{O2}(%)							3.44

Measured concentration of Oxygen at Cremator 7, run 1



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	5-Jan-10
Site	Crematorium	Test Ref	CREM 7
Sample point	Cremator 7, run 1	Time Start	12:06
Test carried out by	S Huntley & T Swannack	Time End	13:46

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
12:06	12:11	20	3.3	2.4	2.8	11.5	8.6	9.8
12:11	12:16	20	3.3	<0.1	1.6	11.5	0.1	5.8
12:16	12:21	20	2.9	2.5	2.8	10.2	8.9	9.8
12:21	12:26	20	3.2	2.1	2.8	11.2	7.4	9.7
12:26	12:31	20	2.8	<0.1	1.2	10.0	0.1	4.1
12:31	12:36	20	3.2	2.5	2.8	11.1	8.7	9.8
12:36	12:41	20	3.0	2.7	2.9	10.7	9.5	10.2
12:41	12:46	20	3.3	2.6	2.9	11.5	9.4	10.4
12:46	12:51	20	3.0	2.3	2.7	10.5	8.3	9.5
12:51	12:56	20	3.0	<0.1	2.6	10.4	0.3	9.3
12:56	13:01	20	<0.1	<0.1	<0.1	0.2	0.1	0.1
13:01	13:06	20	2.5	<0.1	1.3	8.8	0.1	4.6
13:06	13:11	20	2.0	1.5	1.8	7.2	5.2	6.5
13:11	13:16	20	1.9	1.3	1.7	6.6	4.7	6.0
13:16	13:21	20	2.0	1.5	1.7	6.9	5.2	6.2
13:21	13:26	20	1.9	1.4	1.8	6.6	5.1	6.3
13:26	13:31	20	1.7	1.6	1.7	6.1	5.8	6.0
13:31	13:36	20	2.2	1.6	2.0	7.8	5.8	7.1
13:36	13:41	20	2.2	1.1	2.0	7.7	4.1	7.0
13:41	13:46	20	2.1	2.1	2.1	7.6	7.3	7.4
12:06	13:46	400	3.3	<0.1	2.1	11.5	0.1	7.3

Summary of measurements

Average concentration	7.3 $\%CO_2$
Uncertainty	1.1 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

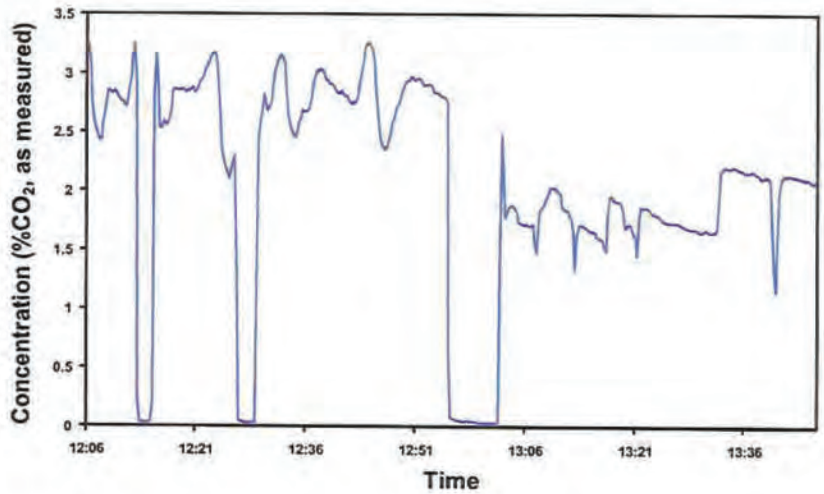
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.08	5.10
Gas into system after sampling	%	0.15	5.15
Drift	% span	1.38	0.98
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)	$x_{i,max}^2$
						$\%CO_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.01
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.02	0.00
Sample volume flow	$u(Corr_{s,vl})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{atmos})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.50	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.09	0.01
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.01	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{cal})$	-		1.00	% value	0.05	0.00
Combined uncertainty	$u(C_{CO2})$						0.16
Expanded uncertainty	$U(C_{CO2})$						0.31
$U(C_{CO2})/C_{CO2}(\%)$							15.04

Measured concentration of Carbon Dioxide at Cremator 7, run 1



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 7(a) h2o
Site	Crematorium	Date	05-Jan-10
Sample point	Cremator 7 run 1	Time start	12:00
Test carried out by	S Huntley & T Swannack	Time End	13:40
		Duration (min)	100
		Data from	crem 7

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	778.32	794.68	16.36
Container 2	827.74	831.45	3.71
Container 3	611.43	613.24	1.81
Container 4	861.5	873.36	11.86
Total (M)	3078.99	3112.73	33.74

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i) \ldots (Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

$SV_{STP} = SV_M \times (273/(273 + T_M) \times (P_M/101.3)$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.8203

Calculation of water vapour content (H_2O_{duct})

$H_2O_{duct} = 100 \times (M \times MV_{STP} / MW_{H2O}) / [SV_{STP} + (M \times MV_{STP} / MW_{H2O})]$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)

MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	4.87 ± 0.35

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)

Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard

Leak rate is no more than 2% of sample flow rate

Sampling duration is within minimum of 30 minutes (Clause 6.1)

Sampling volume is within minimum of 50l (Clause 6.1)

Residual water content at outlet is above 1.25% (Clause 5.8) - outside standard

Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.820 m^3
Average temperature of gas at meter	T	50.4 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.00015 m^3/min
Duration of sampling	t	100 min
Total mass weighed	M	3112.73 g

Source of uncertainty		Value		Value of standard uncertainty		Relative standard uncertainty (%)	
Measurement of sample gas volume	u_rV_m	2.0 %	u_v	$u_{sv}V_m$ =	0.0095 m^3	u_rV_m	1.15
Measurement of sample gas temperature	u_rT_m	1.0 %	u_t	$u_{st}T_m$ =	1.8672 K	u_rT_m	0.58
Measurement of absolute pressure	u_rP_m	1.0 %	u_p	$u_{sp}P_m$ =	5.6927 mb	u_rP_m	0.58
Leakage in sampling line	u_rL	1.8 %	u_l	$u_{sl}L$ =	0.0087 m^3	u_rL	1.06
Measurement of weight - balance uncertainty	u_rW_m	0.01 %	u_{wm}	$u_{sr}W_m$ =	0.1797 g		-
Measurement of weight - balance repeatability	u_rW_r	0.011 g	u_{wr}	$u_{sr}W_r$ =	0.0110 g		-
Total measurement of weight	u_rW	-	-	$u_{sr}W$ =	0.1907 g	u_rW	0.57

Total standard relative uncertainty	$u_r = \sqrt{u_rV_m^2 + u_rT_m^2 + u_rP_m^2 + u_rL^2 + u_rW^2 + Corr_r}$	3.62 %
Total relative uncertainty	$U_r = 1.96u_r$	7.10 %

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 7 (b)
Site	Crematorium		
Sample point	Cremator 7 run 2		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		TPM
Date		05-Jan-10
Time Start		14:20
Time End		15:55
Duration (t)	min	95

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		TPM
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	327.1
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.20
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_o)		0.57
Exhaust gas conditions measurements		crem 7 (b)

Reference conditions

Determination		TPM
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	327.1
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	18.20
Water vapour (H_2O_{duct})	%vol	5.78
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		TPM
Nozzle diameter (d) T124 Titanium	mm	6.280
Initial gas meter reading	m^3	623.216
Final gas meter reading	m^3	624.270
Sampled volume (SV_M)	m^3	1.054

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times Y \times$	$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
			$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		TPM
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.219

SAMPLING DATA TPM

Test Ref crem 7 (b)

Initial gas meter reading 623216 l   Start Time 14:20

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH_d) $h \times K_c \times Cp^2$	Orifice ΔH mm w.g. Actual (ΔH_a)	Isokinetic difference ($\Delta H_a/\Delta H_d$) %	Temperatures Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Meter (T_m) Outlet °C	Impinger (T_{imp}) °C	Oxygen Content %, v/v, dry
0.500	A	14:20	0	623216	6.5	16.20	15	93	332	160	160	51.0		8	
		14:25	5	623287	4.2	10.46	9.7	93	333	160	160	50.0		8	
		14:30	10	623341	5.4	13.45	12.4	92	333	160	160	51.0		9	
		14:35	15	623417	4.2	10.46	9.7	93	333	160	160	51.0		11	
		14:40	20	623493	3	7.47	6.9	92	331	160	160	51.0		12	
		14:45	25	623542	2	4.98	4.6	92	331	160	160	51.0		12	
		14:50	30	623582	3	7.47	6.9	92	327	160	160	51.0		14	
		14:55	35	623617	4.2	10.46	9.7	93	325	160	160	50.0		14	
		15:00	40	623667	3.5	8.72	8	92	327	160	160	51.0		15	
		15:05	45	623717	3.2	7.97	7.4	93	324	160	160	51.0		16	
		15:10	50	623774	5.2	12.96	12	93	326	160	160	51.0		17	
		15:15	55	623839	3.8	9.47	8.8	93	323	160	160	51.0		18	
		15:20	60	623905	7.4	18.44	17	92	324	160	160	51.0		19	
		15:25	65	623948	3.5	8.72	8	92	325	160	160	52.0		9	
		15:30	70	623979	3.8	9.47	8.8	93	327	160	160	52.0		11	
		15:35	75	624032	4.4	10.96	10.1	92	326	160	160	52.0		12	
		15:40	80	624088	5.2	12.96	12	93	323	160	160	52.0		14	
		15:45	85	624152	3.6	8.97	8.3	93	321	160	160	52.0		15	
		15:50	90	624215	3.9	9.72	9	93	324	160	160	52.0		17	
		15:55	95	624270											
	Averages								327.1	160.0	160.0	51.2		13.2	n.m

Final gas meter reading 624270 l   End Time 15:55

Equipment used

Item	File No.
Control box	P1382
Meter coefficient (y)	0.920
K factor, (K_c independent of C_p)	3.531
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1087
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		14:15	15:57
End Time		14:17	15:59
Initial meter reading	m^3	623.2157	624.2701
Final meter reading	m^3	623.216	624.2704
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.15	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	10.0 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	95 min
Theoretical isokinetic sample volume SV_i	1761.95 l
Actual sample volume (SV_a)	1918.56 l
Approach to isokinetic sampling (I)	108.9 %

where Vduct is the average duct velocity based on the above measurements

$V_{duct} = C_p \times (1-\varepsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV_i is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_i = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

Sv_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.76 m^3/s
Flow rate at STP (Q_{STP})	0.78 m^3/s
Flow rate at reference conditions (Q_{Ref})	0.20 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{Ref} + 273)/(T_{duct} + 273)] \times (P_{baro}/P_{Ref})$

$Q_{Ref} = Q_{STP} \times [(20.9 - O_{2Ref})/(20.9 - O_{2meas})] \times [(100 - H_2O_{meas})/(100 - H_2O_{Ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 7 (b)

Filters

Determination		Method Blank	Field Blank	TPM
Filter No.		xxxxxxx	012446	012455
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7349	0.8341
after 2 min	g		0.7350	0.8341
after 3 min	g		0.7350	0.8341
Weight extrapolated to zero time (M_{fi0})	g		0.7349	0.8341
Post-sampling weights				
after 1 min	g		0.7346	0.8624
after 2 min	g		0.7346	0.8624
after 3 min	g		0.7346	0.8624
Weight extrapolated to zero time (M_{ff0})	g		0.7346	0.8624

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		64.8242	71.3238
after 2 min	g		64.8241	71.3238
after 3 min	g		64.8240	71.3238
Weight extrapolated to zero time (M_{ri0})	g		64.8243	71.3238
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		64.8241	71.3339
after 2 min	g		64.8241	71.3339
after 3 min	g		64.8240	71.3339
Weight extrapolated to zero time (M_{rf0})	g		64.8242	71.3339

Summary

Determination		Method Blank (M_{mb})	Field Blank	TPM
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0003	0.0283
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	-0.0001	0.0101
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0000	0.0384

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS

Test Ref crem 7 (b)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = M x 1000/ SV_{Ref}

Discharge rate, kg/h = C x Q_{Ref} x 0.0036

Determination		Field Blank	TPM
Particulate concentration at reference conditions	mg/m^3	0.00	175.52
Uncertainty	mg/m^3	0.00	12.07
Particulate concentration at duct conditions (raw)	mg/m^3	0.00	20.01
Particulate discharge rate	kg/h	0.00	0.13
Uncertainty	kg/h	#DIV/0!	0.01

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	TPM
Volume measurement (m_{vol})	mg	0.00	1.11
Filter weighings (m_f)	mg	-0.27	0.57
Rinsings weighings (m_w)	mg	-0.13	0.50
Total for uncorrected measurement (U_u)	mg	0.30	1.35
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	0.30	1.35
Concentration at 95% confidence interval (U_{95c})	mg/m^3	0.00	12.07

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is less than 2 mg/m3 (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	05-Jan-10
Sample point	Cremator 7 run 2	Time start	14:20
Test carried out by	S Huntley & T Swannack	Time End	15:55
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	95
		Sampling conditions	crem 7 (b)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	550
Volume of sampling solution in field blank (Vsb)	ml	190
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	43.60
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m^3	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\ (mg/m^3) = (\{[V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]\} \times MW_c).(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m^3	112.70
Uncertainty (95% confidence limit)	mg/m^3	12.96
Uncertainty as a proportion of ELV	%	6.48
Discharge rate (D_g)	kg/h	0.081
Uncertainty (95% confidence limit)	kg/h	0.013
Detection limit	mg/m^3	0.258

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m^3	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_u)	mg/m^3	6.61
Correction to reference conditions (m_{corr})	mg/m^3	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m^3	12.957

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London	Date	5-Jan-10
Site	Crematorium	Test Ref	CREM 7 (b)
Sample point	Cremator 7, run 2	Time Start	14:20
Test carried out by	S Huntley & T Swannack	Time End	15:54

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm, dry			$mgCO/m^3$, ref. cond.		
14:20	14:24	20	21	6	10	97	29	45
14:25	14:29	20	9	<5	6	43	19	28
14:30	14:34	20	26	<5	11	118	20	49
14:35	14:39	20	10	<5	6	46	19	26
14:40	14:44	20	9	<5	5	39	16	24
14:45	14:49	20	7	<5	5	32	15	23
14:50	14:54	20	14	<5	6	63	18	29
14:55	14:59	20	9	<5	7	43	17	32
15:00	15:04	20	<5	<5	<5	20	9	13
15:05	15:09	20	<5	<5	<5	12	<5	8
15:10	15:14	20	<5	<5	<5	9	<5	7
15:15	15:19	20	<5	<5	<5	9	<5	7
15:20	15:24	20	<5	<5	<5	9	<5	7
15:25	15:29	20	7	<5	<5	30	<5	16
15:30	15:34	20	8	<5	<5	35	9	19
15:35	15:39	20	<5	<5	<5	20	7	10
15:40	15:44	20	13	<5	<5	59	9	20
15:45	15:49	20	9	<5	5	43	12	24
15:50	15:54	20	6	<5	<5	29	6	15
14:20	15:54	380	26	<5	<5	118	<5	21

Summary of measurements

Average concentration	21.3 $mgCO/m^3$
Uncertainty	21.3 $mgCO/m^3$
Discharge rate	0.015 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

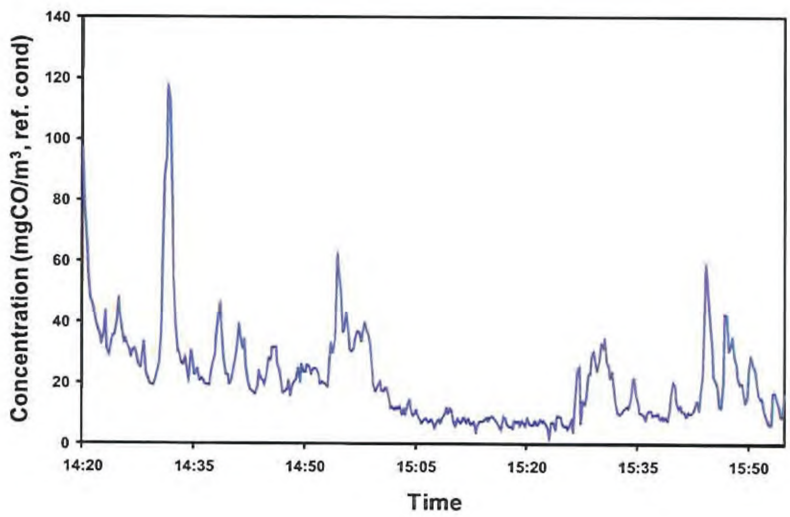
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.10
Gas into system before sampling	ppm	0.30	25.15
Gas into system after sampling	ppm	0.40	25.20
Drift	% span	0.40	0.20
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm CO	mgCO/m³	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.50	% range/10K	0.01	0.02	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 7, run 2



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London	Date	5-Jan-10
Site	Crematorium	Test Ref	CREM 7 (b)
Sample point	Cremator 7, run 2	Time Start	14:20
Test carried out by	S Huntley & T Swannack	Time End	15:55

Measurements: 5 minutes' averaging period

Start	End	No.	Maximum	Minimum	Average	Maximum	Minimum	Average
		Readings	ppm , wet			mgCarbon/m3, ref cond.		
14:20	14:25	10	31	19	22	191	116	139
14:25	14:30	10	27	17	21	168	108	131
14:30	14:35	10	18	14	16	111	90	99
14:35	14:40	10	18	14	16	114	85	103
14:40	14:45	10	22	18	19	140	110	122
14:45	14:50	10	23	21	22	145	132	138
14:50	14:55	10	27	20	24	172	128	152
14:55	15:00	10	23	14	19	146	85	121
15:00	15:05	10	15	10	13	96	60	79
15:05	15:10	10	14	7	12	85	41	74
15:10	15:15	10	3	1	2	17	7	11
15:15	15:20	10	2	<1	1	13	4	7
15:20	15:25	10	8	<1	3	51	3	20
15:25	15:30	10	4	<1	2	28	4	13
15:30	15:35	10	<1	<1	<1	4	3	3
15:35	15:40	10	<1	<1	<1	3	2	2
15:40	15:45	10	<1	<1	<1	1	1	1
15:45	15:50	10	<1	<1	<1	1	<1	1
15:50	15:55	10	<1	<1	<1	<1	<1	<1
14:20	15:55	190	31	<1	10	191	<1	64

Summary of measurements

Average concentration	64 mgCarbon/m3
Uncertainty	48 mgCarbon/m3
Discharge rate	0.046 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is above specified limit of 10% of ELV (BS EN 14789, Clause 1) - non compliance

Calibration Checks

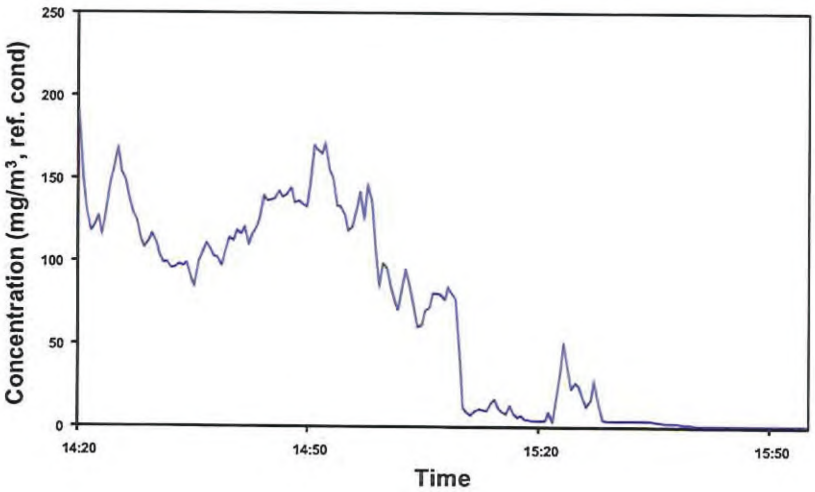
Type	Bernath 3006	Range	0 to 100 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.05	8.90
Gas into system before sampling	ppm	-0.09	8.95
Gas into system after sampling	ppm	-0.21	8.74
Drift	% span	1.35	2.35
Response time	s	7	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm	mg/m^3	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	1.15	1.85	3.44
Zero drift	$u(Corr_{0,dr})$	-		2.00	% range	1.15	1.85	3.44
Span drift	$u(Corr_{s,dr})$	-		2.00	% range	1.15	1.85	3.44
Sample volume flow	$u(Corr_{s,v})$	-		1.00	% range	0.58	0.93	0.86
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	2.00	% range/10K	0.12	0.19	0.03
Electric voltage	$u(Corr_{volt})$	40	V	2.00	% range/10V	2.31	3.71	13.76
Interferents	$u(Corr_{int})$	-		3.50	% range	2.02	3.25	10.54
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		1.00	% range	0.58	0.93	0.86
Repeatability at span	$u(Corr_{s,rep})$	-		2.00	% range	1.15	1.85	3.44
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	$u(C_{VOC})$							6.24
Expanded uncertainty	$U(C_{VOC})$							12.23
$U(C_{VOC})$:ELV (%)								61.17

Measured concentration of Volatile Organic Compounds at Cremator 7, run 2



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London	Date	5-Jan-10
Site	Crematorium	Test Ref	CREM 7 (b)
Sample point	Cremator 7, run 2	Time Start	14:20
Test carried out by	S Huntley & T Swannack	Time End	15:54

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
				%, dry			% dry	
14:20	14:24	20	19.1	16.5	18.2	19.1	16.5	18.2
14:25	14:29	20	18.2	16.7	17.6	18.2	16.7	17.6
14:30	14:34	20	18.2	17.7	17.8	18.2	17.7	17.8
14:35	14:39	20	17.9	16.9	17.5	17.9	16.9	17.5
14:40	14:44	20	18.0	17.2	17.5	18.0	17.2	17.5
14:45	14:49	20	18.3	17.3	17.6	18.3	17.3	17.6
14:50	14:54	20	17.4	17.3	17.3	17.4	17.3	17.3
14:55	14:59	20	18.9	17.4	18.1	18.9	17.4	18.1
15:00	15:04	20	19.3	18.2	18.5	19.3	18.2	18.5
15:05	15:09	20	20.3	18.2	18.5	20.3	18.2	18.5
15:10	15:14	20	20.4	20.1	20.2	20.4	20.1	20.2
15:15	15:19	20	20.9	19.4	20.7	20.9	19.4	20.7
15:20	15:24	20	20.9	18.2	19.4	20.9	18.2	19.4
15:25	15:29	20	20.9	17.5	18.9	20.9	17.5	18.9
15:30	15:34	20	19.2	17.7	18.6	19.2	17.7	18.6
15:35	15:39	20	19.0	16.8	17.8	19.0	16.8	17.8
15:40	15:44	20	18.6	17.0	17.6	18.6	17.0	17.6
15:45	15:49	20	18.2	17.0	17.2	18.2	17.0	17.2
15:50	15:54	20	17.9	17.1	17.6	17.9	17.1	17.6
14:20	15:54	380	20.9	16.5	18.2	20.9	16.5	18.2

Summary of measurements

Average concentration	18.2 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

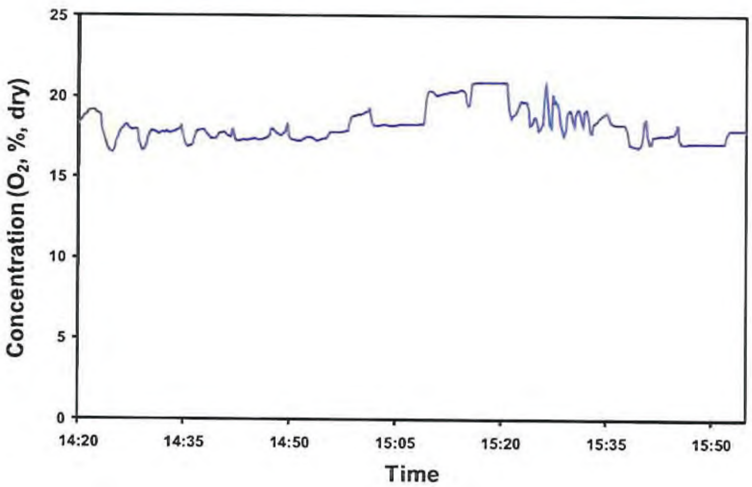
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.10
Gas into system after sampling	%	0.10	13.20
Drift	% span	0.76	0.76
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%O_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	-		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{s,vl})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.40	% range/10K	0.01	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})$:C_{O2}(%)							3.41

Measured concentration of Oxygen at Cremator 7, run 2



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SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	5-Jan-10
Site	Crematorium	Test Ref	CREM 7 (b)
Sample point	Cremator 7, run 2	Time Start	14:20
Test carried out by	S Huntley & T Swannack	Time End	15:54

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
14:20	14:24	20	4.1	1.9	2.7	14.9	6.8	9.8
14:25	14:29	20	3.8	2.5	3.0	13.9	9.2	11.0
14:30	14:34	20	2.7	2.3	2.6	9.8	8.4	9.4
14:35	14:39	20	3.2	2.4	2.7	11.7	8.7	10.0
14:40	14:44	20	2.9	2.5	2.8	10.8	9.1	10.4
14:45	14:49	20	2.9	2.3	2.8	10.7	8.4	10.1
14:50	14:54	20	2.9	2.7	2.8	10.6	10.0	10.4
14:55	14:59	20	2.8	1.9	2.3	10.2	6.8	8.5
15:00	15:04	20	2.1	1.5	2.0	7.8	5.5	7.2
15:05	15:09	20	2.1	0.5	1.8	7.7	1.9	6.7
15:10	15:14	20	0.7	0.5	0.6	2.5	1.7	2.1
15:15	15:19	20	1.2	<0.1	0.2	4.3	0.1	0.7
15:20	15:24	20	2.0	<0.1	1.1	7.2	0.1	4.0
15:25	15:29	20	2.3	0.1	1.5	8.5	0.5	5.3
15:30	15:34	20	2.1	1.3	1.6	7.7	4.7	6.0
15:35	15:39	20	2.6	1.3	2.1	9.6	4.9	7.6
15:40	15:44	20	2.5	1.6	2.1	9.2	5.9	7.9
15:45	15:49	20	2.5	1.8	2.4	9.0	6.5	8.7
15:50	15:54	20	2.4	1.9	2.1	8.7	6.9	7.7
14:20	15:54	380	4.1	<0.1	2.1	14.9	0.1	7.5

Summary of measurements

Average concentration	7.5 $\%CO_2$
Uncertainty	1.1 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

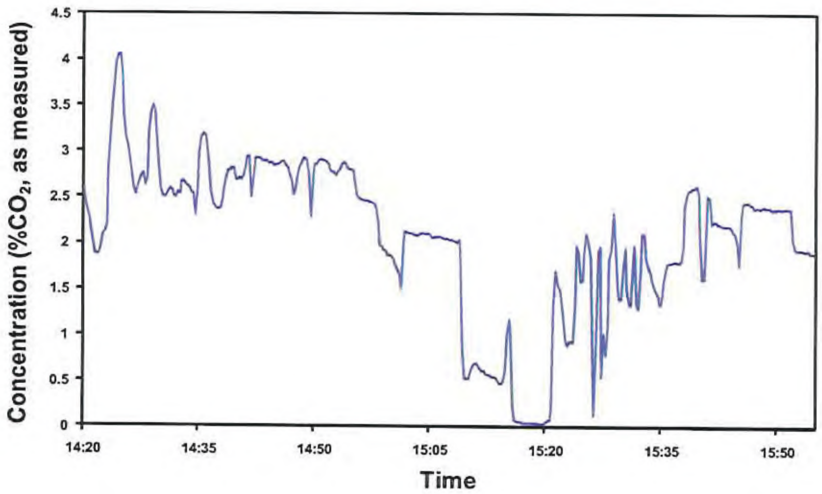
Type	Horiba PG 250	**Range**	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.09
Gas into system before sampling	%	0.08	5.10
Gas into system after sampling	%	0.15	5.15
Drift	% span	1.38	0.98
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%CO_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.01
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.02	0.00
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	2	K	0.50	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.09	0.01
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.01	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.05	0.00
Combined uncertainty	$u(C_{CO2})$						0.16
Expanded uncertainty	$U(C_{CO2})$						0.31
$U(C_{CO2}):C_{CO2}(\%)$							15.04

Measured concentration of Carbon Dioxide at Cremator 7, run 2



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 7 (b)
Site	Crematorium	Date	05-Jan-10
Sample point	Cremator 7 run 2	Time start	14:20
Test carried out by	S Huntley & T Swannack	Time End	15:55
		Duration (min)	95
		Data from	crem 7 (b)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	794.72	812.5	17.78
Container 2	832.45	838.57	6.12
Container 3	613.72	616.1	2.38
Container 4	873.43	886.55	13.12
Total (M)	3114.32	3153.72	39.4

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i)....(Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

$SV_{STP} = SV_M \times (273/(273 + T_M) \times (P_M/101.3)$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.8000

Calculation of water vapour content (H_2O_{duct})

$H_2O_{duct} = 100 \times (M \times MV_{STP}/MW_{H2O})/[SV_{STP} + (M \times MV_{STP}/MW_{H2O})]$

where
MV_{STP} molecular volume at STP (22.412 m^3/kgmole)
MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	5.78 ± 0.43

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is above 1.25% (Clause 5.8) - outside standard
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.800 m^3
Average temperature of gas at meter	T	51.2 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.00015 m^3/min
Duration of sampling	t	95 min
Total mass weighed	M	3153.72 g

Source of uncertainty		Value		Value of standard uncertainty			Relative standard uncertainty (%)	
Measurement of sample gas volume	u,V_m	2.0 %	u_v	u_s,V_m =	$\frac{uV}{\sqrt{3}}$	0.0092 m^3	u_r,V_m	1.15
Measurement of sample gas temperature	u,T_m	1.0 %	u_t	u_s,T_m =	$\frac{u(T+273)}{\sqrt{3}}$	1.8718 K	u_r,T_m	0.58
Measurement of absolute pressure	u,P_m	1.0 %	u_p	u_s,P_m =	$\frac{uP}{\sqrt{3}}$	5.6927 mb	u_r,P_m	0.58
Leakage in sampling line	u,L	1.8 %	u_l	u_s,L =	$\frac{uV}{\sqrt{3}}$	0.0082 m^3	u_r,L	1.03
Measurement of weight - balance uncertainty	u,W_m	0.01 %	u_{wm}	u_s,W_m =	$\frac{u_{wm}M}{\sqrt{3}}$	0.1821 g		-
Measurement of weight - balance repeatability	u,W_r	0.011 g	u_{wr}	u_s,W_r =	u_{wr}	0.0110 g		-
Total measurement of weight	u,W	-	-	u_s,W =		0.1931 g	u_r,W	0.40

Total standard relative uncertainty	$u_r = \sqrt{u_r V_m^2 + u_r T_m^2 + u_r P_m^2 + u_r L^2 + u_r W^2} + Corr_r$	3.82 %
Total relative uncertainty	$U_r = 1.96 u_r$	7.48 %

SCIENTIFICS MONITORING REPORT FORM
PITOT TRAVERSE (BS EN 13284-1)

Company	City of London	Date	06-Jan-10
Site	Crematorium	Test Ref	crem 8 flow
Sample point	Cremator 8	Time Start	08:00
Test carried out by	S Huntley & T Swannack	Time End	08:10

SAMPLING PLANE GEOMETRY

Geometry of duct		Rectangular
Dimension traversed by sampling probe (D)	m	0.42
Other dimension (if applicable)	m	0.4200
Cross sectional area of sampling plane (A)	m^2	0.1764

MOLECULAR WEIGHT & DENSITY DETERMINATION

Duct gas conditions

Ambient temperature (T_a)	°C	9.00
Duct static gas pressure	kPa	-0.05
Average duct gas temperature (T_{duct})	°C	356.00
Barometric pressure (P_m)	kPa	98.60

Calculation of molecular weight from assumed gas composition

Gas	Vol% Dry gas	Vol% Wet gas	Dry Mol Wt g/gmole	Wet Mol Wt g/gmole
CO_2	2.70	2.60	1.19	1.15
O_2	17.10	16.48	5.47	5.28
CO	0.20	0.19	0.06	0.05
N_2	80.00	77.12	22.40	21.59
H_2O	———	3.60	———	0.65
		Total	29.12	28.72

Calculation of dry and wet gas density from molecular weight results

Dry density	kg/m^3	1.30	At STP
Wet density	kg/m^3	1.28	(0°C & 101.3 kPa)
Dry density	kg/m^3	0.55	At Duct Conditions
Wet density (ρ_a)	kg/m^3	0.54	(see above)
Wet specific gravity (sg)		0.99	

CALCULATION OF NOZZLE SIZE & K FACTOR

Exhaust & sample gas conditions

Desired sampling rate at orifice (SR_o)	10 l/min	0.353 ft³/min
Expected meter outlet temperature (T_m)	20 °C	

(guide is a sampling rate of 0.75 ft³/min or 21.2 l/min at the orifice)

Conditions at nozzle		Conditions at orifice/meter	
Sampling rate (SR_n)	22.28 l/min	Sampling rate (SR_o)	10.00 l/min
Temperature (T_{duct})	356.00 °C	Temperature (T_a)	20.00 °C
Pressure (P_{duct})	98.55 kPa	Pressure (P_m)	98.60 kPa
Water vapour (H_2O_{duct}	3.60 %	Water vapour (H_2O_m)	0 %
Molecular weight (M_{duct})	28.72	Molecular weight (M_m)	29.12

Orifice Parameters

Orifice plate coefficient ($\Delta H_@$)	2.1935	" w.g.

Determination of nozzle diameter
based on isokinetic sampling and the average gas velocity

$D_{nr} = 2000 \times \sqrt{[SR_n / V_{duct} \times \pi \times 60000]}$

where D_{nr} is the recommended nozzle diameter (mm)

Recommended nozzle diameter (D_{nr}	=	6.699	mm
Diameter of nozzle selected (D_n)	=	6.28	mm

Determination of K Factor
based on preliminary exhaust gas conditions

K Factor is a proportionality factor relating the pressure drop measured with the Pitot tube in the duct (h) with the corresponding pressure drop at the orifice (ΔH), i.e.

$\Delta H = K * h$

$K = 8.038 \times 10^{-5} \times C_p^2 \times \Delta H_@ \times D_n^4 \times (M_m/M_{duct}) \times [(100-H_2O_{duct})/(100-H_2O_m)]^2 . (T_m+273/T_{duct}+273).(P_{duct}/P_m)$

where $\Delta H_@$ is the orifice plate coefficient (mm w.g.)

K Factor	=	*3.0558*
K Factor $_I$ (independent of C_p)	=	3.0558

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 8 (a)
Site	Crematorium		
Sample point	Cremator 8 run 1		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		06-Jan-10
Time Start		08:54
Time End		10:34
Duration (t)	min	100

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	347.2
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.39
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_s)		0.54
Exhaust gas conditions measurements		crem 8 (a)

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	347.2
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	17.20
Water vapour (H_2O_{duct})	%vol	3.32
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		tpm
Nozzle diameter (d) Ti24 Titanium	mm	6.280
Initial gas meter reading	m^3	624.754
Final gas meter reading	m^3	626.151
Sampled volume (SV_M)	m^3	1.397

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times y \times$	$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100-H_2O_{Meter}]/[100-H_2O_{Ref}]$	Water vapour
			$[20.9-O_{2Duct}]/[20.9-O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.439

SAMPLING DATA tpm

Test Ref crem 8 (a)

Initial gas meter reading 624754 l Start Time 08:54

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH_d) =h x K_i x Cp^2	Actual (ΔH_a)	Isokinetic difference ($\Delta H_a/\Delta H_d$) %	Temperatures Gas (T_{duct}) (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Outlet °C	Impinger (T_{imp}) °C	Oxygen Content %, v/v, dry
0.500	A	08:54	0	624754	9.1	19.62	19.6	100	345	156	155	15.0		6	
		08:59	5	624831	8.3	17.90	17.9	100	346	158	156	18.0		7	
		09:04	10	624905	7.8	16.82	16.8	100	347	160	160	19.0		8	
		09:09	15	624979	14.1	30.40	30.4	100	347	160	160	20.0		9	
		09:14	20	625071	8.4	18.11	18.1	100	347	160	160	20.0		11	
		09:19	25	625161	7.1	15.31	15.3	100	347	160	160	20.0		11	
		09:24	30	625226	5	10.78	10.8	100	347	160	160	20.0		12	
		09:29	35	625281	16.4	35.36	35	99	347	160	160	20.0		12	
		09:34	40	625373	12.8	27.60	27	98	346	160	160	20.0		14	
		09:39	45	625460	6.3	13.58	13.6	100	345	160	160	21.0		15	
		09:44	50	625522	4.9	10.57	10.6	100	347	160	160	21.0		17	
		09:49	55	625582	14.5	31.26	31	99	348	160	160	21.0		19	
		09:54	60	625670	9.2	19.84	19.8	100	347	160	160	21.0		7	
		09:59	65	625749	7.1	15.31	15.3	100	347	160	160	21.0		9	
		10:04	70	625815	6.8	14.66	14.7	100	348	160	160	21.0		11	
		10:09	75	625879	3	6.47	6.5	100	349	160	160	20.0		11	
		10:14	80	625922	5.2	11.21	11.2	100	349	160	160	20.0		12	
		10:19	85	625964	6.5	14.01	14	100	351	160	160	20.0		14	
		10:24	90	626024	7.4	15.96	16	100	347	160	160	20.0		15	
		10:29	95	626096	4.8	10.35	10.4	100	347	160	160	20.0		16	
		10:34	100	626151											
	Averages								347.2	159.7	159.6	19.9		11.8	n.m

Final gas meter reading 626151 l End Time 10:34

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.926
K factor, (K_i independent of C_p)	3.056
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		08:43	10:36
End Time		08:45	10:38
Initial meter reading	m^3	624.724	626.1508
Final meter reading	m^3	624.7242	626.1511
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.1	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	14.1 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	100 min
Theoretical isokinetic sample volume SV_t	2627.00 l
Actual sample volume (SV_a)	2835.12 l
Approach to isokinetic sampling (AI)	107.9 %

where Vduct is the average duct velocity based on the above measurements

$V_{Duct} = C_p \times (1-\varepsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV_t is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_t = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

Sv_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{Baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	2.49 m^3/s
Flow rate at STP (Q_{STP})	1.07 m^3/s
Flow rate at reference conditions (Q_{Ref})	0.39 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{Ref} + 273)/(T_{duct} + 273)] \times (P_{Baro}/P_{Ref})$

$Q_{Ref} = Q_{STP} \times [(20.9 - O_{2Ref})/(20.9 - O_{2duct})] \times [(100 - H_2O_{duct})/(100 - H_2O_{Ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 8 (a)

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012447	012452
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7658	0.8387
after 2 min	g		0.7658	0.8388
after 3 min	g		0.7658	0.8388
Weight extrapolated to zero time (M_{fi0})	g		0.7658	0.8387
Post-sampling weights				
after 1 min	g		0.7656	0.8925
after 2 min	g		0.7656	0.8924
after 3 min	g		0.7657	0.8923
Weight extrapolated to zero time (M_{ff0})	g		0.7655	0.8926

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		71.0315	67.5174
after 2 min	g		71.0314	67.5173
after 3 min	g		71.0314	67.5172
Weight extrapolated to zero time (M_{ri0})	g		71.0315	67.5175
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		71.0313	67.5265
after 2 min	g		71.0313	67.5264
after 3 min	g		71.0313	67.5262
Weight extrapolated to zero time (M_{rf0})	g		71.0313	67.5267

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0003	0.0539
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	-0.0002	0.0092
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0000	0.0631

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m³

SUMMARY OF MEASUREMENTS Test Ref crem 8 (a)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = M x 1000/ SV_{Ref}

Discharge rate, kg/h = C x Q_{Ref} x 0.0036

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m^3	0.00	143.60
Uncertainty	mg/m^3	0.00	8.84
Particulate concentration at duct conditions (raw)	mg/m^3	0.00	22.26
Particulate discharge rate	kg/h	0.00	0.20
Uncertainty	kg/h	#DIV/0!	0.02

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.00	1.83
Filter weighings (m_f)	mg	-0.27	0.57
Rinsings weighings (m_w)	mg	-0.23	0.50
Total for uncorrected measurement (U_u)	mg	0.35	1.98
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	0.35	1.98
Concentration at 95% confidence interval (U_{95c})	mg/m^3	0.00	8.84

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is less than 2 mg/m3 (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	06-Jan-10
Sample point	Cremator 8 run 1	Time start	08:54
Test carried out by	S Huntley & T Swannack	Time End	10:34
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	100
		Sampling conditions	crem 8 (a)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	660
Volume of sampling solution in field blank (Vsb)	ml	245
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	29.70
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

C_g (mg/m³) = $(\{[V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]\} \times MW_c).(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	45.87
Uncertainty (95% confidence limit)	mg/m³	5.27
Uncertainty as a proportion of ELV	%	2.64
Discharge rate (D_g)	kg/h	0.064
Uncertainty (95% confidence limit)	kg/h	0.010
Detection limit	mg/m³	0.154

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_u)	mg/m³	2.69
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m³	5.273

Based on Procedure 55 and Uncertainty Policies 11 & 16
(In accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London	Date	6-Jan-10
Site	Crematorium	Test Ref	crem 8 (a)
Sample point	Cremator 8, run 1	Time Start	08:58
Test carried out by	S Huntley & T Swannack	Time End	10:37

Measurements: 5 minutes' averaging period

Start	End	No.	Maximum	Minimum	Average	Maximum	Minimum	Average
		Readings	ppm , dry			$mgCO/m^3$, ref. cond.		
08:58	09:02	20	16	<5	9	61	16	32
09:03	09:07	20	13	<5	8	63	9	27
09:08	09:12	20	6	<5	<5	25	7	14
09:13	09:17	20	<5	<5	<5	8	<5	<5
09:18	09:22	20	<5	<5	<5	<5	<5	<5
09:23	09:27	20	<5	<5	<5	7	<5	<5
09:28	09:32	20	<5	<5	<5	15	<5	8
09:33	09:37	20	<5	<5	<5	5	<5	<5
09:38	09:42	20	<5	<5	<5	<5	<5	<5
09:43	09:47	20	<5	<5	<5	<5	<5	<5
09:48	09:52	20	<5	<5	<5	7	<5	<5
09:53	09:57	20	<5	<5	<5	<5	<5	<5
09:58	10:02	20	<5	<5	<5	<5	<5	<5
10:03	10:07	20	<5	<5	<5	<5	<5	<5
10:08	10:12	20	<5	<5	<5	<5	<5	<5
10:13	10:17	20	<5	<5	<5	<5	<5	<5
10:18	10:22	20	<5	<5	<5	<5	<5	<5
10:23	10:27	20	<5	<5	<5	<5	<5	<5
10:28	10:32	20	<5	<5	<5	<5	<5	<5
10:33	10:37	20	<5	<5	<5	<5	<5	<5
08:58	10:37	400	16	<5	<5	63	<5	<5

Summary of measurements

Average concentration	<5 $mgCO/m^3$
Uncertainty	5 $mgCO/m^3$
Discharge rate	<0.0069588 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

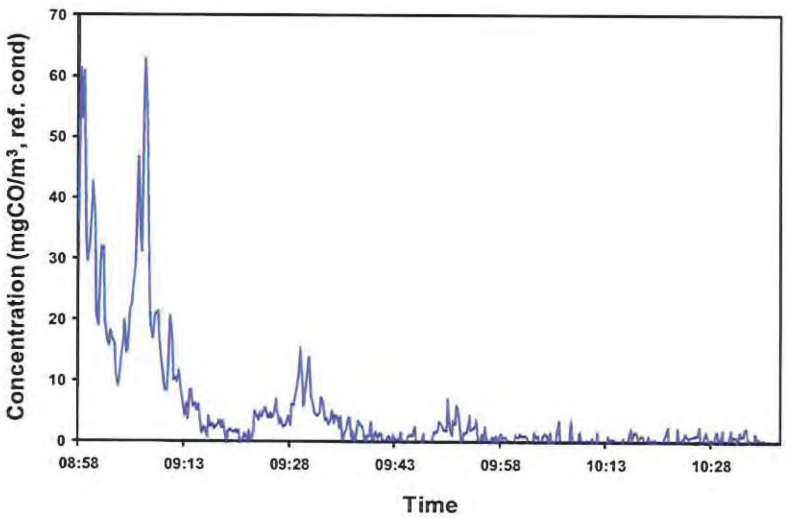
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.15
Gas into system before sampling	ppm	0.40	25.30
Gas into system after sampling	ppm	0.30	25.40
Drift	% span	0.40	0.40
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm CO	$mgCO/m^3$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kPa	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.50	% range/10K	0.01	0.01	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 8, run 1



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London	Date	6-Jan-10
Site	Crematorium	Test Ref	crem 8 (a)
Sample point	Cremator 8, run 1	Time Start	08:54
Test carried out by	S Huntley & T Swannack	Time End	10:34

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum (ppm, wet)	Minimum (ppm, wet)	Average (ppm, wet)	Maximum (mgCarbon/m3, ref cond.)	Minimum (mgCarbon/m3, ref cond.)	Average (mgCarbon/m3, ref cond.)
08:54	08:59	10	<1	<1	<1	3.6	<1	2.6
08:59	09:04	10	<1	<1	<1	2.9	2.3	2.5
09:04	09:09	10	<1	<1	<1	3.3	1.6	2.4
09:09	09:14	10	<1	<1	<1	1.6	1.3	1.4
09:14	09:19	10	<1	<1	<1	1.0	<1	<1
09:19	09:24	10	<1	<1	<1	<1	<1	<1
09:24	09:29	10	<1	<1	<1	<1	<1	<1
09:29	09:34	10	<1	<1	<1	<1	<1	<1
09:34	09:39	10	<1	<1	<1	<1	<1	<1
09:39	09:44	10	<1	<1	<1	<1	<1	<1
09:44	09:49	10	<1	<1	<1	<1	<1	<1
09:49	09:54	10	<1	<1	<1	<1	<1	<1
09:54	09:59	10	<1	<1	<1	<1	<1	<1
09:59	10:04	10	<1	<1	<1	<1	<1	<1
10:04	10:09	10	<1	<1	<1	<1	<1	<1
10:09	10:14	10	<1	<1	<1	<1	<1	<1
10:14	10:19	10	<1	<1	<1	<1	<1	<1
10:19	10:24	10	<1	<1	<1	<1	<1	<1
10:24	10:29	10	<1	<1	<1	<1	<1	<1
10:29	10:34	10	<1	<1	<1	<1	<1	<1
08:54	10:34	200	<1	<1	<1	3.6	<1	<1

Summary of measurements

Average concentration	<1 mgCarbon/m3
Uncertainty	1 mgCarbon/m3
Discharge rate	<0.00139176 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

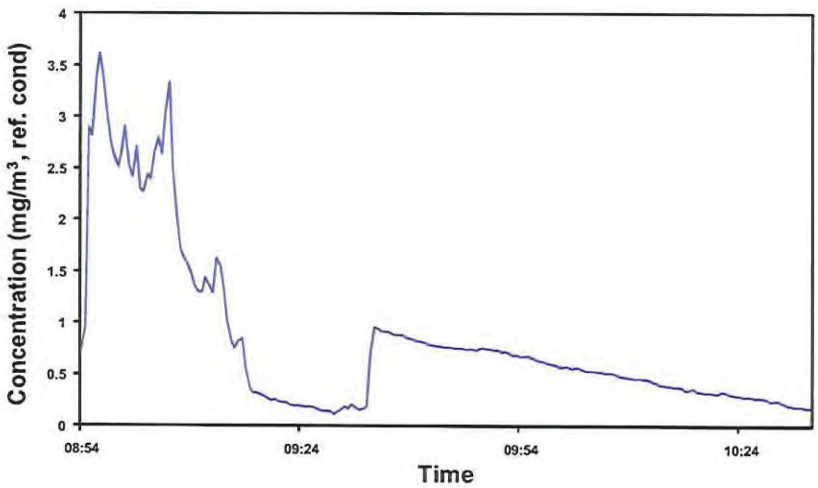
Type	Bernath 3006	Range	0 to 10 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.42	8.90
Gas into system before sampling	ppm	-0.44	8.88
Gas into system after sampling	ppm	-0.26	8.94
Drift	% span	2.02	0.68
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm	mg/m³	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.19	0.03
Zero drift	$u(Corr_{0,dr})$	-		2.00	% range	0.12	0.19	0.03
Span drift	$u(Corr_{s,dr})$	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	$u(Corr_{s,u})$	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	$u(Corr_{adpress})$	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	2.00	% range/10K	0.01	0.01	0.00
Electric voltage	$u(Corr_{volt})$	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	$u(Corr_{int})$	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	$u(Corr_{leak})$	-		0.40	% range	0.02	0.04	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	$u(Corr_{s,rep})$	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	$u(C_{VOC})$							0.63
Expanded uncertainty	$U(C_{VOC})$							1.24
$U(C_{VOC})$:ELV (%)								6.20

Measured concentration of Volatile Organic Compounds at Cremator 8, run 1



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SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London
Site	Crematorium
Sample point	Cremator 8, run 1
Test carried out by	S Huntley & T Swannack

Date	6-Jan-10
Test Ref	crem 8 (a)
Time Start	08:58
Time End	10:37

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			% dry		
08:58	09:02	20	17.9	17.2	17.5	17.9	17.2	17.5
09:03	09:07	20	18.4	16.0	17.0	18.4	16.0	17.0
09:08	09:12	20	18.4	17.2	17.6	18.4	17.2	17.6
09:13	09:17	20	17.4	16.7	17.0	17.4	16.7	17.0
09:18	09:22	20	16.9	16.7	16.8	16.9	16.7	16.8
09:23	09:27	20	16.8	16.2	16.5	16.8	16.2	16.5
09:28	09:32	20	18.6	16.2	17.8	18.6	16.2	17.8
09:33	09:37	20	18.3	17.6	17.9	18.3	17.6	17.9
09:38	09:42	20	17.8	15.9	16.8	17.8	15.9	16.8
09:43	09:47	20	17.4	16.2	16.6	17.4	16.2	16.6
09:48	09:52	20	18.7	17.3	18.1	18.7	17.3	18.1
09:53	09:57	20	18.0	16.8	17.4	18.0	16.8	17.4
09:58	10:02	20	17.3	16.3	16.8	17.3	16.3	16.8
10:03	10:07	20	17.3	16.7	17.0	17.3	16.7	17.0
10:08	10:12	20	17.4	16.7	17.0	17.4	16.7	17.0
10:13	10:17	20	17.1	16.2	16.7	17.1	16.2	16.7
10:18	10:22	20	17.5	16.1	17.0	17.5	16.1	17.0
10:23	10:27	20	17.8	17.5	17.6	17.8	17.5	17.6
10:28	10:32	20	18.1	17.4	17.5	18.1	17.4	17.5
10:33	10:37	20	18.1	16.9	17.4	18.1	16.9	17.4
08:58	10:37	400	18.7	15.9	17.2	18.7	15.9	17.2

Summary of measurements

Average concentration	17.2 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

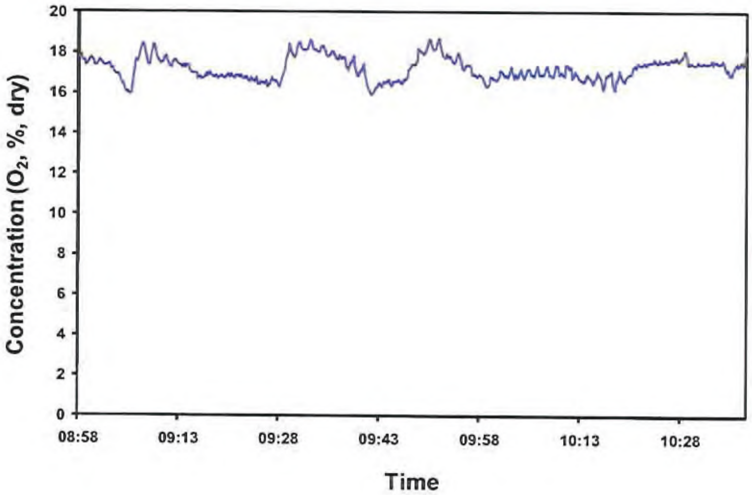
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.10
Gas into system after sampling	%	0.10	13.16
Drift	% span	0.76	0.46
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%O_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	-		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	1	K	0.40	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})$:C_{O2}(%)							3.61

Measured concentration of Oxygen at Cremator 8, run 1



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London
Site	Crematorium
Sample point	Cremator 8, run 1
Test carried out by	S Huntley & T Swannack

Date	6-Jan-10
Test Ref	crem 8 (a)
Time Start	08:58
Time End	10:37

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
08:58	09:02	20	2.8	2.4	2.6	7.9	7.3	7.5
09:03	09:07	20	4.4	2.0	3.2	8.8	7.4	7.9
09:08	09:12	20	2.5	1.8	2.3	7.3	6.5	6.9
09:13	09:17	20	3.2	2.4	2.8	7.4	6.8	7.1
09:18	09:22	20	3.1	2.8	2.9	7.4	6.9	7.1
09:23	09:27	20	3.4	2.9	3.1	7.5	6.9	7.1
09:28	09:32	20	3.5	1.5	2.1	7.5	6.1	6.6
09:33	09:37	20	2.1	1.7	1.9	6.6	6.1	6.3
09:38	09:42	20	3.4	2.1	2.7	6.8	6.4	6.6
09:43	09:47	20	3.2	2.4	2.9	6.9	6.5	6.7
09:48	09:52	20	2.3	1.4	1.8	6.6	6.1	6.2
09:53	09:57	20	2.8	1.9	2.3	6.7	6.2	6.4
09:58	10:02	20	3.1	2.5	2.8	6.8	6.4	6.6
10:03	10:07	20	2.8	2.4	2.6	6.8	6.4	6.6
10:08	10:12	20	2.7	2.3	2.5	6.7	6.1	6.4
10:13	10:17	20	3.1	2.4	2.7	6.4	6.1	6.3
10:18	10:22	20	3.1	2.1	2.5	6.3	6.1	6.2
10:23	10:27	20	2.2	1.9	2.1	6.3	6.0	6.2
10:28	10:32	20	2.2	1.7	2.1	6.1	5.9	6.0
10:33	10:37	20	2.4	1.7	2.1	6.0	5.8	5.9
08:58	10:37	400	4.4	1.4	2.5	8.8	5.8	6.6

Summary of measurements

Average concentration	6.6 $\%CO_2$
Uncertainty	0.8 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

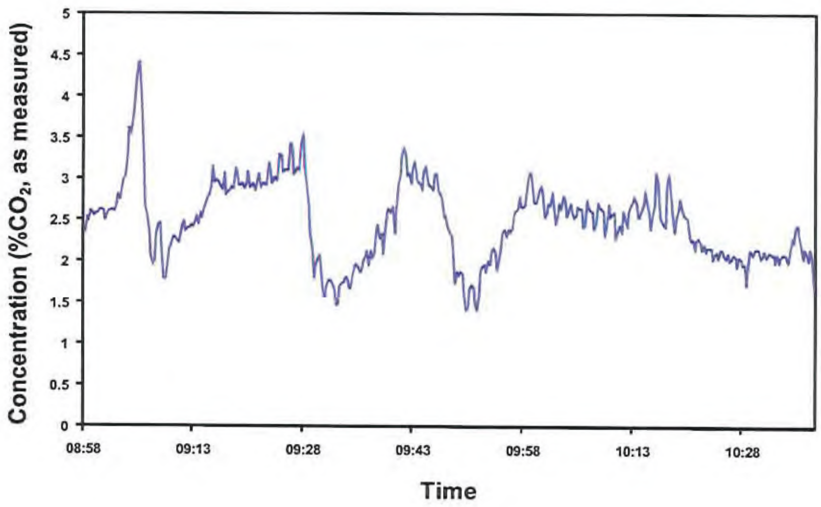
Type	Horiba PG 250	Range	0 to 10 %
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.10
Gas into system before sampling	%	0.08	5.12
Gas into system after sampling	%	0.15	5.19
Drift	% span	1.38	1.37
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%CO_2$	
Lack of fit	u($Corr_{fit}$)	-		2.00	% range	0.12	0.01
Zero drift	u($Corr_{0,dr}$)	-		0.26	% range	0.02	0.00
Span drift	u($Corr_{s,dr}$)	-		0.29	% range	0.02	0.00
Sample volume flow	u($Corr_{s,vf}$)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u($Corr_{apress}$)	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	1	K	0.50	% range/10K	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u($Corr_{int}$)	-		1.60	% range	0.09	0.01
Losses & leakage	u($Corr_{leak}$)	-		0.00	% range	0.00	0.00
Repeatability at zero	u($Corr_{z,rep}$)	-		0.14	% range	0.01	0.00
Repeatability at span	u($Corr_{s,rep}$)	-		0.00	% range	0.00	0.00
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00
Calibration gas	u($Corr_{adj}$)	-		1.00	% value	0.05	0.00
Combined uncertainty	u(C_{CO2})						0.16
Expanded uncertainty	U(C_{CO2})						0.31
U(C_{CO2}):C_{CO2}(%)							12.44

Measured concentration of Carbon Dioxide at Cremator 8, run 1



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	h2o 8 (a)
Site	Crematorium	Date	06-Jan-10
Sample point	Cremator 8 run 1	Time start	08:54
Test carried out by	S Huntley & T Swannack	Time End	10:34
		Duration (min)	100
		Data from	crem 8 (a)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	758.88	774.32	15.44
Container 2	674.65	678.18	3.53
Container 3	497.59	499.73	2.14
Container 4	912.64	923.95	11.31
Total (M)	2843.76	2876.18	32.42

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i)....(Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

$$SV_{STP} = SV_M \times (273/(273 + T_M) \times (P_M/101.3)$$

Volume of dry gas sampled at STP (SV_{STP})	m^3	1.1737

Calculation of water vapour content (H_2O_{duct})

$$H_2O_{duct} = 100 \times (M \times MV_{STP}/MW_{H2O})/[SV_{STP} + (M \times MV_{STP}/MW_{H2O})]$$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)
MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	3.32 ± 0.18

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is below 1.25% (Clause 5.8)
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	1.174 m^3
Average temperature of gas at meter	T	19.9 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.000125 m^3/min
Duration of sampling	t	100 min
Total mass weighed	M	2876.18 g

Source of uncertainty		Value		Value of standard uncertainty		Relative standard uncertainty (%)	
Measurement of sample gas volume	u,V_m	2.0 %	u_v	u_s,V_m =	0.0136 m^3	u_r,V_m	1.15
Measurement of sample gas temperature	u,T_m	1.0 %	u_t	u_s,T_m =	1.6911 K	u_r,T_m	0.58
Measurement of absolute pressure	u,P_m	1.0 %	u_p	u_s,P_m =	5.6027 mb	u_r,P_m	0.58
Leakage in sampling line	u,L	1.1 %	u_l	u_s,L =	0.0072 m^3	u_r,L	0.61
Measurement of weight - balance uncertainty	u,W_m	0.01 %	u_{wm}	u_s,W_m =	0.1661 g		-
Measurement of weight - balance repeatability	u,W_r	0.011 g	u_{wr}	u_s,W_r =	0.0110 g		-
Total measurement of weight	u,W	-	-	u_s,W =	0.1771 g	u_r,W	0.55

Total standard relative uncertainty	$u_r = \sqrt{u_r V_m^2 + u_r T_m^2 + u_r P_m^2 + u_r L^2 + u_r W^2 + Corr}$	2.82 %
Total relative uncertainty	$U_r = 1.96 u_r$	5.53 %

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London
Site	Crematorium
Sample point	Cremator 8 run 2
Test carried out by	S Huntley & T Swannack

Test Ref: crem 8 (b)

SAMPLING TIMES

Determination		TPM
Date		06-Jan-10
Time Start		11:14
Time End		12:54
Duration (t)	min	100

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		TPM
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	347.4
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.28
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_a)		0.54
Exhaust gas conditions measurements		crem 8 (b)

Reference conditions

Determination		TPM
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	347.4
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	17.50
Water vapour (H_2O_{duct})	%vol	3.97
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		TPM
Nozzle diameter (d) TI24 Titanium	mm	6.280
Initial gas meter reading	m^3	626.274
Final gas meter reading	m^3	627.396
Sampled volume (SV_M)	m^3	1.122

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times \gamma \times$	$[273+T_{Ref}]/[273+T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100-H_2O_{Meter}]/[100-H_2O_{Ref}]$	Water vapour
			$[20.9-O_{2Duct}]/[20.9-O_{2Ref}]$	Oxygen

Determination		TPM
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.324

SAMPLING DATA TPM

Test Ref crem 8 (b)

Initial gas meter reading 626274 l   Start Time 11:14

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH_d) =h x K_i x Cp^2	Actual (ΔH_a)	Isokinetic difference ($\Delta H_a/\Delta H_d$) %	Temperatures Gas (T_{duct}) (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Outlet °C	Impinger (T_{imp}) °C	Oxygen Content %, v/v, dry
0.500	A	11:14	0	626274	6.2	13.37	13.4	100	346	157	156	21.0		8	
		11:19	5	626335	11	23.72	23.7	100	348	158	156	21.0		11	
		11:24	10	626417	13.4	28.89	29	100	348	160	160	21.0		11	
		11:29	15	626502	6.3	13.58	13.6	100	347	160	160	21.0		12	
		11:34	20	626565	4.8	10.35	10.4	100	347	160	160	20.0		14	
		11:39	25	626622	3.4	7.33	7.3	100	347	160	160	21.0		14	
		11:44	30	626671	4.1	8.84	8.8	100	347	160	160	21.0		15	
		11:49	35	626722	6.3	13.58	13.6	100	347	160	160	21.0		16	
		11:54	40	626784	5.1	11.00	11	100	346	160	160	20.0		16	
		11:59	45	626843	6.2	13.37	13.4	100	345	160	160	21.0		17	
		12:04	50	626901	4.7	10.13	10.1	100	347	160	160	21.0		18	
		12:09	55	626961	5.1	11.00	11	100	348	160	160	21.0		19	
		12:14	60	627001	4.9	10.57	10.6	100	347	160	160	21.0		7	
		12:19	65	627066	4.1	8.84	8.8	100	347	160	160	21.0		8	
		12:24	70	627118	4.3	9.27	9.3	100	348	160	160	21.0		8	
		12:29	75	627167	4	8.62	8.6	100	349	160	160	20.0		9	
		12:34	80	627217	3.8	8.19	8.2	100	349	160	160	20.0		11	
		12:39	85	627267	3.6	7.76	7.8	100	351	160	160	20.0		12	
		12:44	90	627313	2.4	5.17	5.2	100	347	160	160	20.0		14	
		12:49	95	627354	2.8	6.04	6	99	347	160	160	20.0		16	
		12:54	100	627396											
	Averages								347.4	159.8	159.6	20.7		12.8	n.m

Final gas meter reading 627396 l   End Time 12:54

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (y)	0.926
K factor, (K_i independent of C_p)	3.056
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		11:05	12:56
End Time		11:07	12:58
Initial meter reading	m^3	626.2742	627.3963
Final meter reading	m^3	626.2744	627.3966
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.1	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	11.3 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	100 min
Theoretical isokinetic sample volume SV_i	2108.96 l
Actual sample volume (SV_a)	2287.15 l
Approach to isokinetic sampling (ΔI)	108.4 %

where Vduct is the average duct velocity based on the above measurements

$V_{Duct} = C_p \times (1-\varepsilon) \times \sqrt{2/\rho_a} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV_i is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_i = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

Sv_a is the sample volume at duct conditions

$SV_a = SV_m \times y \times [(273 + T_{duct})/(273 + T_m)] \times (P_{Baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	2.00 m^3/s
Flow rate at STP (Q_{STP})	0.86 m^3/s
Flow rate at reference conditions (Q_{Ref})	0.28 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{Ref} + 273)/(T_{duct} + 273)] \times (P_{Baro}/P_{Ref})$

$Q_{Ref} = Q_{STP} \times [(20.9 - O_{2Ref})/(20.9 - O_{2duct})] \times [(100 - H_2O_{duct})/(100 - H_2O_{Ref})]$

PARTICULATE WEIGHINGS

Test Ref crem 8 (b)

Filters

Determination		Method Blank	Field Blank	TPM
Filter No.		xxxxxxx	012447	012444
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7658	0.7375
after 2 min	g		0.7658	0.7375
after 3 min	g		0.7658	0.7376
Weight extrapolated to zero time (M_{fi0})	g		0.7658	0.7374
Post-sampling weights				
after 1 min	g		0.7656	0.7652
after 2 min	g		0.7656	0.7652
after 3 min	g		0.7657	0.7652
Weight extrapolated to zero time (M_{ff0})	g		0.7655	0.7652

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		71.0315	61.5509
after 2 min	g		71.0314	61.5508
after 3 min	g		71.0314	61.5508
Weight extrapolated to zero time (M_{ri0})	g		71.0315	61.5509
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		71.0313	61.5580
after 2 min	g		71.0313	61.5579
after 3 min	g		71.0313	61.5577
Weight extrapolated to zero time (M_{rf0})	g		71.0313	61.5582

Summary

Determination		Method Blank (M_{mb})	Field Blank	TPM
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0003	0.0278
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	-0.0002	0.0072
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0000	0.0350

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m^3

SUMMARY OF MEASUREMENTS

Test Ref crem 8 (b)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = $M \times 1000 / SV_{Ref}$

Discharge rate, kg/h = $C \times Q_{Ref} \times 0.0036$

Determination		Field Blank	TPM
Particulate concentration at reference conditions	mg/m^3	0.00	108.18
Uncertainty	mg/m^3	0.00	7.68
Particulate concentration at duct conditions (raw)	mg/m^3	0.00	15.30
Particulate discharge rate	kg/h	0.00	0.11
Uncertainty	kg/h	#DIV/0!	0.01

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	TPM
Volume measurement (m_{vol})	mg	0.00	1.01
Filter weighings (m_f)	mg	-0.27	0.57
Rinsings weighings (m_w)	mg	-0.23	0.50
Total for uncorrected measurement (U_u)	mg	0.35	1.27
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	0.35	1.27
Concentration at 95% confidence interval (U_{95c})	mg/m^3	0.00	7.68

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$

$U_c = \sqrt{U_u^2 + m_{corr}^2}$

$U_{95c} = 1.96 \times U_c / SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is less than 2 mg/m3 (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	06-Jan-10
Sample point	Cremator 8 run 2	Time start	11:14
Test carried out by	S Huntley & T Swannack	Time End	12:54
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	100
		Sampling conditions	crem 8 (b)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	650
Volume of sampling solution in field blank (Vsb)	ml	245
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	23.10
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

$C_g\ (mg/m^3) = ([V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]) \times MW_c)_*(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	47.72
Uncertainty (95% confidence limit)	mg/m³	5.49
Uncertainty as a proportion of ELV	%	2.74
Discharge rate (D_g)	kg/h	0.049
Uncertainty (95% confidence limit)	kg/h	0.008
Detection limit	mg/m³	0.207

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_u)	mg/m³	2.80
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m³	5.486

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling within 10% of isokinetic conditions (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London
Site	Crematorium
Sample point	Cremator 8, run 2
Test carried out by	S Huntley & T Swannack

Date	6-Jan-10
Test Ref	crem 8 (b)
Time Start	11:21
Time End	12:56

Measurements: 5 minutes' averaging period

Start	End	No.	Maximum	Minimum	Average	Maximum	Minimum	Average
		Readings	ppm , dry			mgCO/m³, ref. cond.		
11:21	11:26	20	6	<5	<5	38	5	20
11:26	11:31	20	<5	<5	<5	10	<5	<5
11:31	11:36	20	<5	<5	<5	<5	<5	<5
11:36	11:41	20	<5	<5	<5	<5	<5	<5
11:41	11:46	20	<5	<5	<5	<5	<5	<5
11:46	11:51	20	<5	<5	<5	<5	<5	<5
11:51	11:56	20	<5	<5	<5	<5	<5	<5
11:56	12:01	20	<5	<5	<5	<5	<5	<5
12:01	12:06	20	<5	<5	<5	<5	<5	<5
12:06	12:11	20	<5	<5	<5	<5	<5	<5
12:11	12:16	20	<5	<5	<5	<5	<5	<5
12:16	12:21	20	<5	<5	<5	<5	<5	<5
12:21	12:26	20	<5	<5	<5	<5	<5	<5
12:26	12:31	20	<5	<5	<5	<5	<5	<5
12:31	12:36	20	<5	<5	<5	<5	<5	<5
12:36	12:41	20	<5	<5	<5	<5	<5	<5
12:41	12:46	20	<5	<5	<5	<5	<5	<5
12:46	12:51	20	8	<5	<5	35	<5	<5
12:51	12:56	20	<5	<5	<5	9	<5	<5
11:21	12:56	380	8	<5	<5	38	<5	<5

Summary of measurements

Average concentration	<5 mgCO/m³
Uncertainty	5 mgCO/m³
Discharge rate	<0.0050994 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

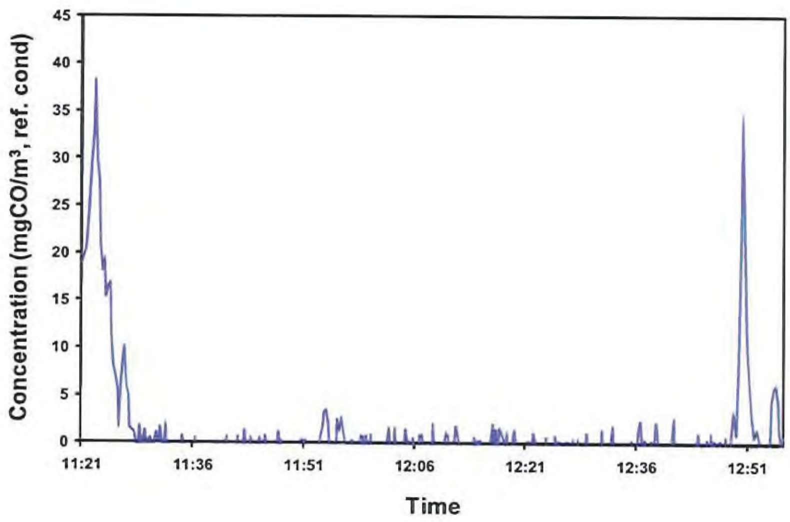
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.15
Gas into system before sampling	ppm	0.40	25.30
Gas into system after sampling	ppm	0.30	25.40
Drift	% span	0.40	0.40
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm CO	$mgCO/m^3$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,v})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	0	K	0.50	% range/10K	0.00	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 8, run 2



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London	Date	6-Jan-10
Site	Crematorium	Test Ref	crem 8 (b)
Sample point	Cremator 8, run 2	Time Start	11:14
Test carried out by	S Huntley & T Swannack	Time End	12:54

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm, wet			mgCarbon/m3, ref cond.		
11:14	11:19	10	<1	<1	<1	<1	<1	<1
11:19	11:24	10	<1	<1	<1	<1	<1	<1
11:24	11:29	10	<1	<1	<1	<1	<1	<1
11:29	11:34	10	<1	<1	<1	<1	<1	<1
11:34	11:39	10	<1	<1	<1	<1	<1	<1
11:39	11:44	10	<1	<1	<1	<1	<1	<1
11:44	11:49	10	<1	<1	<1	<1	<1	<1
11:49	11:54	10	<1	<1	<1	<1	<1	<1
11:54	11:59	10	<1	<1	<1	<1	<1	<1
11:59	12:04	10	<1	<1	<1	<1	<1	<1
12:04	12:09	10	<1	<1	<1	<1	<1	<1
12:09	12:14	10	<1	<1	<1	<1	<1	<1
12:14	12:19	10	<1	<1	<1	<1	<1	<1
12:19	12:24	10	<1	<1	<1	<1	<1	<1
12:24	12:29	10	<1	<1	<1	<1	<1	<1
12:29	12:34	10	<1	<1	<1	<1	<1	<1
12:34	12:39	10	<1	<1	<1	<1	<1	<1
12:39	12:44	10	<1	<1	<1	<1	<1	<1
12:44	12:49	10	<1	<1	<1	<1	<1	<1
12:49	12:54	10	<1	<1	<1	<1	<1	<1
11:14	12:54	200	<1	<1	<1	<1	<1	<1

Summary of measurements

Average concentration	<1 mgCarbon/m3
Uncertainty	1 mgCarbon/m3
Discharge rate	<0.00101988 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

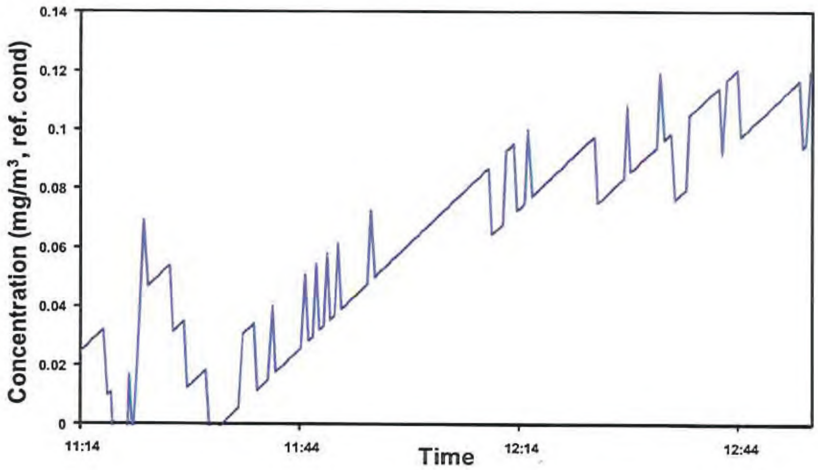
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.42	8.90
Gas into system before sampling	ppm	-0.26	8.94
Gas into system after sampling	ppm	-0.31	8.74
Drift	% span	0.56	2.24
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm	mg/m^3	
Lack of fit	u($Corr_{fit}$)	-		2.00	% range	0.12	0.19	0.03
Zero drift	u($Corr_{0,dr}$)	-		2.00	% range	0.12	0.19	0.03
Span drift	u($Corr_{s,dr}$)	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	u($Corr_{s,vl}$)	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	u($Corr_{apress}$)	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	0	K	2.00	% range/10K	0.00	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	u($Corr_{int}$)	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	u($Corr_{leak}$)	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	u($Corr_{z,rep}$)	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	u($Corr_{s,rep}$)	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u($Corr_{adj}$)	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	u(C_{VOC})							0.63
Expanded uncertainty	U(C_{VOC})							1.24
U(C_{VOC}):ELV (%)								6.19

Measured concentration of Volatile Organic Compounds at Cremator 8, run 2



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London	Date	6-Jan-10
Site	Crematorium	Test Ref	crem 8 (b)
Sample point	Cremator 8, run 2	Time Start	11:21
Test carried out by	S Huntley & T Swannack	Time End	12:56

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
				%, dry			% dry	
11:21	11:26	20	19.0	17.9	18.3	19.0	17.9	18.3
11:26	11:31	20	18.0	16.7	17.3	18.0	16.7	17.3
11:31	11:36	20	17.5	16.7	17.0	17.5	16.7	17.0
11:36	11:41	20	18.2	17.2	17.4	18.2	17.2	17.4
11:41	11:46	20	18.0	17.1	17.6	18.0	17.1	17.6
11:46	11:51	20	18.2	17.0	17.4	18.2	17.0	17.4
11:51	11:56	20	18.3	17.3	17.7	18.3	17.3	17.7
11:56	12:01	20	17.6	17.3	17.5	17.6	17.3	17.5
12:01	12:06	20	17.9	17.5	17.7	17.9	17.5	17.7
12:06	12:11	20	18.0	17.3	17.5	18.0	17.3	17.5
12:11	12:16	20	17.8	17.4	17.5	17.8	17.4	17.5
12:16	12:21	20	18.2	17.5	17.8	18.2	17.5	17.8
12:21	12:26	20	17.5	17.5	17.5	17.5	17.5	17.5
12:26	12:31	20	17.9	17.4	17.7	17.9	17.4	17.7
12:31	12:36	20	17.7	17.0	17.2	17.7	17.0	17.2
12:36	12:41	20	17.5	17.0	17.4	17.5	17.0	17.4
12:41	12:46	20	19.0	17.0	17.7	19.0	17.0	17.7
12:46	12:51	20	18.1	16.8	17.4	18.1	16.8	17.4
12:51	12:56	20	18.1	16.5	17.3	18.1	16.5	17.3
11:21	12:56	380	19.0	16.5	17.5	19.0	16.5	17.5

Summary of measurements

Average concentration	17.5 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

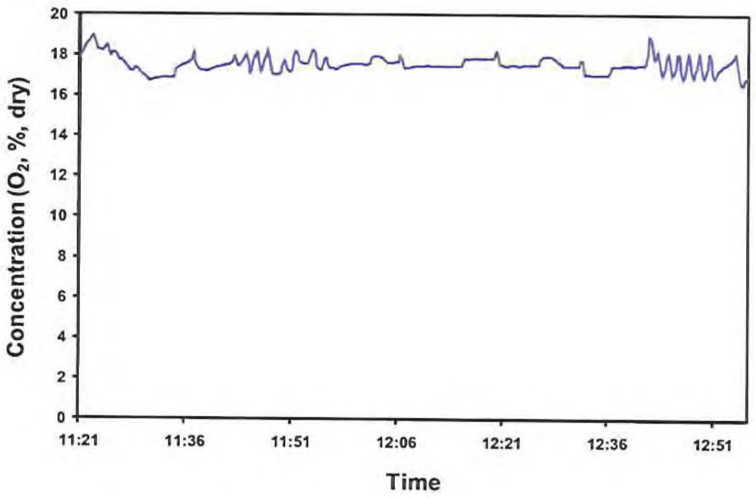
Type	Horiba PG 250	**Range**	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.10
Gas into system after sampling	%	0.10	13.16
Drift	% span	0.76	0.46
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%O_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	-		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	0	K	0.40	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2}):C_{O2}(\%)$							3.54

Measured concentration of Oxygen at Cremator 8, run 2



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London
Site	Crematorium
Sample point	Cremator 8, run 2
Test carried out by	S Huntley & T Swannack

Date	6-Jan-10
Test Ref	crem 8 (b)
Time Start	11:21
Time End	12:56

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
11:21	11:26	20	2.5	1.5	1.9	8.3	6.7	7.4
11:26	11:31	20	3.1	2.1	2.7	7.5	7.2	7.4
11:31	11:36	20	3.1	2.7	3.0	7.8	7.4	7.5
11:36	11:41	20	2.7	2.1	2.6	7.8	7.2	7.4
11:41	11:46	20	2.5	2.0	2.3	7.1	6.6	6.9
11:46	11:51	20	2.6	1.8	2.3	6.8	6.4	6.6
11:51	11:56	20	2.3	1.7	2.1	6.6	6.3	6.5
11:56	12:01	20	2.3	2.1	2.2	6.3	6.1	6.2
12:01	12:06	20	2.1	1.9	2.0	6.2	6.1	6.2
12:06	12:11	20	2.2	1.8	2.1	6.2	6.0	6.1
12:11	12:16	20	2.1	1.9	2.1	6.1	6.0	6.0
12:16	12:21	20	2.0	1.6	1.9	6.1	5.9	6.1
12:21	12:26	20	2.1	2.0	2.1	6.0	6.0	6.0
12:26	12:31	20	2.1	1.8	1.9	6.0	5.9	6.0
12:31	12:36	20	2.3	1.9	2.2	6.0	5.8	5.9
12:36	12:41	20	2.3	2.0	2.1	5.9	5.9	5.9
12:41	12:46	20	2.3	1.1	1.8	5.9	5.6	5.8
12:46	12:51	20	2.4	1.6	2.0	5.9	5.7	5.8
12:51	12:56	20	2.6	1.6	2.1	5.9	5.7	5.8
11:21	12:56	380	3.1	1.1	2.2	8.3	5.6	6.4

Summary of measurements

Average concentration	6.4 $\%CO_2$
Uncertainty	0.9 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

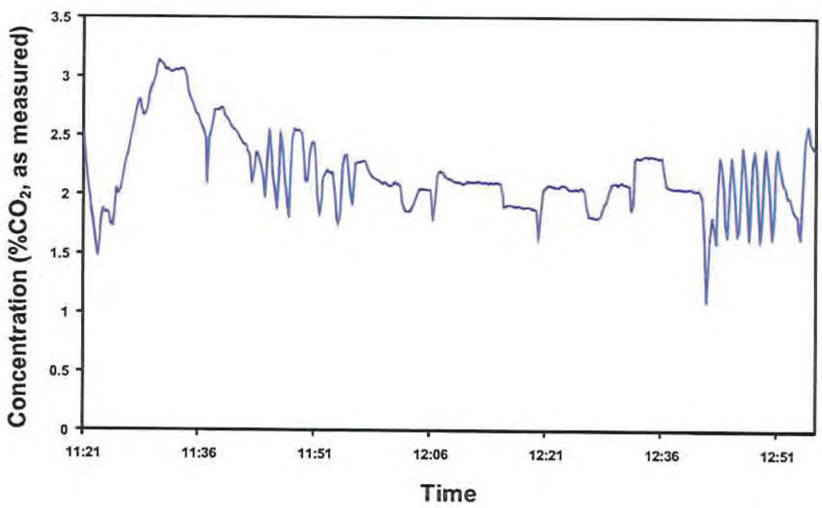
Type Horiba PG 250 **Range** 0 to 10 %
Equipment No. P1301
Measurement method Non-dispersive infra-red

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.10
Gas into system before sampling	%	0.08	5.12
Gas into system after sampling	%	0.15	5.19
Drift	% span	1.38	1.37
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						%CO_2	
Lack of fit	u($Corr_{fit}$)	-		2.00	% range	0.12	0.01
Zero drift	u($Corr_{0,dr}$)	-		0.26	% range	0.02	0.00
Span drift	u($Corr_{s,dr}$)	-		0.29	% range	0.02	0.00
Sample volume flow	u($Corr_{s,vf}$)	-		0.00	% range	0.00	0.00
Atmospheric pressure	u($Corr_{apress}$)	0	kPa	0.00	% range/2kPa	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	0	K	0.50	% range/10K	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	0.00	% range/10V	0.00	0.00
Interferents	u($Corr_{int}$)	-		1.60	% range	0.09	0.01
Losses & leakage	u($Corr_{leak}$)	-		0.00	% range	0.00	0.00
Repeatability at zero	u($Corr_{z,rep}$)	-		0.14	% range	0.01	0.00
Repeatability at span	u($Corr_{s,rep}$)	-		0.00	% range	0.00	0.00
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00
Calibration gas	u($Corr_{adj}$)	-		1.00	% value	0.05	0.00
Combined uncertainty	u(C_{CO2})						0.16
Expanded uncertainty	U(C_{CO2})						0.31
U(C_{CO2}):C_{CO2}(%)							14.23

Measured concentration of Carbon Dioxide at Cremator 8, run 2



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 8 (b) h2o
Site	Crematorium	Date	06-Jan-10
Sample point	Cremator 8 run 2	Time start	11:14
Test carried out by	S Huntley & T Swannack	Time End	12:54
		Duration (min)	100
		Data from	crem 8 (b)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	678.18	694.26	16.08
Container 2	677.92	680.44	2.52
Container 3	499.43	501.32	1.89
Container 4	923.78	934.49	10.71
Total (M)	2779.31	2810.51	31.2

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i)....(Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

$$SV_{STP} = SV_M \times (273/(273 + T_M) \times (P_M/101.3)$$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.9403

Calculation of water vapour content (H_2O_{duct})

$$H_2O_{duct} = 100 \times (M \times MV_{STP}/MW_{H2O})/[SV_{STP} + (M \times MV_{STP}/MW_{H2O})]$$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)
MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	3.97 ± 0.24

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)
Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard
Leak rate is no more than 2% of sample flow rate
Sampling duration is within minimum of 30 minutes (Clause 6.1)
Sampling volume is within minimum of 50l (Clause 6.1)
Residual water content at outlet is above 1.25% (Clause 5.8) - outside standard
Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.940 m^3
Average temperature of gas at meter	T	20.7 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.000125 m^3/min
Duration of sampling	t	100 min
Total mass weighed	M	2810.51 g

Source of uncertainty		Value		Value of standard uncertainty		Relative standard uncertainty (%)	
Measurement of sample gas volume	u,V_m	2.0 %	u_v	u_s,V_m =	0.0109 m^3	u_r,V_m	1.15
Measurement of sample gas temperature	u,T_m	1.0 %	u_t	u_s,T_m =	1.6954 K	u_r,T_m	0.58
Measurement of absolute pressure	u,P_m	1.0 %	u_p	u_s,P_m =	5.6927 mb	u_r,P_m	0.58
Leakage in sampling line	u,L	1.3 %	u_l	u_s,L =	0.0072 m^3	u_r,L	0.77
Measurement of weight - balance uncertainty	u,W_m	0.01 %	u_{wm}	u_s,W_m =	0.1623 g		-
Measurement of weight - balance repeatability	u,W_r	0.011 g	u_{wr}	u_s,W_r =	0.0110 g		-
Total measurement of weight	u,W	-	-	u_s,W =	0.1733 g	u_r,W	0.56

Total standard relative uncertainty	$u_r = \sqrt{u_r.V_m^2 + u_r.T_m^2 + u_r.P_m^2 + u_r.L^2 + u_r.W^2} + Corr_r$	3.10 %
Total relative uncertainty	$U_r = 1.96u_r$	6.08 %

SCIENTIFICS MONITORING REPORT FORM
TOTAL PARTICULATE MATTER to BS EN 13284-1/BS ISO 9096

Company	City of London	Test Ref	crem 8 (c)
Site	Crematorium		
Sample point	Cremator 8 run 3		
Test carried out by	S Huntley & T Swannack		

SAMPLING TIMES

Determination		tpm
Date		06-Jan-10
Time Start		13:15
Time End		14:55
Duration (t)	min	100

Sampling plane

Dimension traversed by sampling probe (D)	m	0.42
Cross sectional area of sampling plane (A)	m^2	0.18

Duct gas conditions

Determination		tpm
Ambient temperature (T_{Amb})	°C	9.0
Average duct gas temperature (T_{duct})	°C	348.1
Duct static gas pressure (P_{Static})	kPa	-0.05
Barometric pressure (P_{Baro})	kPa	98.60
Volume flow rate @ ref. conditions (Q_{Ref})	m^3/s	0.25
Gas compressibility correction (ε)		0.995
Wet gas density (ρ_a)		0.54
Exhaust gas conditions measurements		crem 8 (c)

Reference conditions

Determination		tpm
Actual Duct Flow Conditions		
Average temperature (T_{duct})	°C	348.1
Total pressure (P_{duct})	kPa	98.55
Oxygen (O_{2duct})	%vol,dry	17.70
Water vapour (H_2O_{duct})	%vol	4.47
Reference Conditions		
Temperature (T_{Ref})	°C	0
Pressure (P_{Ref})	kPa	101.3
Oxygen (O_{2Ref})	%vol, dry	11
Water vapour (H_2O_{Ref})	%vol	0

Sampling conditions

Determination		tpm
Nozzle diameter (d) Ti24 Titanium	mm	6.280
Initial gas meter reading	m^3	627.571
Final gas meter reading	m^3	628.671
Sampled volume (SV_M)	m^3	1.100

Calculation of sample gas volume at reference conditions, SV_{Ref}

				Corrections
SV_{Ref}	=	$SV_{Meter} \times \gamma \times$	$[273 + T_{Ref}]/[273 + T_{Meter}]$	Temperature
			P_{Baro}/P_{Ref}	Pressure
			$[100\text{-}H_2O_{Meter}]/[100\text{-}H_2O_{Ref}]$	Water vapour
			$[20.9\text{-}O_{2Duct}]/[20.9\text{-}O_{2Ref}]$	Oxygen

Determination		tpm
Sampled volume @ ref. conditions (SV_{Ref})	m^3	0.297

SAMPLING DATA tpm

Test Ref crem 8 (c)

Initial gas meter reading 627571 l   Start Time 13:15

Distance from Duct Wall Fraction of D	Port	Time of Day h:mm	Run time mm	Gas meter reading l	Pitot Reading (h) mm w.g.	Orifice ΔH mm w.g. Desired (ΔH_d) =h x K_t x Cp^2	Orifice ΔH mm w.g. Actual (ΔH_a)	Isokinetic difference ($\Delta H_a/\Delta H_d$) %	Temperatures Gas (T_{duct}) °C	Probe (T_p) °C	Filter (T_f) °C	Meter (T_m) Inlet °C	Meter (T_m) Outlet °C	Impinger (T_{imp}) °C	Oxygen Content %, v/v, dry
0.500	A	13:15	0	627571	9.5	20.48	20.5	100	349	158	159	22.0		11	
		13:20	5	627655	9.2	19.84	19.8	100	352	159	159	22.0		11	
		13:25	10	627725	10.9	23.50	23.5	100	351	160	160	22.0		11	
		13:30	15	627801	7.1	15.31	15.3	100	349	160	160	22.0		12	
		13:35	20	627872	3.6	7.76	7.8	100	348	160	160	22.0		14	
		13:40	25	627921	3.4	7.33	7.3	100	347	160	160	22.0		14	
		13:45	30	627968	3.8	8.19	8.2	100	347	160	160	22.0		15	
		13:50	35	628018	3.9	8.41	8.4	100	347	160	160	22.0		16	
		13:55	40	628073	4.1	8.84	8.8	100	346	160	160	22.0		16	
		14:00	45	628116	4.2	9.06	9.1	100	345	160	160	22.0		17	
		14:05	50	628173	4.1	8.84	8.8	100	347	160	160	22.0		18	
		14:10	55	628222	4.4	9.49	9.5	100	348	160	160	22.0		19	
		14:15	60	628273	4.3	9.27	9.3	100	347	160	160	22.0		6	
		14:20	65	628322	4.9	10.57	10.6	100	347	160	160	22.0		8	
		14:25	70	628385	4.1	8.84	8.8	100	348	160	160	22.0		8	
		14:30	75	628436	4.2	9.06	9.1	100	349	160	160	22.0		9	
		14:35	80	628487	3	6.47	6.5	100	349	160	160	22.0		11	
		14:40	85	628538	3	6.47	6.5	100	351	160	160	22.0		12	
		14:45	90	628588	2.9	6.25	6.3	101	347	160	160	22.0		12	
		14:50	95	628622	2.8	6.04	6	99	347	160	160	22.0		14	
		14:55	100	628671											
	Averages								348.1	159.9	159.9	22.0		12.7	n.m

Final gas meter reading 628671 l   End Time 14:55

Equipment used

Item	File No.
Control box	P1302
Meter coefficient (γ)	0.926
K factor, (K_t independent of C_p)	3.056
Orifice plate pressure units	mm w.g.
Pitot differential pressure units	mm w.g.
Pitot	S
Pitot coefficient (C_p)	0.84
Probe liner thermocouple Titanium	P1007
Duct gas thermocouple	P1611
Oven thermocouple	P1395
Impinger exit thermocouple	P1333
Timer	P1187

Leak check

		Start	End
Start Time		13:11	14:57
End Time		13:13	14:59
Initial meter reading	m^3	627.5707	628.6705
Final meter reading	m^3	627.5709	628.6708
Duration of leak test	min	2	2
Pump vacuum	"Hg	-15	-15
Leak rate	l/min	0.1	0.15
Less than 2% of normal sampling rate?		Yes	Yes

Approach to isokinetic sampling

Average gas velocity (V_{duct})	10.9 m/s
Nozzle diameter (D_n)	6.280 mm
Sampling time (t)	100 min
Theoretical isokinetic sample volume SV_t	2017.44 l
Actual sample volume (SV_a)	2246.13 l
Approach to isokinetic sampling (AI)	111.3 %

where Vduct is the average duct velocity based on the above measurements

$V_{Duct} = C_p \times (1-\varepsilon) \times \sqrt{2/\rho_s} \times \sqrt{h}$ (Reference BS 1042:Section 2.1:1983 (ISO 3966), pages 8&9)

SV_t is the theoretical isokinetic sample volume based on V_{duct} & D_n

$SV_t = V_{duct} \times \pi \times [D_n/2000]^2 \times t \times 60 \times 1000$

Sv_a is the sample volume at duct conditions

$SV_a = SV_m \times \gamma \times [(273 + T_{duct})/(273 + T_m)] \times (P_{Baro}/P_{duct}) \times (100 - H_2O_m)/(100 - H_2O_{duct})$

Determination of exhaust gas flow rate

based on measurements at sample points only

Flow rate at duct conditions (Q_{duct})	1.91 m^3/s
Flow rate at STP (Q_{STP})	0.82 m^3/s
Flow rate at reference conditions (Q_{Ref})	0.25 m^3/s

where

$Q_{duct} = V_{duct} \times A$

$Q_{STP} = Q_{duct} \times [(T_{Ref} + 273)/(T_{duct} + 273)] \times (P_{Baro}/P_{Ref})$

$Q_{Ref} = Q_{STP} \times [(20.9 - O_{2Ref})/(20.9 - O_{2duct})] \times [(100 - H_2O_{duct})/(100 - H_2O_{Ref})]$

PARTICULATE WEIGHINGS Test Ref crem 8 (c)

Filters

Determination		Method Blank	Field Blank	tpm
Filter No.		0	012447	012445
Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Diameter	mm	110	110	110
Material		Quartz	Quartz	Quartz
Pre-sampling weights				
after 1 min	g		0.7658	0.7420
after 2 min	g		0.7658	0.7420
after 3 min	g		0.7658	0.7420
Weight extrapolated to zero time (M_{fi0})	g		0.7658	0.7420
Post-sampling weights				
after 1 min	g		0.7656	0.7726
after 2 min	g		0.7656	0.7726
after 3 min	g		0.7657	0.7727
Weight extrapolated to zero time (M_{ff0})	g		0.7655	0.7725

Rinsings

Pre-sampling conditioning temperature (±5°C)	°C	180	180	180
Post-sampling conditioning temperature (±5°C)	°C	160	160	160
Pre-sampling weights (container only)				
after 1 min	g		71.0315	68.3861
after 2 min	g		71.0314	68.3860
after 3 min	g		71.0314	68.3860
Weight extrapolated to zero time (M_{ri0})	g		71.0315	68.3861
Post-sampling weights (container and evaporated rinsings)				
after 1 min	g		71.0313	68.3938
after 2 min	g		71.0313	68.3937
after 3 min	g		71.0313	68.3936
Weight extrapolated to zero time (M_{rf0})	g		71.0313	68.3939

Summary

Determination		Method Blank (M_{mb})	Field Blank	tpm
Mass collected on filter ($M_f = (M_{ff0} - M_{fi0} - M_{fmb})$)	g	0.0000	-0.0003	0.0305
Mass collected in rinsings ($M_r = (M_{rf0} - M_{ri0} - M_{rmb})$)	g	0.0000	-0.0002	0.0078
Total mass collected ($M = M_f + M_r$)	g	0.0000	0.0000	0.0383

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for filter weighing (U17)	0.57 mg
Standard uncertainty for washings weighing (U17)	0.50 mg
Limit of detection for filter weighing (U17)	0.50 mg
Limit of detecion for washings weighing (U17)	0.50 mg
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Emission Limit Value

Emission limit value (ELV) at reference conditions	80 mg/m^3

SUMMARY OF MEASUREMENTS Test Ref crem 8 (c)

Calculation of Particulate Concentration and Discharge Rate

Particulate concentration (C), mg/m^3 = $M \times 1000/ SV_{Ref}$

Discharge rate, kg/h = $C \times Q_{Ref} \times 0.0036$

Determination		Field Blank	tpm
Particulate concentration at reference conditions	mg/m^3	0.00	128.86
Uncertainty	mg/m^3	0.00	8.87
Particulate concentration at duct conditions (raw)	mg/m^3	0.00	17.05
Particulate discharge rate	kg/h	0.00	0.12
Uncertainty	kg/h	#DIV/0!	0.01

Note: Field blank results based on average sampling conditions

Uncertainty budget

Uncertainties		Field Blank	tpm
Volume measurement (m_{vol})	mg	0.00	1.11
Filter weighings (m_f)	mg	-0.27	0.57
Rinsings weighings (m_w)	mg	-0.23	0.50
Total for uncorrected measurement (U_u)	mg	0.35	1.34
Correction to reference conditions (m_{corr})	mg	0.00	0.00
Total for corrected measurement (U_c)	mg	0.35	1.34
Concentration at 95% confidence interval (U_{95c})	mg/m^3	0.00	8.87

Based on Procedure 55 and Uncertainty Policies 11 & 17
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

$U_u = \sqrt{m_{vol}^2 + m_f^2 + m_w^2}$
$U_c = \sqrt{U_u^2 + m_{corr}^2}$
$U_{95c} = 1.96 \times U_c/SV_{Ref}$

COMPLIANCE WITH BS EN 13284-1:2002/BS ISO 9096 CONDITIONS

Flow conditions (BS EN 13284-1, 5.2 & BS ISO 9096, 5.3)

Standard	ISO 9096
Angle of gas flow less than 15°	Yes
No local negative gas flow	Yes
Minimum differential pressure greater than 5 Pa	Yes
Ratio of highest to lowest local gas velocites less than 3:1	No

Compliance with BS ISO 9096

Blank value is less than 10% of ELV (Table 3)
Nozzle diameter greater than 4 mm (Clause 6.2.2)
Average sampling rate was within -5% and +15% of isokinetic conditions (Clause 7.3.5)
Leak rate is within 2% of sample rate (Clause 7.3.5)
Blank value is less than 2 mg/m3 (Table 3)

SCIENTIFICS MONITORING REPORT FORM
Hydrogen chloride to BS EN 1911

Company	City of London	Test Ref	HCl
Site	Crematorium	Date	06-Jan-10
Sample point	Cremator 8 run 3	Time start	13:15
Test carried out by	S Huntley & T Swannack	Time End	14:55
Determinand	Hydrogen chloride to BS EN 1911	Duration (min)	100
		Sampling conditions	crem 8 (c)

ANALYSIS OF COLLECTED SOLUTIONS

Determination		HCl
Volume of sampling solution in first stage (Vs1)	ml	510
Volume of sampling solution in field blank (Vsb)	ml	245
Chloride detection limit in sampling solution (qd)	mg/l	0.10
Chloride in first stage sampling solution (qs1)	mg/l	29.60
Chloride in field blank sampling solution (qcb)	mg/l	0.00
Emission limit value (ELV, daily)	mg/m³	200

Calculation of hydrogen chloride concentration in duct gas, Cg

C_g (mg/m³) = $(\{[V_{s1} \times q_{s1}]+[V_{s2} \times q_{s2}]\} \times MW_c)_{\cdot}(V_{mstd} \times MW_{cl} \times N_a)$

where MWc is the molecular weight of hydrogen chloride (i.e. 36.5 kg/kgmole)
MWcl is the molecular weight of the chloride ion (i.e. 35.5 kg/kgmole)
Na is the number of chloride ions in hydrogen chloride (i.e. 1)

Calculation of hydrogen chloride discharge rate, Dg

$D_g = C_g \times Q_{Ref} \times 0.0036$

MEASUREMENTS OF HYDROGEN CHLORIDE

Determination		HCl
Concentration at reference conditions (C_g)	mg/m³	52.22
Uncertainty (95% confidence limit)	mg/m³	6.00
Uncertainty as a proportion of ELV	%	3.00
Discharge rate (D_g)	kg/h	0.048
Uncertainty (95% confidence limit)	kg/h	0.008
Detection limit	mg/m³	0.176

FIELD BLANK

Determination		HCl
Field blank concentration*	mg/m³	0.00
Field blank as a proportion of ELV	±%	0.0

*assuming same sample volume as for sample

Uncertainty Calculation Parameters

Standard uncertainty for gas volume measurement (U6)	2.9 %
Standard uncertainty for liquid volume measurement (U16)	1 %
Analytical uncertainty at X times LOD (U15)	5 %
X (U15)	10
Standard uncertainty for oxygen correction (U11)	0.95 %
Standard uncertainty for gas flow measurement (U14)	5.7 %

Uncertainty budget

Uncertainties		HCl
Sample gas volume measurement (m_{vol})	%	2.9
Solution volume measurement (m_{sol})	%	1.0
Analysis of washings (m_w)	%	5.0
Total for uncorrected measurement (U_u)	mg/m³	3.06
Correction to reference conditions (m_{corr})	mg/m³	0.00
Concentration at 95% confidence interval (U_{95c})	mg/m³	6.004

Based on Procedure 55 and Uncertainty Policies 11 & 16
(in accordance with requirements of BS EN ISO 14956:2002 and ENV 13005 (GUM))

COMPLIANCE WITH STANDARD

Probe temperature is at least 150C (Clause 6.2)
Leak rate less than 2% of sample rate (Clause 1-8.2)
Sampling outside 10% of isokinetic conditions - outside standard (Clause 1-5.1.5)
Sample concentration is greater than 10 times field blank (3-4.2.1)
Field blank concentration is less than 10% of ELV (not normative)
Measurement uncertainty is less than 20% of ELV (not normative)

SCIENTIFICS MONITORING REPORT FORM
Carbon Monoxide to BS EN 15058:2006

Company	City of London
Site	Crematorium
Sample point	Cremator 8, run 3
Test carried out by	S Huntley & T Swannack

Date	6-Jan-10
Test Ref	crem 8 (c)
Time Start	13:18
Time End	14:57

Measurements: 5 minutes' averaging period

Start	End	No.	Maximum	Minimum	Average	Maximum	Minimum	Average
		Readings	ppm , dry			$mgCO/m^3$, ref. cond.		
13:18	13:22	20	<5	<5	<5	11	<5	7
13:23	13:27	20	<5	<5	<5	18	<5	12
13:28	13:32	20	<5	<5	<5	7	<5	<5
13:33	13:37	20	<5	<5	<5	<5	<5	<5
13:38	13:42	20	<5	<5	<5	<5	<5	<5
13:43	13:47	20	<5	<5	<5	<5	<5	<5
13:48	13:52	20	<5	<5	<5	<5	<5	<5
13:53	13:57	20	<5	<5	<5	<5	<5	<5
13:58	14:02	20	<5	<5	<5	<5	<5	<5
14:03	14:07	20	<5	<5	<5	<5	<5	<5
14:08	14:12	20	<5	<5	<5	<5	<5	<5
14:13	14:17	20	<5	<5	<5	5	<5	<5
14:18	14:22	20	<5	<5	<5	<5	<5	<5
14:23	14:27	20	<5	<5	<5	<5	<5	<5
14:28	14:32	20	<5	<5	<5	<5	<5	<5
14:33	14:37	20	<5	<5	<5	<5	<5	<5
14:38	14:42	20	<5	<5	<5	<5	<5	<5
14:43	14:47	20	<5	<5	<5	<5	<5	<5
14:48	14:52	20	<5	<5	<5	<5	<5	<5
14:53	14:57	20	<5	<5	<5	<5	<5	<5
13:18	14:57	400	<5	<5	<5	18	<5	<5

Summary of measurements

Average concentration	<5 $mgCO/m^3$
Uncertainty	5 $mgCO/m^3$
Discharge rate	<0.004563 kgCO/h

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of ELV (Clause 7.3)

Calibration Checks

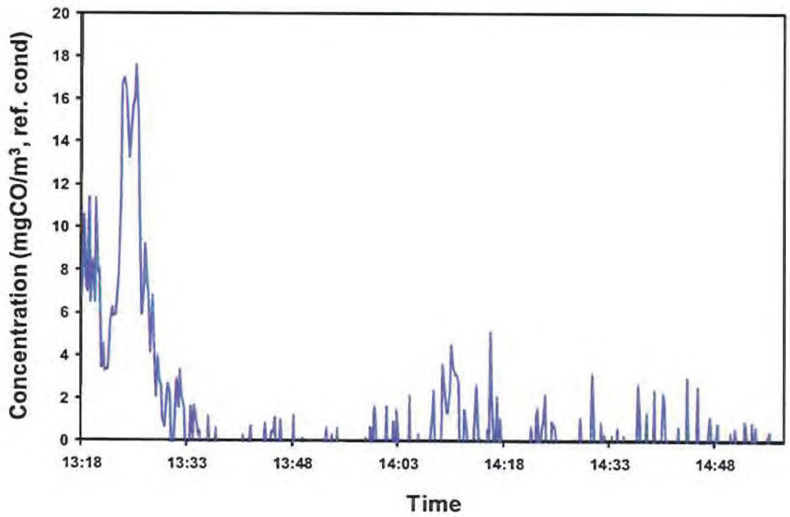
Type	Horiba PG 250	**Range**	0 to 50 ppm
Equipment No.	P1301		
Measurement method	Non-dispersive infra-red		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	25.12
		Analyser response	
Gas into analyser before sampling	ppm	0.00	25.15
Gas into system before sampling	ppm	0.40	25.30
Gas into system after sampling	ppm	0.30	25.40
Drift	% span	0.40	0.40
Response time	s	22	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm CO	mgCO/m^3	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.58	0.72	0.52
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.08	0.09	0.01
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.08	0.10	0.01
Sample volume flow	$u(Corr_{s,u})$	-		0.00	% range	0.00	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	0	K	0.50	% range/10K	0.00	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.46	0.58	0.33
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.04	0.05	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.40	0.50	0.25
Combined uncertainty	$u(C_{CO})$							1.06
Expanded uncertainty	$U(C_{CO})$							2.08
$U(C_{CO})$:ELV (%)								2.08

Measured concentration of Carbon Monoxide at Cremator 8, run 3



SCIENTIFICS MONITORING REPORT FORM
Volatile Organic Compounds to BS EN 12619:1999 & BS EN 13526:2002

Company	City of London		Date	6-Jan-10
Site	Crematorium		Test Ref	crem 8 (c)
Sample point	Cremator 8, run 3		Time Start	13:15
Test carried out by	S Huntley & T Swannack		Time End	14:55

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			ppm, wet			mgCarbon/m3, ref cond.		
13:15	13:20	10	<1	<1	<1	1.4	1.3	1.3
13:20	13:25	10	<1	<1	<1	1.3	1.2	1.3
13:25	13:30	10	<1	<1	<1	1.3	1.3	1.3
13:30	13:35	10	<1	<1	<1	1.2	1.2	1.2
13:35	13:40	10	<1	<1	<1	1.2	1.2	1.2
13:40	13:45	10	<1	<1	<1	1.1	1.1	1.1
13:45	13:50	10	<1	<1	<1	1.1	1.1	1.1
13:50	13:55	10	<1	<1	<1	1.1	1.0	1.1
13:55	14:00	10	<1	<1	<1	1.1	1.0	1.0
14:00	14:05	10	<1	<1	<1	1.0	<1	1.0
14:05	14:10	10	<1	<1	<1	<1	<1	<1
14:10	14:15	10	<1	<1	<1	<1	<1	<1
14:15	14:20	10	<1	<1	<1	<1	<1	<1
14:20	14:25	10	<1	<1	<1	<1	<1	<1
14:25	14:30	10	<1	<1	<1	<1	<1	<1
14:30	14:35	10	<1	<1	<1	<1	<1	<1
14:35	14:40	10	<1	<1	<1	<1	<1	<1
14:40	14:45	10	<1	<1	<1	<1	<1	<1
14:45	14:50	10	<1	<1	<1	<1	<1	<1
14:50	14:55	10	<1	<1	<1	<1	<1	<1
13:15	14:55	200	<1	<1	<1	1.4	<1	<1

Summary of measurements

Average concentration	<1 mgCarbon/m3
Uncertainty	1 mgCarbon/m3
Discharge rate	<0.0009126 kgCarbon/h

Compliance with BS EN 12619/BS EN 13526

Correction for drift applied to measurements (BS EN 14789, Clause 8.4.3)
Response time is within limit (BS EN 12619, Clause 6.1.1)
Uncertainty is within specified limit of 10% of ELV (BS EN 14789, Clause 1)

Calibration Checks

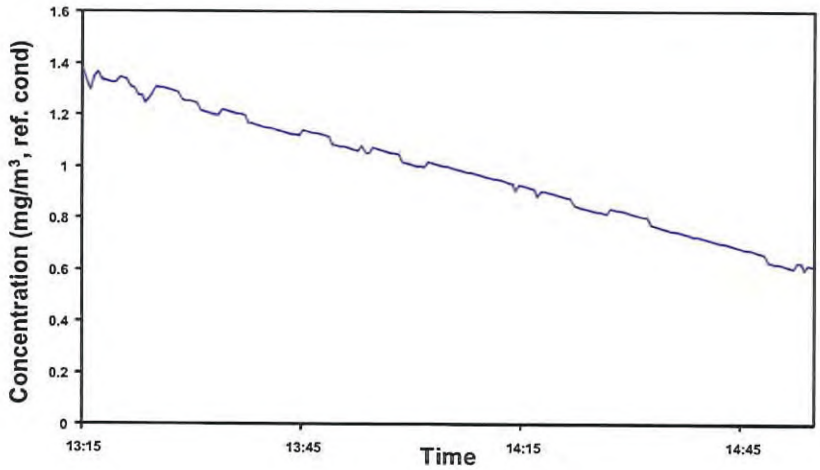
Type	Bernath 3006	**Range**	0 to 10 ppm
Equipment No.	P1366		
Measurement method	Flame ionisation detection		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	ppm	0.00	8.92
		Analyser response	
Gas into analyser before sampling	ppm	-0.42	8.90
Gas into system before sampling	ppm	-0.31	8.74
Gas into system after sampling	ppm	-0.17	8.92
Drift	% span	1.57	2.06
Response time	s	9	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})		x_{imax}^2
						ppm	mg/m^3	
Lack of fit	u($Corr_{fit}$)	-		2.00	% range	0.12	0.19	0.03
Zero drift	u($Corr_{0,dr}$)	-		2.00	% range	0.12	0.19	0.03
Span drift	u($Corr_{s,dr}$)	-		2.00	% range	0.12	0.19	0.03
Sample volume flow	u($Corr_{s,v}$)	-		1.00	% range	0.06	0.09	0.01
Atmospheric pressure	u($Corr_{apress}$)	0	kPa	0.50	% range/2kP	0.00	0.00	0.00
Ambient temperature	u($Corr_{temp}$)	0	K	2.00	% range/10K	0.00	0.00	0.00
Electric voltage	u($Corr_{volt}$)	40	V	2.00	% range/10V	0.23	0.37	0.14
Interferents	u($Corr_{int}$)	-		3.50	% range	0.20	0.32	0.11
Losses & leakage	u($Corr_{leak}$)	-		1.80	% range	0.10	0.17	0.03
Repeatability at zero	u($Corr_{z,rep}$)	-		1.00	% range	0.06	0.09	0.01
Repeatability at span	u($Corr_{s,rep}$)	-		2.00	% range	0.12	0.19	0.03
Converter efficiency	u($Corr_{conv}$)	-		100.00	% reading	0.00	0.00	0.00
Response factor	u($Corr_{resp}$)	-		100.00	% reading	0.00	0.00	0.00
Calibration gas	u($Corr_{adj}$)	-		1.00	% value	0.06	0.10	0.01
Combined uncertainty	u(C_{VOC})							0.65
Expanded uncertainty	U(C_{VOC})							1.28
U(C_{VOC}):ELV (%)								6.40

Measured concentration of Volatile Organic Compounds at Cremator 8, run 3



SCIENTIFICS MONITORING REPORT FORM
Oxygen to BS EN 14789:2005

Company	City of London
Site	Crematorium
Sample point	Cremator 8, run 3
Test carried out by	S Huntley & T Swannack

Date	6-Jan-10
Test Ref	crem 8 (c)
Time Start	13:18
Time End	14:57

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			% dry		
13:18	13:22	20	18.1	15.7	17.0	18.1	15.7	17.0
13:23	13:27	20	18.9	16.7	18.2	18.9	16.7	18.2
13:28	13:32	20	17.8	17.0	17.2	17.8	17.0	17.2
13:33	13:37	20	17.7	16.6	17.3	17.7	16.6	17.3
13:38	13:42	20	17.5	16.6	17.0	17.5	16.6	17.0
13:43	13:47	20	18.2	17.6	17.9	18.2	17.6	17.9
13:48	13:52	20	18.6	17.0	17.8	18.6	17.0	17.8
13:53	13:57	20	18.2	17.6	18.0	18.2	17.6	18.0
13:58	14:02	20	18.3	17.3	17.8	18.3	17.3	17.8
14:03	14:07	20	17.9	17.7	17.8	17.9	17.7	17.8
14:08	14:12	20	17.8	17.6	17.7	17.8	17.6	17.7
14:13	14:17	20	17.9	17.8	17.9	17.9	17.8	17.9
14:18	14:22	20	18.2	17.6	17.9	18.2	17.6	17.9
14:23	14:27	20	18.1	17.6	17.8	18.1	17.6	17.8
14:28	14:32	20	18.4	17.5	18.1	18.4	17.5	18.1
14:33	14:37	20	17.8	17.3	17.6	17.8	17.3	17.6
14:38	14:42	20	17.8	17.7	17.7	17.8	17.7	17.7
14:43	14:47	20	19.3	17.2	18.0	19.3	17.2	18.0
14:48	14:52	20	18.3	17.1	17.8	18.3	17.1	17.8
14:53	14:57	20	18.5	17.1	17.9	18.5	17.1	17.9
13:18	14:57	400	19.3	15.7	17.7	19.3	15.7	17.7

Summary of measurements

Average concentration	17.7 $\%O_2$, dry
Uncertainty	0.6 $\%O_2$, dry

Compliance with BS 15058:2006

No correction for drift applied (Clause 8.4.3)
Response time is within limit (Clause 7.2)
Uncertainty is within specified limit of 6% of measured concentration (Clause 1)

Calibration Checks

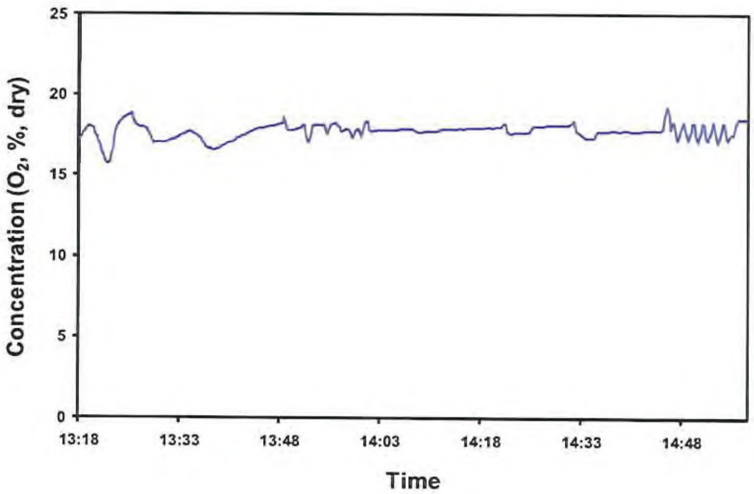
Type	Horiba PG 250	Range	0 to 25 %
Equipment No.	P1301		
Measurement method	Zirconium cell		

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	13.10
		Analyser response	
Gas into analyser before sampling	%	0.00	13.10
Gas into system before sampling	%	0.00	13.10
Gas into system after sampling	%	0.10	13.16
Drift	% span	0.76	0.46
Response time	s	19	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty (x_{imax})	x_{imax}^2
						$\%O_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.29	0.08
Zero drift	$u(Corr_{0,dr})$	-		0.11	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.24	% range	0.03	0.00
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	0	K	0.40	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		0.00	% range	0.00	0.00
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.00	% range	0.00	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.13	0.02
Combined uncertainty	$u(C_{O2})$						0.32
Expanded uncertainty	$U(C_{O2})$						0.62
$U(C_{O2})$:C_{O2}(%)							3.50

Measured concentration of Oxygen at Cremator 8, run 3



SCIENTIFICS MONITORING REPORT FORM
Carbon Dioxide to ISO 12039:2001

Company	City of London	Date	6-Jan-10
Site	Crematorium	Test Ref	crem 8 (c)
Sample point	Cremator 8, run 3	Time Start	13:18
Test carried out by	S Huntley & T Swannack	Time End	14:57

Measurements: 5 minutes' averaging period

Start	End	No. Readings	Maximum	Minimum	Average	Maximum	Minimum	Average
			%, dry			$\%CO_2$, ref. cond.		
13:18	13:22	20	4.7	2.5	3.4	8.9	8.6	8.7
13:23	13:27	20	3.7	1.6	2.2	8.7	7.2	7.8
13:28	13:32	20	3.0	2.3	2.8	7.8	7.3	7.6
13:33	13:37	20	3.4	2.5	2.8	7.8	7.7	7.8
13:38	13:42	20	3.4	2.6	3.0	7.8	7.7	7.8
13:43	13:47	20	2.5	2.0	2.3	7.6	7.4	7.5
13:48	13:52	20	2.6	1.7	2.1	7.4	6.5	6.9
13:53	13:57	20	2.2	1.8	2.0	6.8	6.5	6.7
13:58	14:02	20	2.3	1.7	2.0	6.6	6.4	6.5
14:03	14:07	20	2.1	1.9	2.0	6.5	6.3	6.4
14:08	14:12	20	2.1	2.0	2.0	6.3	6.3	6.3
14:13	14:17	20	1.9	1.8	1.9	6.3	6.1	6.2
14:18	14:22	20	2.0	1.6	1.8	6.1	6.0	6.1
14:23	14:27	20	2.0	1.7	1.8	6.0	5.9	6.0
14:28	14:32	20	2.0	1.5	1.7	5.9	5.8	5.9
14:33	14:37	20	2.2	1.9	2.0	5.9	5.9	5.9
14:38	14:42	20	1.9	1.9	1.9	5.9	5.8	5.9
14:43	14:47	20	2.2	0.9	1.7	5.9	5.5	5.8
14:48	14:52	20	2.2	1.5	1.8	5.9	5.6	5.8
14:53	14:57	20	2.3	1.4	1.7	5.9	5.5	5.7
13:18	14:57	400	4.7	0.9	2.2	8.9	5.5	6.7

Summary of measurements

Average concentration	6.7 $\%CO_2$
Uncertainty	1.0 $\%CO_2$

Compliance with BS 14792:2005

No correction for drift applied (BS EN 14789, Clause 8.4.3)
Response time is within limit (ISO 12039, Clause A.2)
Uncertainty is above specified limit of 6% of measured concentration (BS EN 14789, Clause 1) - non compliance

Calibration Checks

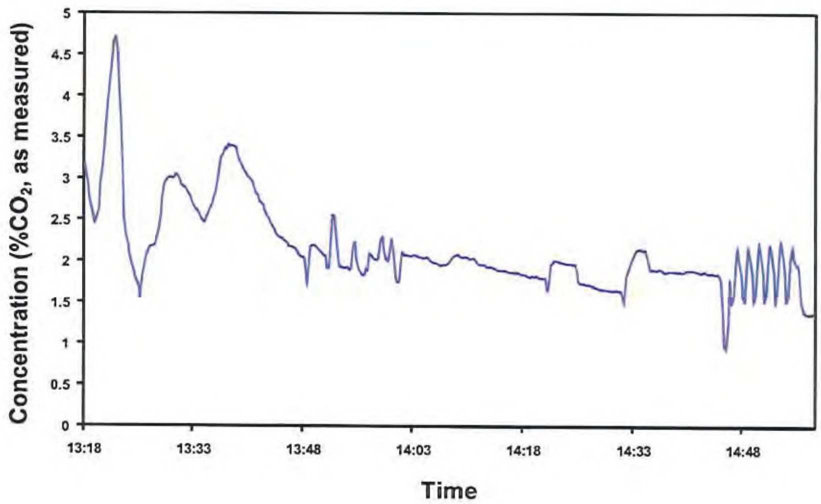
Type Horiba PG 250 **Range** 0 to 10 %
Equipment No. P1301
Measurement method Non-dispersive infra-red

Calibration		Zero	Span
Gas reference		CH49	DG2
Concentration	%	0.00	5.08
		Analyser response	
Gas into analyser before sampling	%	0.00	5.10
Gas into system before sampling	%	0.08	5.12
Gas into system after sampling	%	0.15	5.19
Drift	% span	1.38	1.37
Response time	s	25	

Uncertainty budget

Quantity		Variation		Value		Partial uncertainty ($x_{i,max}$)	$x_{i,max}^2$
						$\%CO_2$	
Lack of fit	$u(Corr_{fit})$	-		2.00	% range	0.12	0.01
Zero drift	$u(Corr_{0,dr})$	-		0.26	% range	0.02	0.00
Span drift	$u(Corr_{s,dr})$	-		0.29	% range	0.02	0.00
Sample volume flow	$u(Corr_{s,vf})$	-		0.00	% range	0.00	0.00
Atmospheric pressure	$u(Corr_{apress})$	0	kPa	0.00	% range/2kP	0.00	0.00
Ambient temperature	$u(Corr_{temp})$	0	K	0.50	% range/10K	0.00	0.00
Electric voltage	$u(Corr_{volt})$	40	V	0.00	% range/10V	0.00	0.00
Interferents	$u(Corr_{int})$	-		1.60	% range	0.09	0.01
Losses & leakage	$u(Corr_{leak})$	-		0.00	% range	0.00	0.00
Repeatability at zero	$u(Corr_{z,rep})$	-		0.14	% range	0.01	0.00
Repeatability at span	$u(Corr_{s,rep})$	-		0.00	% range	0.00	0.00
Converter efficiency	$u(Corr_{conv})$	-		100.00	% reading	0.00	0.00
Response factor	$u(Corr_{resp})$	-		100.00	% reading	0.00	0.00
Calibration gas	$u(Corr_{adj})$	-		1.00	% value	0.05	0.00
Combined uncertainty	$u(C_{CO2})$						0.16
Expanded uncertainty	$U(C_{CO2})$						0.31
$U(C_{CO2}):C_{CO2}(\%)$							14.36

Measured concentration of Carbon Dioxide at Cremator 8, run 3



SCIENTIFICS MONITORING REPORT FORM
WATER VAPOUR DETERMINATION to BS EN 14790:2005

Company	City of London	Test Ref	crem 8 (c) h2o
Site	Crematorium	Date	06-Jan-10
Sample point	Cremator 8 run 3	Time start	13:15
Test carried out by	S Huntley & T Swannack	Time End	14:55
		Duration (min)	100
		Data from	crem 8 (c)

Collection of water from gas

Collection Stage (ci)	Initial Mass(Mci_i) g	Final Mass (Mci_f) g	Mass gain (Mci) g
Container 1	694.31	711.67	17.36
Container 2	680.47	683.59	3.12
Container 3	501.38	503.79	2.41
Container 4	934.52	946.13	11.61
Total (M)	2810.68	2845.18	34.5

Mass of water collected (M) = $\Sigma(Mc1_f - Mc1_i)....(Mci_f - Mci_i)$

Calculation of dry gas sample volume at STP (SV_{STP})

SV_{STP} = $SV_M \times (273/(273 + T_M) \times (P_M/101.3)$

Volume of dry gas sampled at STP (SV_{STP})	m^3	0.9176

Calculation of water vapour content (H_2O_{duct})

H_2O_{duct} = $100 \times (M \times MV_{STP}/MW_{H2O})/[SV_{STP} + (M \times MV_{STP}/MW_{H2O})]$

where MV_{STP} molecular volume at STP (22.412 m^3/kgmole)

MW_{H2O} molecular weight of water (18 kg/kgmole)

Water vapour content (H_2O_{duct})	%	4.47 ± 0.28

Compliance with BS 14790

Uncertainty less than 20% of measured value (Clause 7.3)

Temperature is greater than 4oC based on calculated water dew point (Clause 6.4.2) - outside standard

Leak rate is no more than 2% of sample flow rate

Sampling duration is within minimum of 30 minutes (Clause 6.1)

Sampling volume is within minimum of 50l (Clause 6.1)

Residual water content at outlet is above 1.25% (Clause 5.8) - outside standard

Sampling temperature was within minimum of 120oC during sampling (Clause 5.2)

Uncertainty Budget (based on BS 14790 and Uncertainty Policy U25)

Volume of sampled gas	V	0.918 m^3
Average temperature of gas at meter	T	22.0 °C
Average barometric pressure at meter	P	986 mb
Sampling line leakage		0.000125 m^3/min
Duration of sampling	t	100 min
Total mass weighed	M	2845.18 g

Source of uncertainty		Value		Value of standard uncertainty			Relative standard uncertainty (%)	
Measurement of sample gas volume	u,V_m	2.0 %	u_v	u_s,V_m =	$\frac{u_v V}{\sqrt{3}}$	0.0106 m^3	u_r,V_m	1.15
Measurement of sample gas temperature	u,T_m	1.0 %	u_t	u_s,T_m =	$\frac{u_t(T+273)}{\sqrt{3}}$	1.7032 K	u_r,T_m	0.58
Measurement of absolute pressure	u,P_m	1.0 %	u_p	u_s,P_m =	$\frac{u_p P}{\sqrt{3}}$	5.6927 mb	u_r,P_m	0.58
Leakage in sampling line	u,L	1.4 %	u_l	u_s,L =	$\frac{u_l V}{\sqrt{3}}$	0.0072 m^3	u_r,L	0.79
Measurement of weight - balance uncertainty	u,W_m	0.01 %	u_{wm}	u_s,W_m =	$\frac{u_{wm} M}{\sqrt{3}}$	0.1643 g		-
Measurement of weight - balance repeatability	u,W_r	0.011 g	u_{wr}	u_s,W_r =	u_{wr}	0.0110 g		-
Total measurement of weight	u,W	-	-	- u_s,W =		0.1753 g	u_r,W	0.51

Total standard relative uncertainty	$u_r = \sqrt{u_r V_m^2 + u_r T_m^2 + u_r P_m^2 + u_r L^2 + u_r W^2 + Corr_r}$	3.25 %
Total relative uncertainty	$U_r = 1.96 u_r$	6.36 %

ANALYTICAL REPORTS

Cremator 1

Test No.	Sample		Tag No.	Laboratory	Report No.
PCDDs & PCDFs & PCBs					
	Field blank	Probe washings	7721956	Scientifics	OJ0440DF
	Field blank	Resin trap	7721286		
	Field blank	Filter	7721957		
	Sample	Probe washings	7721287		
	Sample	Resin trap	7721289		
	Sample	Filter	7721288		
Hydrogen chloride					
	Field blank	Impinger washings	7721281	Scientifics	EJ0405R
Run 1	Sample	Impinger washings	7721952		
Run 2	Sample	Impinger washings	7721953		
Run 3	Sample	Impinger washings	7721954		
Particulates					
	Field blank	Washings	012376W	Scientifics	N/A
	Field blank	Filter	012376		
Run 1	Sample	Washings	012454W		
	Sample	Filter	012454		
Run 2	Sample	Washings	012448W		
	Sample	Filter	012448		
Run 3	Sample	Washings	012451W		
	Sample	Filter	012451		

Cremator 6

Test No.	Sample		Tag No.	Laboratory	Report No.
Hydrogen chloride					
	Field blank	Impinger washings	7721964	Scientifics	EJ0405R
Run 1	Sample	Impinger washings	7721961		
Run 2	Sample	Impinger washings	7721962		
Run 3	Sample	Impinger washings	7721963		
Particulates					
	Field blank	Washings	012467W	Scientifics	N/A
	Field blank	Filter	012467		
Run 1	Sample	Washings	012450W		
	Sample	Filter	012450		
Run 2	Sample	Washings	012468W		
	Sample	Filter	012468		
Run 3	Sample	Washings	012466W		
	Sample	Filter	012466		

Cremator 7

Test No.	Sample		Tag No.	Laboratory	Report No.
Hydrogen chloride					
	Field blank	Impinger washings	7721281	Scientifics	EJ0405R
Run 1	Sample	Impinger washings	7721284		
Run 2	Sample	Impinger washings	7721858		
Particulates					
	Field blank	Washings	012446W	Scientifics	N/A
	Field blank	Filter	012446		
Run 1	Sample	Washings	012443W		
	Sample	Filter	012443		
Run 2	Sample	Washings	012455W		
	Sample	Filter	012455		

Cremator 8

Test No.	Sample		Tag No.	Laboratory	Report No.
Hydrogen chloride					
	Field blank	Impinger washings	7721282	Scientifics	EJ0405R
Run 1	Sample	Impinger washings	7721859		
Run 2	Sample	Impinger washings	7721860		
Run 3	Sample	Impinger washings	7721951		
Particulates					
	Field blank	Washings	012447W	Scientifics	N/A
	Field blank	Filter	012447		
Run 1	Sample	Washings	012452W		
	Sample	Filter	012452		
Run 2	Sample	Washings	012444W		
	Sample	Filter	012444		
Run 3	Sample	Washings	012445W		
	Sample	Filter	012445		

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EJ0405R
Customer reference: 091121
Scientifics Mitcheldean
Analyst: M. Dina
Date: 01/02/10

This reissued report replace the original EJ0405.
The solutions arrived in good condition,were booked into our system and stored in a secure sample store at room temperature until analysis.
The samples were measured by IC in accordance with HS/WI/1087 issue 6 for anions. This method is UKAS accredited.
The QC standards were prepared from a different source to that of the calibration standards.
Results are expressed as mg. L^{-1} = µg. mL^{-1} in the samples as received.

Customer Reference	Lab Reference	Chloride Cl
Units		mg/L
LOD		0.1
7721281	EJ0405	<0.1
7721282	EJ0406	<0.1
7721283	EJ0407	<0.1
7721284	EJ0408	35.10
7721858	EJ0409	43.60
7721859	EJ0410	29.70
7721860	EJ0411	23.10
7721951	EJ0412	29.60
7721952	EJ0413	4.38
7721953	EJ0414	0.25
7721954	EJ0415	10.90
7721961	EJ0416	4.75
7721962	EJ0417	19.70
7721963	EJ0418	6.29
7721964	EJ0419	<0.1
QC Expected (mg/L)		10.00
QC Obtained (mg/L)		10.51

Comments:
Results are expressed as mg. L^{-1} = µg. mL^{-1} in the samples as received.
Measurement uncertainty for those results significantly above the LOD is estimated to be ± 10% for the solution measurements.
Results within an order of magnitude of the LOD have a higher uncertainty.

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Results From The Analysis of Stack Gas Sample For Dioxins and Furans

Client:	Nick Ford Scientifics Ltd. Acacia Building 13 Vantage Point Business Village Mitchelsean Gloucestershire GL17 0DD
Testing Facility:	Harwell Scientifics 551 South Becquerel Avenue Harwell Science and Innovation Campus Chilton Didcot Oxon OX11 0TB
Telephone:	01235 841982
Laboratory Reference:	OJ0440-441
Customer Reference:	7721956-57,286 and 7721286-89
Job Number:	091121
Samples Received:	19 January 2010
Analysis Completed:	29 January 2010
Approved by:	
Date:	
Approver's name:	Lesley Sansom
Job Title:	Senior Analyst
Report Date:	29 January 2010

UKAS TESTING 1015

Test Report :OJ0440DF: Page 1 of 8

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Introduction

Two samples were received in good condition for the analysis of dioxins and furans.

Sample Preparation

On receipt, each resin trap was spiked with an extraction standard containing a selection of ^{13}C labelled dioxin/furan isomers. The resin was then air-dried.

Each resin and filter set was soxhlet extracted with toluene for a minimum of 18 hours. The resulting liquors were added to the washings and condensates and reduced to a few mls by air blow down prior to chromatographic separation and clean up. The resulting liquids were reduced in volume and solvent exchanged into a GC standard containing a selection of ^{13}C labelled dioxin/furan isomers. The final volume of liquid was 0.02 ml. The resulting liquid was then stored refrigerated until ready for analysis by gas chromatography-high resolution mass spectrometry (GC-HRMS).

A laboratory blank was prepared with the samples.

The UKAS accredited method used for the sample preparation was HS/WI/3007 Issue 14, which complies with EN1948-2: 2006.

Measurement

The concentrated sample was transferred to GC vials and analysed for all congeners and total homologue groups using a Hewlett Packard 5890 GC and Micromass Autospec HRMS operating at a resolution of 10000. The GC column used was a 60 m Restek Dioxin 2. Injection volume was 1µl.

Due to the guaranteed chromatographic resolution of the GC column it was not necessary to carry out the confirmatory analysis.

Calibration was achieved using a relative response standard containing known amounts of native and ^{13}C dioxin/furan isomers.

Identification of individual isomers was achieved by a combination of GC retention times and mass spectra. Identities of isomers significantly above the limit of detection were confirmed by isotope ratio.

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The integration windows needed for the total dioxin/furan analysis were determined using a commercially available standard containing the first and last eluting isomers of each congener group specific to the GC column used.

The UKAS accredited method used for the sample measurement was HS/WI/3018 Issue 6 which complies with EN1948-3:2006.

Calculations

Limits of detection (LOD) were determined by assessing the baseline noise of a signal free portion of the chromatograms for one standard. The limits of detection quoted are the higher of either the calculated limits of detection or the concentrations detected in the laboratory blank.

Results

The results of the analysis of the samples are presented on pages 5-6. The results of the analysis of the blank and LOD determinations are presented on page 7. The results for the ITEQ values for humans, fish and birds are given on page 8.

The ITEQ values for individual congeners have been calculated for each sample using the NATO CCMS and WHO schemes. Where an isomer has a result less than the LOD a value equivalent to the LOD has been used to determine the ITEQ. Therefore, these values represent a worst case assessment. Additional total ITEQ values have also been calculated, assuming that where a result is less than the limit of detection then the ITEQ contribution is zero. The NATO CCMS and WHO factors are listed below for your information :

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TEF schemes for Dioxins and Furans				
Congener	NATO I-TEF	WHO-TEF		
		Humans / Mammals	Fish	Birds
Dioxins				
2,3,7,8-TCDD	1	1	1	1
1,2,3,7,8-PeCDD	0.5	1	1	1
1,2,3,4,7,8-HxCDD	0.1	0.1	0.5	0.05
1,2,3,6,7,8-HxCDD	0.1	0.1	0.01	0.01
1,2,3,7,8,9-HxCDD	0.1	0.1	0.01	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01	0.001	<0.001
OCDD	0.001	0.0003	-	-
Furans				
2,3,7,8-TCDF	0.1	0.1	0.05	1
1,2,3,7,8-PeCDF	0.05	0.03	0.05	0.1
2,3,4,7,8-PeCDF	0.5	0.3	0.5	1
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1	0.1
1,2,3,4,6,7,8_HpCDF	0.01	0.01	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01	0.01	0.01
OCDF	0.001	0.0003	0.0001	0.0001

Precision and Accuracy

The internal variability (repeatability) for the filter/cooler method was at a mean concentration of 0.040 ng ITEQ/m^3 ± 0.060 ng ITEQ/m^3 and at a mean concentration of 0.030 ng ITEQ/m^3 ± 0.014 ng ITEQ/m^3.

The external variability (reproducibility) at a mean concentration of 0.035 ng ITEQ/m^3 was 0.050 ng ITEQ/m^3.

The overall uncertainty attached to these results, based on the results of QC materials and reference materials is estimated to be 25%.

UKAS TESTING 1015

Test Report :OJ0440DF: Page 4 of 8

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Results from the Analysis of Stack Gas Samples for Dioxins & Furans

Laboratory Reference OJ0440
Customer Reference 091121 7721956-57.286

Analyte (Dioxin/Furan Isomer)		Result (ng)	Extraction Recov. (%)	Sampling Recov. (%)	NATO ITEQ (ng)	WHO TEQ (ng)
DIOXINS						
2378	Tetra CDD	<0.0020	71		0.0020	0.0020
12378	Penta CDD	<0.0020	70		0.0010	0.0020
123478	Hexa CDD	<0.020	79		0.0020	0.0020
123678	Hexa CDD	<0.020	84		0.0020	0.0020
123789	Hexa CDD	<0.020			0.0020	0.0020
1234678	Hepta CDD	<0.020	61		0.00020	0.00020
OCDD	Octa CDD	<0.020	48		0.000020	0.0000060
Total 2378-Dioxins		**0.10**			**0.0092**	**0.010**
Total Tetra		0.019				
Total Penta		0.061				
Total Hexa		0.13				
Total Hepta		0.048				
FURANS						
2378	Tetra CDF	<0.0020	70		0.00020	0.00020
12378	Penta CDF	<0.0020		75	0.00010	0.000060
23478	Penta CDF	<0.0020	65		0.0010	0.00060
123478	Hexa CDF	<0.020	83		0.0020	0.0020
123678	Hexa CDF	<0.020	67		0.0020	0.0020
234678	Hexa CDF	<0.020	69		0.0020	0.0020
123789	Hexa CDF	<0.020		88	0.0020	0.0020
1234678	Hepta CDF	<0.020	69		0.00020	0.00020
1234789	Hepta CDF	<0.020		82	0.00020	0.00020
OCDF	Octa CDF	<0.020	52		0.000020	0.0000060
Total 2378-Furans		**0.15**			**0.0097**	**0.0093**
Total Tetra		0.028				
Total Penta		0.024				
Total Hexa		0.049				
Total Hepta		0.045				
Mean Recoveries (%)			**68**	**82**		
Total 2378 Isomers		**0.25**			**0.019**	**0.019**
Total ITEQ (<LoD = 0)					**0.0**	**0.0**

1. < - not detected. (LOD quoted)
2. CDD : chlorodibenzo-p-dioxin. CDF : chlorodibenzofuran.

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Results from the Analysis of Stack Gas Samples for Dioxins & Furans

Laboratory Reference OJ0441
Customer Reference 091121 7721286-89

Analyte (Dioxin/Furan Isomer)		Result (ng)	Extraction Recov. (%)	Sampling Recov. (%)	NATO ITEQ (ng)	WHO TEQ (ng)
DIOXINS						
2378	Tetra CDD	<0.0020	76		0.0020	0.0020
12378	Penta CDD	0.0030	59		0.0015	0.0030
123478	Hexa CDD	<0.020	56		0.0020	0.0020
123678	Hexa CDD	<0.020	90		0.0020	0.0020
123789	Hexa CDD	<0.020			0.0020	0.0020
1234678	Hepta CDD	<0.020	83		0.00020	0.00020
OCDD	Octa CDD	0.031	52		0.000031	0.0000093
Total 2378-Dioxins		**0.12**			**0.0097**	**0.011**
Total Tetra		0.049				
Total Penta		0.19				
Total Hexa		0.26				
Total Hepta		0.10				
FURANS						
2378	Tetra CDF	0.0073	69		0.00073	0.00073
12378	Penta CDF	0.016		110	0.00080	0.00048
23478	Penta CDF	0.0025	56		0.0013	0.00075
123478	Hexa CDF	<0.020	98		0.0020	0.0020
123678	Hexa CDF	<0.020	99		0.0020	0.0020
234678	Hexa CDF	<0.020	92		0.0020	0.0020
123789	Hexa CDF	<0.020		87	0.0020	0.0020
1234678	Hepta CDF	<0.020	81		0.00020	0.00020
1234789	Hepta CDF	<0.020		87	0.00020	0.00020
OCDF	Octa CDF	<0.020	54		0.000020	0.0000060
Total 2378-Furans		**0.17**			**0.011**	**0.010**
Total Tetra		0.15				
Total Penta		0.12				
Total Hexa		0.085				
Total Hepta		0.13				
Mean Recoveries (%)			74	94		
Total 2378 Isomers		**0.29**			**0.021**	**0.021**
Total ITEQ (<LoD = 0)					**0.0043**	**0.0050**

1. < - not detected. (LOD quoted)
2. CDD : chlorodibenzo-p-dioxin. CDF : chlorodibenzofuran.

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Results from the Analysis of Stack Gas Samples for Dioxins & Furans

	Blank ng	LOD ng	QC std ng	Target ng
Dioxins				
2378	0.00014	0.0020	0.089	0.10
12378	0.000012	0.0020	0.44	0.50
123478	0.00024	0.020	0.47	0.50
123678	0.00014	0.020	0.50	0.50
123789	0.00019	0.020	0.45	0.50
1234678	0.001700	0.020	0.42	0.50
OCDD	0.002000	0.020	0.84	1.0
Furans				
2378	0.00024	0.0020	0.093	0.10
12378	0.00018	0.0020	0.47	0.50
23478	0.00001	0.0020	0.42	0.50
123478	0.00033	0.020	0.43	0.50
123678	0.00046	0.020	0.43	0.50
234678	0.00040	0.020	0.42	0.50
123789	0.00035	0.020	0.51	0.50
1234678	0.00090	0.020	0.45	0.50
1234789	0.00027	0.020	0.42	0.50
OCDF	0.00067	0.020	0.94	1.0
Total ITEQ ng	**0.019**			

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Results from the Analysis of Stack Gas Samples for Dioxins & Furans

Laboratory Reference	Customer Reference		NATO (ng)	WHO (Humans) (ng)	WHO (Fish) (ng)	WHO (Birds) (ng)
OJ0440	091121 7721956-7, 86	Worst Case <LOD=LOD	0.019	0.019	0.024	0.020
		Best Case <LOD=0	0.0	0.0	0.0	0.0
OJ0441	091121 7721287-89	Worst Case <LOD=LOD	0.021	0.021	0.026	0.028
		Best Case <LOD=0	0.0043	0.0050	0.0054	0.014

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Disclaimer

Scientifics Limited completed this Report on the basis of a defined programme of work and terms and conditions agreed with the Client. We confirm that in preparing this Report, we have exercised all reasonable skill and care, taking into account the project objectives, the agreed scope of work, prevailing site conditions and the degree of manpower and resources allocated to the project.

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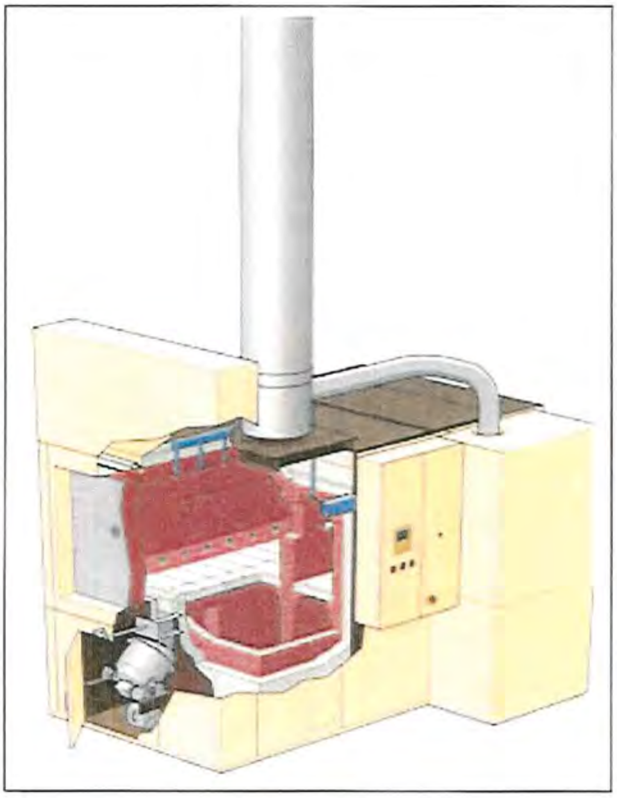
Any questions or matters arising from this Report should be addressed in the first instance to the Project Manager.

END OF REPORT

Facultatieve Technologies

Cremation & Incineration Equipment

TECHNICAL SPECIFICATION
FTII & FTIII CREMATOR
(UK SPECIFICATION)



Date: June 2010 *FTII & FTIII* (S.E) A.M.Brookes

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Facultatieve Technologies

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Facultatieve Technologies

1.0 INTRODUCTION

The *FTII & FTIII* Cremators have been specifically designed to cater for the specific needs of the modern day crematorium facility. The cremators enable the proper disposal of coffins and human remains whilst complying with the necessary flue gas emission requirements.

This cremator has been specifically designed after many years of experience and research in this very specialised field. In designing the cremator, we have minimised the necessary labour required to operate it, and the simplicity of its design ensures easy operation.

The design of this cremator is very capable of reducing the body to a high quality inert ash in a very efficient manner.

1.1 The Advanced Technical Features of the *FTII & FTIII* Cremator

- **Excellent environmental performance** - emissions conforming to current European and other World Standards.
- **Robust solid hearth** - providing single pass raking for ease of use.
- Excellent Extended Hearth Life.
- **Highest quality refractories** - including 63% Alumina in areas of heavy wear.
- **Robust construction** - a design capable of 6 or more cremations per day and cremations times around 60 to 80 minutes fully achievable.
- **One secondary combustion zone burner** to ensure a secondary zone temperature of 850°C, which can be maintained under all conditions of normal operation.
- Easily removable factory finished decorative outer casing.
- **Automatic control of air** - for both combustion and flue gas cooling purposes.
- **Advanced modern PLC control** features facility to ensure optimum combustion conditions by continuously monitoring throughout each cremation.
- **Automatic control of suction.**
- **Automatic temperature control** of both primary and post combustion zones.
- **Automatic fail safe** against over temperature and pressure.
- **Compact design**, enabling easy installation.

2.0 ENVIRONMENTAL PERFORMANCE

The design of this cremator provides a post combustion zone which maintains the flue gas temperature greater than 850°C for a time of greater than 2 seconds during operation, with an oxygen content of greater than 6%. Average over the cremation cycle and never falling below 3% (measured dry).

Tests on *FTII* & *FTIII* cremators in conjunction with our mercury abatement filtration system have been proven the equipment to comply and surpass the emission limits set out in PG5/2 (04) and AQ1(05). Independent tests conducted in the UK detailing the emissions into the atmosphere after the filtration process are available upon request.

Similarly emissions of Carbon Monoxide will be less than 100 mg/m^3 at all times, as measured at reference conditions of 11% O_2, 101.3 kPa, 0°C, dry.

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3.0 PROPOSED INSTALLATION

The *FTII & FTIII* Cremators are of a modular design, which allows the user to pick and choose the options available.

The basic cremator will consist:

- *FTII* Cremator (Single end design).
- Dedicated combustion air fan.
- Dedicated draught control system comprising ejector air fan and ejector system.
- Automatic PLC based control system.
- Easy to use Human Machine Interface (HMI) in the form of a standard desktop PC.
- Flue gas monitoring equipment - utilising extractive gas analysis systems, and including O_2, CO analysers and indicative particulate monitor.
- Computer control station, complete with data logging system.
- Remote engineering support - via modem.
- Coanda ejector. (only on equipment not fitted with a filter).
- Industry leading flat *interactive* touch screen Human Machine Interface mounted on the machine.

In addition, the following ***options*** may be considered (at additional **cost**):

- Remote location of combustion air fan and ejector fan.
- Increase in primary chamber width to allow larger coffins to be cremated (upgrade to *FTIII* unit)
- Double end design.
- Automatic coffin loading systems.
- Increased refractory specification.

Facultatieve Technologies experienced staff are happy to discuss any additional requirements as necessary.

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4.0 CREMATOR GENERAL DESCRIPTION

4.1 Principle of Operation

The cremator comprises a primary chamber of generous proportions into which the coffin is inserted and within which the primary combustion takes place. The hearth comprises flat sillimanite tiles. To keep the primary chamber entirely separate from the secondary chamber and avoid bypassing of the flue gases the hearth itself contains no openings, this ensures that all materials are retained for combustion in the primary chamber. The waste gas produced from this phase of the process exits the primary chamber via transfer ports in the chamber sidewall, descending below the solid hearth into the secondary combustion zone in which the gas phase combustion takes place.

The gases enter this zone and are then heated if necessary by the secondary zone burner and treated by the introduction of additional air. The flue gases make numerous passes within the secondary combustion zone, where the temperature is maintained at the required combustion temperature of 850°C, such that the two requirements of temperature and oxygen are met to ensure compliance to the local environmental requirements. Feedback to the control system from the emissions monitoring equipment ensures close control is always maintained, resulting in low pollutant emissions and excellent fuel economy.

4.2 Primary Combustion Chamber

The primary chamber is equipped with a single burner located in the end wall and two independently controlled sets of air jet comprising: -

- Air jets along the top of the arch.
- Side air along the sidewall of the cremator slightly above the hearth.

4.3 Secondary Combustion Zone

The FT cremator benefits from a generously designed secondary combustion zone, 3.2 m^3 in volume, and is sufficient sized to ensure a flue gas residence time of 2 seconds at all times during operation.

The FT cremator is designed with a secondary combustion zone comprising a series of passes below, and to one side of the primary chamber; one independently operated burner within this zone ensures that the temperature requirements are maintained while adequate supplies of secondary air and the tortuous flue path ensure high levels of turbulence to promote complete combustion.

The post combustion of the flue gases is completed within these high intensity areas, and thus all smells and smoke are eliminated. The design of the post combustion chambers ensures a lengthy, complex passage through the cremator prior to the flue gas exit.

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4.4 Combustion System

The primary chamber burner has a maximum rating of 270 kW and this enables normal operating temperature in the range of 800°C to be achieved in the primary chamber.

(The maximum allowable operating temperature is 1100°C to 1150°C).

The secondary combustion zone burner has a maximum rating of 350 kW which will enable temperatures of 850°C to be achieved in the secondary chamber as required by the local Environmental Regulations.

The primary and secondary burners are mounted at the rear of the cremator facilitating easy access for maintenance and repair.

The burners are configured for ***fully modulating control,*** are ignited automatically and the burner system is protected against flame failure, thereby complying with the gas regulations and BS 5885 Part II.

4.5 Control Valves and Instrumentation

The addition of combustion air to the combustion process is effected by five modulating control valves, controlling individual supplies to each of the burners, primary chamber air supplies and the supply of air to the secondary combustion chamber.

The cremator primary chamber under pressure condition is controlled via a differential pressure transducer controller, controlling the eductor draught generation system, and also protecting against system overpressures.

The primary chamber and secondary chamber temperatures are measured via type K thermocouples, temperatures are all displayed on the PC control station.

4.6 Combustion Air System

The cremator installation is supplied with combustion air by a dedicated fan, with a design duty capable of providing the air pressure and flow requirements of the Cremator. For higher operational efficiencies and reduced operational costs the fan is controlled by an inverter this ensures that the minimum of power is used during the cremation process. The fan is located in an integrated enclosure within the cremator's decorative panelling, the enclosure is acoustically lined.

4.7 Induced Draught System
- Cremator Underpressure / Draught Generation

The cremator underpressure is constantly measured and controlled by the addition of a cooling air volume into the hot flue gases via a coanda ejector located shortly after the cremator waste gas outlet.

The volume of ejector air is constantly modulated by an inverter controlled ejector air fan motor, the speed of the fan (hence the level of draught) is controlled by the cremator's PLC control system.

The pressure sensor / controller also continually monitors any overpressure condition within the cremators primary chamber. On detection of overpressure the combustion air to cremator is automatically turned off such that the combustion rate within the cremator is rapidly reduced. On sustained overpressure, the cremator will go into abort mode until the cause of problem is identified (for example, this could be the failure of the ejector air supply).

This separate ejector fan is located in an integrated enclosure within the cremator's decorative panelling, which is acoustically lined.

Note: In systems fitted with a mercury abatement system this item is removed from the cremator and its function is replaced with the total system ID fan.

4.8 Cremator Process Control – PLC Based

The cremator is supplied with a dedicated **Programmable Logic Controller**, this controller supervises the operation of the cremator the combustion process and automated loading if the FDI loader is fitted to the unit.

The cremator's control panel design is based upon a modern "*compact design*" PLC, complete with 32 digital inputs and 32 digital outputs in standard configuration with a maximum of 48 dependant on options fitted to individual cremators. The programmable logic controller is supplied, preloaded with our dedicated control software programme.

Facultatieve Technologies utilises the Mitsubishi PLC and associated *Melsec* computer software for process control of the cremator.

Manufacturer:	Mitsubishi
Base unit Type:	FX 2 N – 64 MR

4.9 Personal Computer Based Control System Including Data Logging

The cremator, is supplied (as standard) with a personal computer (PC) with integrated modem, the operator interface comprises standard keyboard and mouse arrangement together with a standard TFT monitor and the following software pre installed.

- Microsoft Windows XP Pro operating system
- Opsoft for Windows
- Integrated graphics package
- Mitsubishi Melsec Medoc package
- Norton PC Anywhere

A quality colour inkjet printer is provided so enabling the cremator operator to print down the data logging reports when required.

The cremator (and optional filter system if installed by Facultatieve Technologies) is be controlled via the integrated computer system. This PC based control system detailed below provides an industry leading control graphics package, and offers the added benefit of data logging and remote engineering support via a computer link.

For the above control interface, the PLC design includes a serial data card, which, via a RS 232 or RS 485 connection communicates with the computer system. Allowing the use of our Windows based Optsoft graphics package to operate a **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition system – known as **SCADA.**

The software control program includes automatic data logging this information is used to automatically generate a report in a format agreed by the UK Environmental Authorities and requires no further manipulation by the operator.

The control enclosure, including the PLC system is located on the rear of the cremator. Within this enclosure the equipment is situated to minimise the effects of heat, and is adequately ventilated so ensuring trouble free operation.

The PLC based control system is capable of the total control of the cremator and all its functions in order to complete the cremation process once the primary chamber has been charged without the need for operator assistance so simplifying the day to day operation of the cremator.

The PLC control system automatically varies the combustion programme according to coffin type and body weight. The system monitors many signal inputs from thermocouples throughout the cremator, information form the gas analysers and sends output signals to control the combustion air levels, burner operation, draught control system controlling the cremator at its optimum performance level. Ensuring cremations times are reduced, fuel efficiently is increased and emission limits are adhered to.

The system also monitors for combustion and component faults, taking appropriate action as required and transmitting the alarms to the operator display as necessary. Should the need arise, provision has also been included for a manual override. Manual control of the cremator is logged by the control system. However the control system whilst under manual control will prevent a dangerous situation from arising from incorrect manual operation.

4.10 Cremator Process Control – Safety Features

The burner flame failure and burner safety systems are housed separately from the burners. They comprise flame failure safety relays connected to a flame rectification type probe, to monitor "start" flame and "main" flame, which automatically shut off gas and air supply valves in the event of flame failure of either the main burner or afterburner, and to prevent burner ignition if the safety circuits are not energised.

Separate gas and air pressure switches are set to shut off the burners if the air supply or gas pressure fall below pre-determined safety levels.

Electrical interlocks prevent the charging door being opened for the introduction of a coffin unless the temperature in the secondary combustion zone exceeds 850°C. For additional safety the charging door will only partially open for ashing out purposes.

The cremator is fitted with automatic suction control to maintain a pre-set suction condition within the primary chamber for all normal combustion conditions. This is achieved by either a dedicated ejector fan or system ID fan on filters installations.

4.11 Remote Engineering Support

In order to support the cremator from our technical centre, the standard cremator control system is supplied with a modem. This enables remote observation of cremator parameters, retrieval and analysis of cremator emission data. The system also allows the cremator to be interrogated by our expert technicians to resolve operating problems without the initial requirement to attend site to rectify the problem.

Such a modem facility, already operating at many crematorium throughout the UK and Europe enables offsite maintenance scheduling, installation management, remote monitoring of cremator performance and operator assistance should the need arise.

4.12 Flue Gas Monitoring

The cremator is supplied as standard with an extractive flue gas analysis system, comprising combined oxygen and carbon monoxide analyser – the Siemens Ultramat 23 with fast response electrochemical cell for Oxygen detection and Infra red for Carbon monoxide detection, an indicative flue gas particulate monitor such as the Skil 252 (Single Output) monitor is also provided. These flue gas analysers are located to enable the analyser readings to be on display to the operating staff at the most convenient points within the crematory, and are repeated on the PC control station.

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The standard configuration provides for the continuous monitoring of:

- Oxygen
- Carbon monoxide
- Primary chamber temperature
- Secondary combustion chamber inlet / outlet temperature
- Flue gas particulate level
- High opacity alarm

Facultatieve Technologies qualified staff are happy to discuss any additional requirements as necessary.

4.13 Cremator Loader (Optional Item)

Facultatieve Technologies can offer numerous coffin loading systems, varying from simple manual transfer trolleys to fully automatic powered static loaders integrated into the design of the cremator as well as powered mobile coffin charging trolleys.

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5.0 CREMATOR CONSTRUCTION DESCRIPTION

5.1 Casing and Framework

The casing and framework of the cremator is fabricated of steel plate and sectional steel construction, the whole braced for rigidity, so as to properly support the refractory and insulating materials with which the casing is lined.

The overall external dimensions of the cremator are:

	FTII Cremator		FTIII Cremator	
	Single end	Double end	Single end	Double end
Length (m)	3.86	3.73	3.86	3.73
Width (m)	2.12	2.12	2.15	2.15
Height (m)	2.45	2.45	2.45	2.45
Height over door gear (m)	3.30	3.30	3.30	3.30
Weight (kg)	12,600	12,600	13,500	13,500

The cremator size is generally as detailed by the *FTII & FTIII* brochure.

5.2 Cremator Charging Door

The refractory lined charge door is situated at the front of the cremator is counterbalanced and suspended on precision roller chains for ease of operation. Operation is by means of a single phase electric motor controlled by adjacent push buttons, interlocked to prevent charging unless the secondary combustion chamber temperature is above 850 °C. The door opens to the full dimensions of the primary chamber thus allowing for maximum coffin size.

The dimensions of the charging aperture are: -

	FTII Cremator		FTIII Cremator	
	Single end	Double end	Single end	Double end
Width (mm)	900	900	1100	1100
Height (mm)	800	800	800	800

The **recommended maximum** size of coffin which can be inserted into the machine is:

	FTII Cremator		FTIII Cremator	
	Single end	Double end	Single end	Double end
Length (mm)	2350	2350	2350	2350
Width (mm)	860	860	1050	1050
Height (mm)	700	700	700	700

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5.3 Ash Removal

5.3.1 Single Ended Cremator

Access for raking on single ended units is through the charging door. At the end of the cremation, the door is opened to a safe, partially open position, which protects the operator from the radiated heat. The door is operated by a pushbutton and door height is controlled by PLC control system.

5.3.2 Double Ended Cremator

Access for raking on double ended units is through a dedicated rear ash door. At the end of the cremation the door is opened by pushbutton operation to its fully open position so giving the operator easy access to the calcined remains. This door is designed constructed and installed in a similar manner to the charging door. In the open position the aperture is 230mm high x 350mm wide.

In both of the above designs the ash then may be raked (using an ash rake) and removed directly via the integral ash chute, into a refractory sump positioned below the ash out door. Whilst within this refractory lined ash box the ashes can be cooled automatically by a flow of cold air. The cooled ashes can then be dropped into the attached stainless ash box, by manually opening a slide valve. The ashes can then be removed from the cremator and transported elsewhere for further processing if so desired.

5.4 Access for Maintenance

The need for access for maintenance has been carefully considered in the cremator design, and facilities have been provided for the cleaning out of accumulations of ash in any of the chambers and flue passages, access ports being provided for this purpose.

5.5 External Finish

Externally, the cremator casing is clad with pre-finished painted panels before leaving our production facility. Consequently, no additional finishing of these items is required and they are a distinctive feature of the cremator.

As well as giving the cremator a pleasing appearance, the panels ensure operator safety, by preventing any hot surfaces from being touched. The cladding panels ensure a gap of air between the internal cremator casing, and the external surfaces. This greatly reduces the external surface temperatures experienced.

The charging door at the front of the cremator is faced with stainless steel surrounded by a stainless steel bezel. The rear ashing out door on double ended units is also finished in stainless steel.

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5.6 Refractory Materials – FT Cremator

5.6.1 Refractory Lining

Refractories are of high quality, comprising fire-brick, backed by calcium silicate insulation and microporous insulating materials.

Location of refractory in cremator	Quality of refractory (Alumina content)	Thermal conductivity (W/m °C)	Bulk density (g/cm^3)	Maximum operating temperature (°C)
Used in areas of high turbulence.	63%	2.0	2.25	1600
Used in cremator sidewalls.	42%	1.9	2.25	1400
Used in cremator hearth.	65%	1.62	2.45	1600
Castable refractories used for burner quarls, lintels and outlet port.	50%	N/A	2.37	1600
Ash chute.	50%	N/A	2.37	1400

- As an optional extra cost item, **all** the hot face brickwork of the cremator can be supplied in **63% alumina** content refractory (replacing the above 42% alumina material).

5.6.2 High Quality Insulation

Type and location of insulation	Insulation thickness (mm)	Thermal conductivity (W/m °C)	Bulk density (g/cm^3)	Maximum operating temperature (°C)
Calcium Silicate Insulation used in the areas around and between the refractories and the steel casing.	75	0.10	0.2	1050
High grade microporous insulation included within the insulation layers between the steel casing and the internal refractory.	25	0.3	0.3 to 0.35	950

The quality and thickness of the insulation materials used in the construction of the cremator are such that the exterior casing is kept at a safe temperature for the operators at all times.

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6.0 TECHNICAL SPECIFICATION – *FT* CREMATOR

6.1 Cremator Primary Chamber Internal Dimensions

	FTII Cremator		FTIII Cremator	
	Single end	Double end	**Single end**	Double end
Length (mm)	2500	2500	2500	2500
Width (mm)	900	900	1100	1100
Height (mm) (To top of Arch)	960	960	960	960

6.2 Secondary Combustion Chamber

Secondary combustion chamber volume 3.2 m^3
Residence time in secondary combustion chamber > 2 seconds

The secondary combustion chamber is specifically designed to ensure a **flue gas residence time of 2 *seconds*** at a flue gas temperature of 850°C and oxygen content of 6%.

6.3 Burners

	Max fire	Min fire
Primary chamber burner (kW)	270	60
Secondary chamber burner (kW)	350	150

Burner fuel: Natural gas or LPG

Burner control mode: Continuous modulation of burner output, burners are low NOx design.

Burner controls:

Manufacturer	Kromschroeder
Model	BCU 370
Flame detector	Ionisation probe

Burner gas valves:
Primary and secondary chamber burners are fitted with fully modulating 240V gas safety control valves.

6.4 Utility / Fuel Consumption

Typical gas consumption of the cremator per cremation:
20 – 25 m^3 of Natural Gas
(Based upon five cremations per day, five days per week including preheat time. Natural Gas (net $CV_{nat\ gas}$> 34.82 MJ/m^3)).
Typical electrical consumption per hour under normal running conditions:
8.75 kWh

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6.5 Cremation Capacity

This design of cremator is robust, and will perform up to **6 cremations per normal working day,** however, it is fully capable of operating for extended periods beyond "normal working hours", as required.

6.6 Air Requirements

	Flow (m^3_N/h)	Pressure (Pa)	Motor (kW)	Manufacturer	Model
Combustion Air Fan	1500 (Design)	6000	5.5	Fans and Blowers Ltd	QP 5615
Ejector Air Fan	500 (Min) 2500 (Max)	5500	5.5	Fans and Blowers Ltd	QP 5615

	Modulating flow	
	Max flow (m^3_N/h)	Min flow (m^3_N/h)
Combustion air to primary chamber	500	0
Secondary chamber air	900	0

Air fan frequency inverter variable speed controller:

Manufacturer	Danfoss
Model	HVAC 6000 Series With built in RFI filter

6.7 Cremator Process Data

	Temperatures (℃)		Pressure (Pa)	
	Max	Min	Max	Min
Primary chamber	1050	750	-10 mm	-70 mm
Secondary chamber	1150	850 (Design)	N/A	

Note: Primary chamber temperature and pressure varies with progress of cremation.

6.8 Flue Gas Conditions

	Condition
Flue gas temperature	850℃
Flue gas volume exit of secondary combustion chamber (Typical)	1270 m^3_N / h
Content of carbon monoxide Typical content over the cremation	<50 mg/Nm^3 (Using natural gas fuel)
Flue gas particulate content (Typically)	<80 mg/Nm^3

Gas sampling for combustion control of flue gases is made in the exit duct of the cremator.

All above figures are given at reference conditions of 273K, 101.3 kPa, dry, 11 % vol/vol oxygen

6.9 Cremator Heat Loss

Although fabricated from the highest quality refractories and insulating materials, the cremator will lose heat to its surrounding environment. This heat loss is via convection, from all its surfaces, and is calculated as 11 kW at maximum.

6.10 Cremator Control / Instruments

Thermocouples

Primary chamber	No 1	Type K - Ni / Cr Element
Secondary chamber inlet	No 1	Type K - Ni / Cr Element
Secondary chamber outlet	No 1	Type K - Ni / Cr Element
Chimney	No 1	Type K - Ni / Cr Element

	Manufacturer	Type
Primary chamber pressure controller	Skil Controls Ltd	222
Cremator air valve motors	Kromschroeder	ICW - 20

Each of the above probes is connected to an indicator mounted on the control panel for visual indication of all process values.

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Cremation & Incineration Equipment

Flue Gas Cooling and Filtration Equipment for Single Cremator Installation

UK Technical Specification

Date: Jan 11 | Single Cremator Installation | A.M.Brookes

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1.0 General System Description

To enable the flue gases to be filtered they must be first conditioned to a temperature (cooled) necessary for the cleaning within the filter system. For this reason thermal energy (heat) must be removed from the flue gases.

The flue gas from the cremator enters the air to water cooler (boiler) via a refractory lined duct, and is cooled down to the filter operating temperature range of 120°C to 150°C. The heat removed from the flue gas is transferred in the water / glycol circulation system to a dedicated air blast cooler located externally from the filter equipment.

Between the boiler and fabric filter, fresh reagent additive ***Factivate*** is added to the flue gases. The flue gases and the ***Factivate*** are homogeneously mixed within a reaction volume prior to entering the filter.

Within the fabric filter, a cake of additive and dust builds up on the filter bags, thus improving filter efficiencies and filter bag lifespan.

The special automatic control system for the fabric filter cleaning controls the operation of the filter (e.g. differential pressure) and ensures that there is sufficient additive ***(Factivate)*** on the filter bags during operation.

The adsorption of the mercury, dioxins and furans occurs with the ***Factivate*** in the air stream and in the dust/additive cake on the filter bags.

Furthermore, the concentration of acidic gases such as SO_2 and especially HF and HCl is reduced by reaction with the chemical reagent.

During the cleaning process of the filter, the released dust cake falls into the filter hopper. A motorised mechanical screw conveyor transports the dust and spent reagent to a container for waste disposal. Typically the automatic cleaning process occurs once a day – at shutdown, so ensuring that the filter is cleaned of "used additive" at the end of every operational day, and so starts operation the following day using only fresh additive. Such operation dramatically reduces the risk of filter fires, especially as the additive selected has natural fire retardant capabilities.

An induced draught fan draws the cleaned gas through the fabric filter, and passes it to atmosphere through the chimney stack. The control of this fan, via a frequency controller (inverter), ensures the correct cremator underpressure (as measured in the cremator) at all times. The induced draught fan is suitably sized to overcome all the resistances within the cremator, flue gas cooling and filter equipment.

A compressor is included to supply the compressed air requirements of the fabric filter cleaning system.

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The premixed chemical reagent additive mixture will be supplied in easily manageable closed containers, which can be easily introduced into the automatic reagent feeding station. Under fully controlled conditions, the reagent is fed via a dosing screw into the filter system in the required amount necessary to ensure compliance with the local emission regulations.

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2.0 Technical Design Data

Operating hours	:	Up to 24 hours per day
Temperature after Cremator	:	Normal.850 °C Max. 1100 °C Temporary 1200 °C for up to 10 minutes
Volume flow per Boiler	:	1550 Nm^3/h
Temperature before Filter	:	Approx. 150 °C Peaks up to 180 °C for max. 5% of the cremation
HCl Inlet Filter (Typically)	:	50 mg/Nm^3
SO_2 Inlet Filter (Typically)	:	70 mg/Nm^3
Dust content	:	~ 200 mg/Nm^3
Type of dust	:	Ash
Grain size	:	Fine / very fine
Dust density	:	700 to 800 kg/m^3
Mercury	:	1 mg/Nm^3
Place of erection	:	Inside a building
Climatic conditions	:	Western Europe
Height above sea level	:	< 300 m

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3.0 Equipment Specification

3.1 Cremator Draught Control System

To ensure optimum process pressure conditions in the cremator oven, the under pressure (negative) in the cremator oven is constantly measured by pressure transducer controlling instruments. These control signals are used to constantly modulate the speed of the filter system's induced draught fan during the filter system operation.

3.2 Flue Gas Cooling – General Description

Heat removal from the flue gases is necessary only for conditioning of the gases to a temperature necessary for the correct operation of the flue gas cleaning system. In normal configuration the boiler system is supplied with an air blast cooler system normally located external to the building. The coolant fluid in the system is a water / glycol mix. As an option, if required, the recovered heat will be transferred to a heat accumulator system and / or district heating system.

The flue gas cooling plant is sized to accept the flue gases from the cremator and is designed to accept the wide thermal load variation of the flue gases exhausting from the cremator.

The hot water is recirculated around the water circuit by suitably sized recirculation pump. The recirculation circuit will also be fitted with a thermal expansion system comprising a vessel fitted with a pressurised diaphragm, system fill connections and safety pressure relief equipment.

3.2.1 Flue Gas Cooler (Boiler)
(Flue gas to water cooler)

The flue gas cooler is designed as a conventional waste heat boiler, of multi-pass design. The design of the boiler is such that the flue gases pass up the inside of the boiler tubes and water based coolant is pumped through the shell on the outside of the tubes.

Technical Data:

Maximum		
Flue Gas Volume	:	2850 Nm^3/h
Gas Temperature inlet	:	800 °C (normal)
Gas Temperature outlet	:	150 °C
Convective power	:	450 kW (design)
		600 kW (max thermal)
Water Temperature inlet	:	75 °C
Water Temperature outlet	:	95 °C
Boiler pressure Design	:	6.0 Bar
Water volume	:	21.0 m^3/h

Differential Pressure gas	:	410 Pa (normal)
Differential Pressure gas	:	1170 Pa (max)
Differential Pressure water	:	400 mbar (normal)

3.2.2 Automatic Soot Cleaning System

The equipment proposed would be a **"DANBLAST"** system. This system relies upon an automatic shock blast to clean the inside of the flue gas tubes of solid deposits, and is often referred to as a "soot blowing system".

This system utilises a supply of compressed air, at a pressure of 8-bar maximum, which will be supplied from the air compressor system supplied in conjunction with the flue gas filter installation.

The process of soot cleaning is **automatically** controlled by the dedicated PLC control system. As part of the cremation plant's automatic shutdown sequence at the end of the operational day, the boiler "sootblowing" sequence would commence, this sequence typically lasting 30 to 60 minutes, in which time each nozzle would soot blow two times in sequence.

The soot and dirt removed from inside the boiler tubes would pass onto the filter unit entrained in the moving flue gases being drawn through the equipment by the filter's induced draught fan.

Essentially this system removes the requirement to **manually clean** the boiler, other than perhaps once a year, so that the boiler may also be inspected at the same time.

3.2.3 Air Blast Cooler (Re-cooler)

To remove heat from the system, the re-circulating hot water based coolant is passed to the air blast cooler, normally located externally to the process equipment. Ambient (cool) air is force ventilated over the tubes by fans located on the cooler, while the hot water / glycol mixture passes inside the finned cooling pipes.

Technical Data:

The heat exchanger (air blast cooler) consists of:

Finned pipe heat exchanger, consisting of aluminium finned copper tubes

Max. Temperature (design)	:	120 °C
Max. Excess pressure	:	6 bar
Number of Axial-fans	:	6 placed on the inlet side with protective grating.
Electric Motors	:	400 V / 50 Hz / 0.5 kW
Cooling power	:	450 kW (Design) 600 kW (Max Thermal)

Coolant Water volume	:	21.0 m^3/h
Coolant Media	:	25% v/v ethylene glycol in water
Temperature inlet	:	95 °C
Temperature outlet	:	75 °C
Differential Pressure	:	Approx. 68 kPa
Sound Pressure Level axial fans	:	47 dB_A at 10 m

3.2.4 Water Control System

The system will be complete according to the relevant country standards. The water circulation pipework will include duty and standby circulation pumps, all necessary valving, insulation, and two (valved) connections to enable heat recovery from the water circuit as necessary.

3.2.5 Heat Recovery System

Note: For future heat recovery we can supply a dedicated plate heat exchanger within the water circuit to enable heat recovery, for connection into the crematorium's central heating systems (by others) as necessary.

Typically, the plate heat exchanger, complete with manual isolation valves on both primary and secondary circuits, will be as follows:

Type of Heat Exchanger	:	Plate Exchanger
Supplier	:	HRS Coolers or similar
Design Rating	:	120 kW
Flow rate	:	12 m^3/h
Temperature of Water	:	55 to 65 C
Pressure Drop	:	32 Pa

3.2.6 Piping

Interconnecting pipework is included within our scope of supply, connecting the flue gas boiler to the externally located air blast cooler. All pipework will be thermally insulated and covered with a protective cladding.

3.4 Additive/Reagent - Dosing System

Factivate Reagent Additive Station

Consisting of charge unit with support structure to accept easily manageable ***Factivate*** reagent 15kg containers. Each container is lifted into the charging station via the dedicated door which is closed and sealed before reagent transfer, so ensuring the automatic addition of reagent under controlled clean safe conditions.

Factivate Dosing unit

Consist of a frequency controlled dosing screw conveyor, and injection piece to inject reagent additive into the flue gas ductwork
Dosing range : 0,2 – 2,0 kg/h per cremator

3.5 Reaction Volume

For a thorough mixing of the gas stream and additive, a reaction volume is designed within the interconnecting ductwork, between the boiler and the filter. This reaction volume is complete with a reagent additive-distribution pipe, and inspection openings.

3.6 Compact Filter Unit

Filter Type: Dantherm FD 3 / 2.5 / 30 (or similar)

The filter is supplied complete with compressed air cleaning system configured for operation on the dirty gas side, and is delivered fully functional, with filter fabric elements and compressed air cleaning system installed.

The filter unit consists of:

- A filter housing in fully welded sheet steel construction with separate dirty gas and clean gas compartments.
- Inspection doors to allow easy access for maintenance and inspection work.
- Cleaning system with pressure reducer, compressed air tank, electromagnetic actuated diaphragm valves, injector nozzle and jet tubes.
- Connecting flanges for dirty gas connection and dust collecting hopper.

Technical Data:

Designed for negative pressure up to	:	60 mbar
Maximum number of filter cassettes	:	30 pcs.
Averaged compressed air consumption (During cleaning cycle)	:	12 Nm^3/h
Filter Element(s) (Consisting of filter bag and spacer mat.)	:	60 off

Technical Data:

Filter media	:	Aramid
Temperature resistant up to	:	190 °C
Self ignition temperature	:	>485 °C
Overall installed filtering area	:	55 m^2
Overall effective filtering area	:	55 m^2

3.6.1 Filter Dirty Flue Gas Inlet Transition

Arranged above the filter fabric elements, manufactured as a fully welded sheet steel construction with baffles for guiding the dirty gas flow, inspection doors and the connecting flange for the dirty gas ductwork.

3.6.2 Dust / Spent Product Collecting Hopper

Arranged under the filter fabric elements for the collection of the separated dust, manufactured as a fully welded sheet steel construction with connection flanges to the filter housing and the screw conveyor. Supplied with integral support structure in suitably designed structural steel section.

3.6.3 Spent / Reagent System

Consisting of a screw conveyor arranged under the filter for the conveyance of the separated dust in fully welded sheet steel construction with connecting flanges to the dust collecting hopper and to the discharge valve.

Including gear motor : 1.1 kW 22,5 rpm

Support structure in suitably designed structural steel construction.

3.6.4 Spent Reagent Storage Bin

Arranged under the waste product screw conveyor, to store the spent product from the filter hopper (above).

Capacity : **200** litre

3.7 Induced Draught Fan (for total Filter/Cremator Plant)

For the conveyance of the cleaned gas through the total integrated cremator and filter installation.

Fan Type:	Single-stage, one-sided suction. Impeller mounted directly on the fan shaft, overhang type, with two bearings.
Fan Design:	Industrial fan in heavy-duty fully welded sheet steel construction. Housing with cleaning opening and drainhole for condensate Impeller with backwards inclined or radial blades. Electrodynamically balanced in two planes.

Technical data:
(Design point)

Flow rate	:	3,800 Am^3/h
Total pressure at 150 °C	:	70 mbar
Power requirement at 150 °C	:	18.5 kW
Impeller speed	:	2930 rpm

Induced Draught Fan supplied with cooling disc for shaft cooling of the fan, arranged between fan housing and motor including protection against accidental contact.

Anti Vibration Mounts – 1 set for vibration-free erection on the fan including fastening plates.

Electric Motor for Induced Draught Fan
According to IEC norms

Designed for Frequency control via separate inverter system controlled using the system underpressure in the cremator.

3.8 Compressed Air Station

As an integral part of the filter installation, an air compressor is supplied, and will be of the rotary screw design type. The compressed system will be supplied complete with compressed air reservoir (pressure vessel), and necessary valving, automatic oil / moisture separators and interconnecting pipework from the installation to filter installation, soot blowing system and other compressed air users supplied as part of the filter installation.

Air Compressor Type: Screw Compressor – Atlas Copco GA 5 (or similar)

Technical:

Effective Air Volume by 7 bar	:	1 x 0,24 m^3/min
Max. Pressure	:	8 bar
Electric Motor	:	2,2 kW / 400 V / 50Hz
Compressed Air Receiver/Tank	:	1 off
Capacity	:	250 litres
Max. Pressure	:	11 bar
Max. Temperature	:	50 °C

3.9 Refractorised Flue Gas Ductwork

To convey the hot flue gases from the **single** cremator flue gas offtake, refractory lined ducting will be supplied, fabricated from mild steel, internally lined using 1400 °C grade castable refractory further insulated with calcium silicate insulation.

To ensure safe operation during emergency situations the above refractory duct is supplied with a by pass duct, fitted with a pneumatically actuated (fail open) damper, which on the detection of emergency condition opens. The duct is fitted with a device to cool the gases prior to direct entry to the chimney stack.

3.9.1 Cool Flue Gas Ductwork

To convey the cooled flue gases from the flue gas cooler (boiler) to the filter installation and finally to the chimney, ducting is supplied from 3mm thick mild steel, of welded fabrication, supplied with flanged connections, designed for good flow characteristics.

The ducting will be supplied with all necessary flanges, fittings, connection pieces, screws and seals.

Flue Gas Ducting consisting of:

- Connecting duct from cooler (boiler) to filter
- Filter Preheat Bypass connecting duct
- Connecting duct from filter to induced draught fan
- Connecting duct from induced draught fan to chimney

3.9.2 Filter Bypass Valve

Placed in the ductwork to allow the flue gases to bypass the filter system, generally used to preheat the system prior to cremation, to protect the filter system against flue gas moisture.

Comprising pneumatically actuated twin butterfly valve arrangement, complete with system vent damper.

3.9.3 Filter Outlet Valve

Placed in the ductwork at the outlet of the filter, to ensure that the filter is isolated from the flue gases during bypass condition.

Comprising pneumatically actuated butterfly valve arrangement.

3.10 Thermal Insulation

For the exterior surfaces of the filter plant, thermal insulation is to be installed for contact (personnel) protection and to avoid the cooling of the plant parts during short standby periods.

Mineral wool Insulation thickness	:	50 to 100 mm
Mineral wool Insulation density	:	100 kg/m³

Thermal Insulation areas addressed

- Insulation of the cooler

- Insulation of the filter housing, -hood, and -screw conveyor
- Insulation of the ductwork

3.11 Exterior Surface Treatment - Filter Unit

The exterior surfaces of the filter unit receive a single layer of two component epoxy resin prime coating, layer thickness at least 40 µm. These exterior surfaces are treated with a supplementary top coating on alkyd resin basis, layer thickness at least 40 µm.

The application of different types of paint may cause colour variances.

Any filter components supplied in special steel, galvanised steel or insulated surfaces are excluded from the above surface treatment.

3.12 Filter System Control and Electrical System

A dedicated control system is supplied for the automatic and integrated operation of the (cremator) flue gas boiler and filter system.

The control system will comprise of the following:

3.12.1 Control Enclosure

The enclosure will be designed conforming to European regulations; and comprise of a sheet steel cabinet, protected to IP 54. The enclosure will house power and control section, as well as wiring of devices in cable ducts. The control cabinet is designed with a minimum of fuses, completely wired on outlet clamps.

The control system will be based upon a "Mitsubishi" Programmable Logic Controller

The control enclosure also includes:

- 1 off Main Switch

as well as the following components:

- 1 off Control of the Induced Draught Fan utilising Frequency Inverter.
- 1 off Negative pressure control in connection with speed dependent induced draught fan
- 1 off Screw Conveyor control
- 1 off Control of the additive/ reagent dosing system
- 1 off Measurement of flue gas temperature after cooler
- 1 off Control of the cooler (boiler) water control system
- 1 off Control of the cooling fans from the re-cooler

The operator interface for the filter system will be via the SCADA based computer interface preloaded onto an IBM PC, supplied complete with a 17" TFT Flat Screen monitor.

3.12.2 Electric Cabling

The cabling between the plant and our control cabinet has been calculated with a medium cable length of 20 m. The electric cabling consists of:

- Cable
- Cable glands
- Galvanised cable tray
- Fastening material
- Accessories

The incoming power supply to the control panel is to be provided by the client. For actual Power requirements please refer to our electric motor schedule as listed within our engineering documentation / information package.

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4.0 Equipment Documentation

Documentation will be supplied in the English language Two copies of the following will be supplied:

- Plant description
- Operation description
- Maintenance - and lubrication instructions
- Spare parts list

The information signs on the plant will be supplied in the English language.

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5.0 OPERATIONAL PERFORMANCE

5.1 Dust emissions in Flue Gases

The residual dust content in clean gas is max. 10 mg/Nm³, referred to 11%O_2 v/v, measured according to VDI 2066.

5.2 Gaseous emissions

The concentration of the gaseous acidic and metallic pollutants will be abated by the flue gas treatment system. Based upon the inlet concentration of pollutants (as detailed in section 2.0 – Technical Design Data) and a ***Factivate*** reagent dosing rate of 300 grammes per hour, the flue gas emissions will be within the limits set down in the Process Guidance Note 5/2 (04) Issued September 2004: -

Emission	PG5/2 (04)
	Concentration Limit Value
Hydrogen Chloride excluding Particulate Matter	30 mg/m³
Total Particulate Matter from Cremator	20 mg/m³
Carbon Monoxide	100 mg/m³
Organic Compounds excluding Particulate Matter expressed as total carbon	20 mg/m³
Mercury	0.05 mg/m³
Dioxin	0.1 ng/ m³

Concentration values stated at standard gas reference conditions of 273 K, 1.013 Bar,11 % O_2, dry gas.

5.3 Sound emissions from the filter equipment.

The sound pressure level LAeq according to DIN 45635 - part 1 - at the plant is max. 70 dB_A in a distance of 1m. This is only valid for free field conditions without reflections.

The indicated sound pressure levels are valid for the non throttled operation of the plant, i.e. 100 % fan output.

Attenuation materials will be applied to the main ventilation fan to ensure compliance with the required 70 dB_A at 1metre distance, during normal operation hours.
Please note the other noise generating equipment will be supplied in normal (non silenced) format, both the Boiler Auto cleaning system and the filter cleaning produce noise during the shutdown process. This is after normal operating hours, and as such not considered for noise within our normal operational hours.

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6.0 GUARANTEE

The filter installation, and its component parts (with the exception of those consumable items necessary for operation), are guaranteed for a period of 12 months from the date of hand over and a 3 year design liability, excepting fair wear and tear, subject to entering into a Service Contract with Facultatieve Technologies.

The design life of such equipment is taken as twenty years, this is of course dependant upon the equipment being operated and routinely maintained in accordance with supplied written instructions, and operated by trained personnel in possession of a Facultatieve Technologies Training Certificate. Replacement of all spares and consumable parts within such time must be with genuine components as approved by Facultatieve Technologies.

The above design life is offered in good faith, however Facultatieve Technologies cannot be held responsible for any changes within relevant legislation that may impact upon the above design life.

Conditions for unrestricted validity of our guarantee:

- The plant has to be operated according to our operating and maintenance instructions, and operated by trained personnel.
- The plant has to be operated within the established design parameters.
- The plant has to be commissioned by FTL nominated commissioning engineers.

Exclusion from guarantee

- Mechanical destruction of the equipment caused by handling malpractice.

The cleaned flue gas emission limits can only be assured, if sufficient addition of reagent is made to the system, and is in full accordance with the equipment's operating instructions.

In case of altered site conditions, the addition of the additive quantity may only be adjusted to the respective new requirement by agreement with FTL.

Consumable items are excluded from the scope of the guarantee

Proof of clean gas values:
The actual proof of achieving the required emission values of clean gas of the proposed filter plant can only be carried out by an authorised measuring institute.

Facultatieve Technologies has a policy of continuous improvement and reserve the right to amend this specification without prior notice.

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CONTROL AND MONITORING SYSTEMS FOR FT CREMATORS

Overview

The following document describes in detail the control and monitoring system proposed. As already advised this control system has already been supplied to the UK cremation industry and conform to the requirements of PG 5/2 (04).

The control package proposed is the product of many years of experience within the industry and represents our most sophisticated version of our **SCADA** control system yet.

This control system is designed by our "in house" specialist software engineers, using standard industry programme code. The actual control programme is downloaded onto propriety industrial grade PLC controllers, to which full access will be made to client via a password system local on site.

The PLC based control system utilises standard components, and interfaces with a simple, higher automated graphical control system, commonly referred to as **SCADA**. Graphical interfaces have been developed for both our FT cremators, and the Mercury Abatement Systems, all integrate seamlessly into one overall system, such that the cremators and filter systems can be controlled from one common place.

Additionally our integrated control system generates all the necessary reports as defined by the requirements of PG 5/2 (04), all automatically, and without HUMAN intervention.

A summary of our integrated SCADA control system is included, and described below.

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SCADA Cremator Screen Description

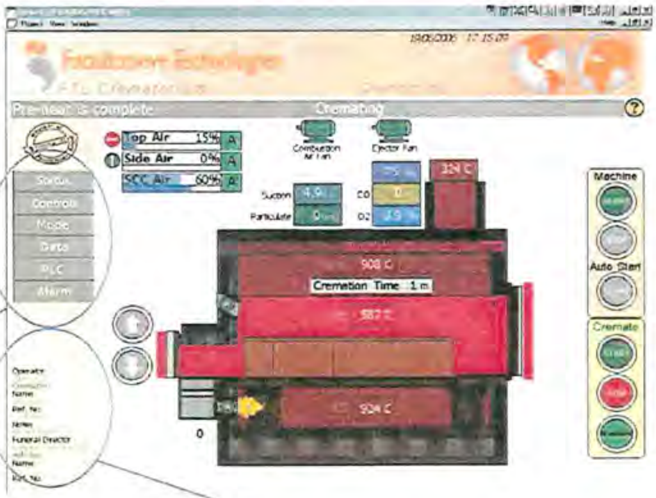
The control screens on the cremator are run under a **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition (SCADA) package called Wing. These screens will be automatically activated on PC start up. They can be closed down by clicking on the cross in the top right hand corner of the screen (this will stop all data logging, trending and will delete any stored user information). They can also be restarted from the Cremator icon.

These screens communicate directly with the PLC and display various data items from the PLC. The screen can be closed and the PC shutdown without affecting the cremator control.

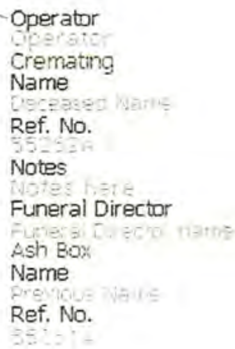
The screen has been developed over many years to make the cremation process as simple as possible for the operator.

The screen initially loaded is the main Status screen, shown below. All the main activities for normal running of the machine can be carried out from this screen.

The screen has a navigation bar on the left hand side. This controls access to all screens on the system. Simply by clicking or touching (if a touch screen is fitted) on the appropriate button the desired screen will be displayed. This navigation bar will be displayed on every page.



Information about the cremation is entered at the bottom of the screen. This is reproduced automatically on the cremation report.



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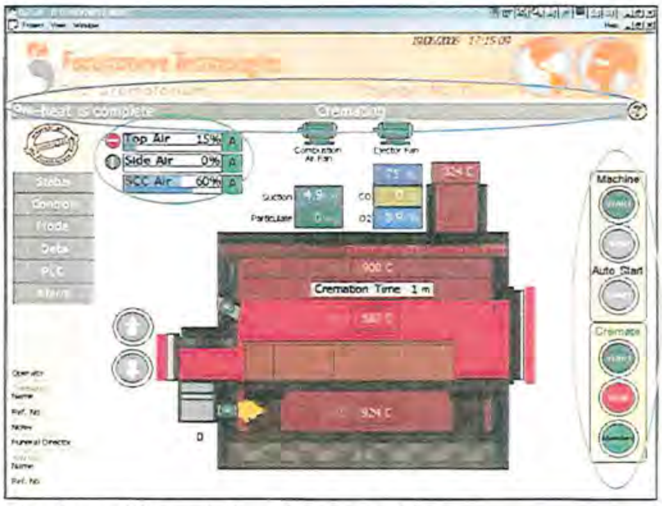
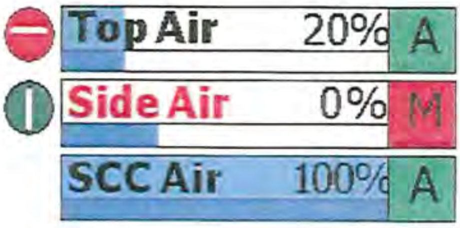


A Status bar is displayed at all times and on all screens, this gives various data about the status of the machine.

The controls most used are also displayed on this screen.

The air controls display the current levels and targets of the various air dampers on the machine. The dark blue line at the bottom of the bar is the target automatically set by the PLC. The lighter blue bar is the actual position of the damper. The top and side air dampers have limit switches fitted to detect their fully closed position. This is for safety reasons so that the operator cannot open the charge door with an combustion air on. This limit switch position is indicated by the symbol to the left of the air status bar. A red symbol indicates that the air is open, a green symbol indicates that the air is closed. In the picture above the side air is selected to manual and closed. The actual target position can be seen by the dark blue bar.



The controls on the right of the screen are used to start and stop the machine, both automatically and manually. The lower controls are used to start and stop cremation and to select the desired profile for cremation.

If fitted, a motorised ash door can also be operated from the status screen, using the open and close buttons to the left of the ash door.

The ash cool can also be operated from the status screen, by simply clicking on the ash cool box the ash cool can be turned on and off.

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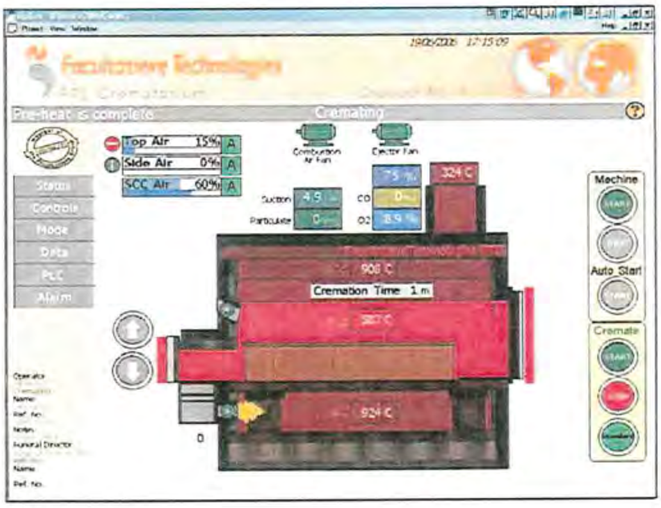
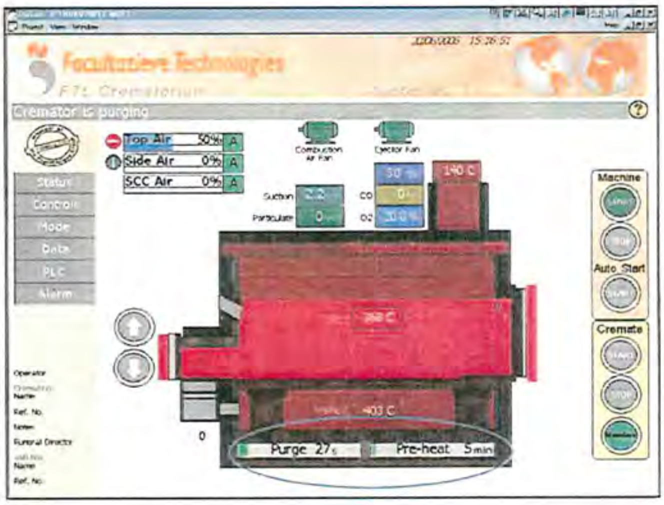
Various other data is displayed on the screen, including the temperatures and analytical data. The boxes that this data is displayed in will change colour to indicate that a parameter is out of normal operating range. This does not indicate an alarm condition but is designed to bring the operators attention to the parameter that is out of range.





Before the machine is started the estimated pre-heat time is displayed at the bottom of the cremator.

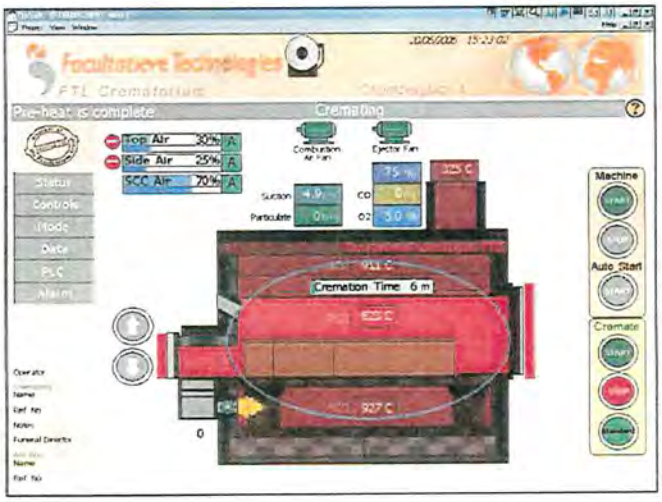
When the machine is started the purge time is displayed at the bottom of the screen.

The pre-heat time will then start to decrement.

Once cremating the coffin icon and the cremation time are shown in the main chamber.

The cremation count is automatically incremented after each charge.

The next button on the Navigation bar is the controls page.



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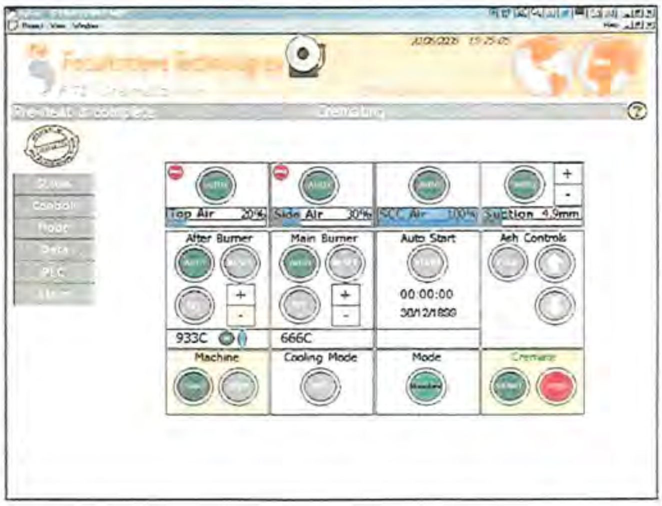
The Controls Page

This page contains all the cremator controls and allows for manual operation of each component on the cremator.



The air controls, mode and the start and stop controls are all duplicated on this page. In addition the burners and suction can be manually operated.

There is also a cooling mode selection. This is to allow the machine to be cooled for maintenance purposes.

Each part of the machine has 2 modes, auto and manual. In auto, the machine will cremate with minimal operator intervention required. Manual mode allows the operator to intervene as their experience dictates. All of the more safety critical controls are password protected to prevent their use by untrained personnel. Even in manual mode all safety functions are still active and the cremator will still take corrective action if an unsafe situation should occur in manual mode.

The next button on the Navigation bar is the Mode page.

The Mode Page

This page displays the selected profile. These are used to determine the combustion air during a cremation. The operator can select which profile they wish to use depending on the size of the charge to be inserted into the machine. Thus the machine controls can adapt very easily to different sizes of coffin. The profiles also provide a backup mechanism for secondary air control, in case a fault is detected with the oxygen readings.

The numbers above the air levels indicate the time in the cycle when the air levels will change. The coloured levels are the values to which the air will automatically move.

The Main burner also has a profile this is based on the desired temperature in the main chamber.

Very Heavy Charges

On screen version 30+, a new features has been added to aid with the cremation of very large charges, i.e. charges over 150kg.

If the heavy profile is selected then the operator will be prompted with a message box - *"Is the charge > 150kg"*. If he selects no, then the heavy profile will run normally. The message *"Max charge temperature 550°C"* will also appear. This is an automatic feature to cool the main chamber prior to charging. If the operator selects yes, then he will be prompted with the message *"Enter weight in kg"*. He should enter the known or estimated weight in kg's. A message box will then appear stating, for example *"Estimated Cremation Time 2 hours 8 minutes"*. The heavy profile will then be automatically modified to increase it time range over the estimated cremation time. The message *"Max charge temperature 550°C"* will also appear as mentioned earlier.

The next button on the Navigation bar is the Data page.

The Data Page

The Data page displays all the data required for the reporting requirements.

The data displayed is currently updated during/and at the end of each cremation. The operators can keep a check as to the performance of the machine against the requirements of PG5/2 (04) at any time.

The reporting package for the FTII/FTIII is currently designed to meet the requirements of PG5/2 (04). However, provision has been made to allow change over to the future requirements.

All the reports listed below are all automatically generated, these are all stored on the hard disk in a directory called *C:\Report*.

Reports can be selected to print (from the analytical screen) automatically as well as being stored on disk. Each month the reports are automatically collated ready to archive to CD. Simply click on the desired report. When a cross is shown the report will be print enabled.

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The actual reports generated by the control system are listed below: -

Cremation report

Crematorium
Cremator Number: 1
Cremation Number: 1
Operators Name: FGT
Deceased Name: Test
Notes: Notes
Cremation Reference Number: 12345
Cremation time 75 minutes
Possible instrumentation Faults: -SCC Outlet Thermocouple

	Min	Ave	Max	
Carbon Monoxide	0	5	45	mg/M3 at 11% Oxygen
Indicative Particulate Matter	4	35	55	mg/M3 at 11% Oxygen
Oxygen	4	7.8	15	%
PCC Temperature C	820	780	950	
SCC inlet Temperature C	860	920	980	C
SCC outlet Temperature C	855	870	900	C
Cremation Gas Usage (If Fitted)		0 M3		

Operator ______________________________

Notes :
==

The cremation report is not a requirement of PG5/2 04, but it is useful as a record of each individual charge and as management data. This report is automatically generated at the end of the cremation cycle, when the operator selects cremate stop.
It records all the following information: -

- The chamber number
- The cremation number
- Cremation data entered by the operator.
- The cremation duration.
- Possible instrumentation faults

On the cremation report a possible instrument fault is recorded under the following circumstances: -

Oxygen	If the Oxygen is outside the expected limits for a fixed period during the cremation cycle. These are O_2>18% or O_2<0.5%.
CO	If the Oxygen is high and the CO is high for a fixed period, this would tend to indicate that there was a leak in the air sampling system. This is activated if – O_2>5% and CO>950Nmg/m3.
Particulate	If the Particulate is outside the expected limits for a fixed period during the cremation cycle. This is activated if the particulate >195Nmg/m3.

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SCC Temperature	If the Secondary chamber temperature is outside the expected limits for a fixed period during the cremation cycle. This would indicate the possible failure of the thermocouple or temperature instrument. This is activated if the SCC temperature>1200°C or <850°C.

These faults are logged and counted and reported on the monthly report

- The minimum, average and maximum values of CO, Oxygen, Particulate and secondary chamber temperatures. The maximum and minimum values are instantaneous values. The average is calculated over the first 60 minutes of the cremation.
- Cremation gas is recorded if a meter is fitted.
- The Cremation mode is recorded. The profile selected on charge and any subsequent changes during the cycle.
- There is an area left for the operator to sign and make notes if desired.

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Daily report

Crematorium	
Cremator number	[illegible]
Start Temperatures	
Main Chamber	[illegible] C
Secondary Inlet Chamber	[illegible] C
Secondary Outlet Chamber	[illegible] C
Flue	120 C
Pre-heat Time	[illegible] Minutes
Pre-heat Gas Usage	[illegible] M3
Waiting Time	[illegible] Minutes
Waiting Time Gas Usage (if fitted)	[illegible] M3
Total Cremation Time	[illegible] Minutes
Number of Cremations	[illegible]
Average Cremation Time	[illegible] Minutes
Time efficiency	[illegible] %

Visual & Olfactory test carried out at:________ Result:____________

Carried out by Sign:________________ Print:__________________

Notes :

===

The daily report is also not a requirement of PG5/2 04, but it is useful as a record of the days cremation data and as management data. This report is automatically generated when the operator selects cremator stop.

It records all the following information: -

- The chamber number
- Machine start temperatures
- Fuel usage data if a meter is fitted
- Total cremation time
- The total number of cremations
- Average cremation time
- Time efficiency

  This is a calculation based on the ration of wasted (standing time, between cremations) and the actual time per cremation.

  $$Eff_T\ (\%) = \frac{\text{Crem Time} - \text{Stand Time}}{\text{Crem Time}} \times 100$$

- There is an area left for the operator to sign and make notes if desired.

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Excessive CO report

Crematorium
Cremator Number 1
This report must be handed to the relevant environmental authorities.
The last cremation 60 minute mean emission of Carbon Monoxide
= 105 mg/m3
This report forms the list of excursions as required PG5/2(04)
and should handed to the relevant environmental authorities.

Operator:__________________________
Supervisor:__________________________
Notes:

Excessive CO report (Twice Limit)

Crematorium
Cremator Number 1
This report must be handed to the relevant environmental authorities immediately
The last cremation 60 minute mean emission of Carbon Monoxide exceeded twice the required limit
= 210 mg/m3
This report forms the list of excursions as required PG5/2(04)
and should handed to the relevant environmental authorities.

Operator:__________________________

Supervisor:__________________________
Notes:

Excessive Particulate report

Crematorium
Cremator Number 1
This report must be handed to the relevant environmental authorities.
The cremation 60 minute mean emission of indicative Particulate matter
= 110 mg/m3
This report forms the list of excursions as required PG5/2(04)
and should be handed to the relevant environmental authorities.

Operator:__________________________
Supervisor:__________________________
Notes:

Excessive Particulate report (Twice Limit)

Crematorium
Cremator Number 1
This report must be handed to the relevant environmental authorities.
The last cremation 60 minute mean emission of indicative Particulate matter
= 215 mg/m3
This report forms the list of excursions as required PG5/2(04)
and should handed to the relevant environmental authorities.

Operator:__________________________
Supervisor:__________________________
Notes:

The excessive emission reports are a requirement of PG5/2 04. These reports are automatically generated if the emissions exceed the levels set in the guidance note.
It records all the following information: -

- The chamber number
- The emission level.

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Monthly report

Monthly Report for Crematorium
Cremator number: 1 FTII Cremator
Report for month period starting 01 April 2005
Total number of cremations: 102
Number of cremations with results not reported: 0
Number of cremations with possible instrumentation faults: 2

Parameter	PG5/2 criteria for peroid	Ave Value	Min Value	Max Value
SCC inlet C	>850C	920	873	1080 C
SCC outlet C	>850C	880	861	975 C
O2 % (Dry)	Ave >6% Min >3%	8.0	3.0	13.0 %
CO	mg/m3	[illegible]	[illegible]	75 mg/M3 at 11% Oxygen
Particulate	mg/m3	25	[illegible]	54 mg/M3 at 11% Oxygen

	PG5/2 criteria	CO	Particulate
% of cremations over the limit	<5%	[illegible]	[illegible]
No. of cremations over the limit		11	2
No. of cremations over 2 x the limit	Nil	3	[illegible]

Monthly 95 percentile of cremation values

Parameters	95 Percentile Nmg/m3
Particulates	27
CO	21

Reporting to PG5/2 2004
This report should be forwarded to the relevant environmental authority.

Cremations Exceeding 100% limits (CO 200mg. Particulate 160mg)
Cremations Above the 95%% limits (CO 100mg, Particulate 80mg)
CO 105mg 12/08/08 Ref 13654

Operator Name:______________________
Notes:

The monthly report is a requirement of PG5/2 04. This report is automatically generated on the first day of the month.
It records all the following information: -

- The chamber number and machine type
- The start date for the data that the report covers
- The total number of cremations in the month
- The total number of cremations with results not reported. This is a comparison between the number of cremations counted and the number of reports generated.
- The total number of cremations with possible instrumentation faults (see the description under cremation report).
- The minimum, average and maximum values of CO, Oxygen, Particulate and secondary chamber temperatures. The maximum and minimum values are instantaneous values, over the entire month. The average is the sum of all the 60 minute cremation averages divided by the number of

cremations.

- The percentage of cremations <5% over the limit. This is the percentage of total cremations over the emission limit.
- The number of cremations over the limit. This is the total number of cremations that have exceeded the limit (including those twice the limit).
- The number of cremations over twice the limit. This is the number of cremations that have exceeded twice the limit.
- Monthly 95 percentile of cremation values. This is the 95 percentile of the cremation 60 minute averages.
- List of excessive emissions.
- List of twice the limit excessive emissions.

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The Alarm Screen

This screen lists all the alarms and displays their current status.

The alarms are grouped into categories due to their relevant severity. This is to make fault finding by an operator an easier task.

The alarm text is also colour coded depending on the importance of the alarm.

- If the alarm is clear then the text will be black
- If an alarm is active the text will go red.
- If an alarm is acknowledged then the text will appear blue.

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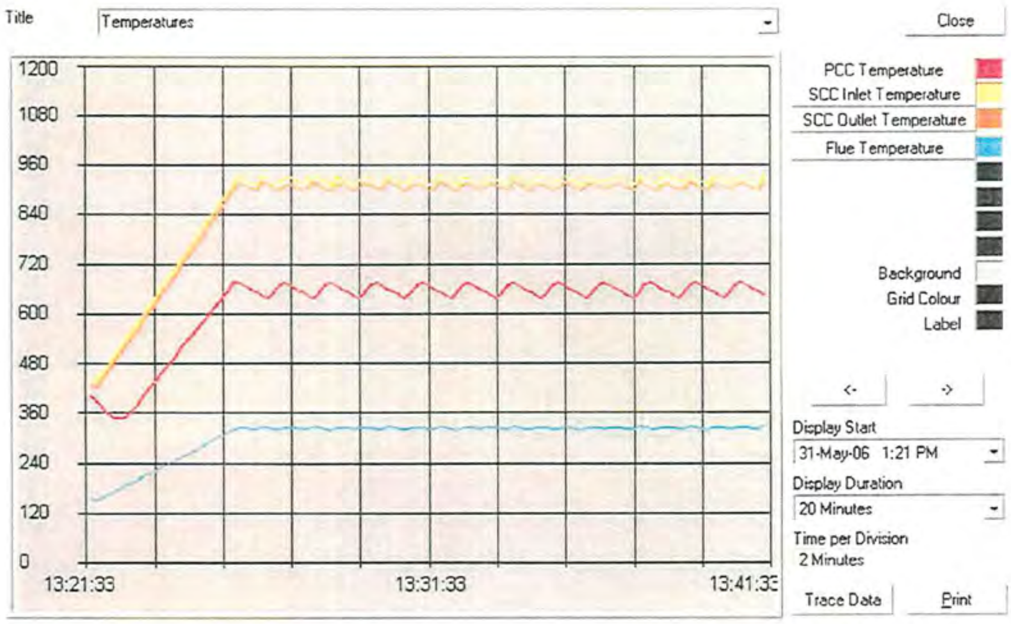
Trending

The system can trend all analytical information in real-time. The trend graphs can be viewed in real-time by the operator. Or they can be taken away and used for diagnostic purposes by an FTL engineer. All trend graphs can provide historical data and are automatically backed up with the reports at the end of each month.



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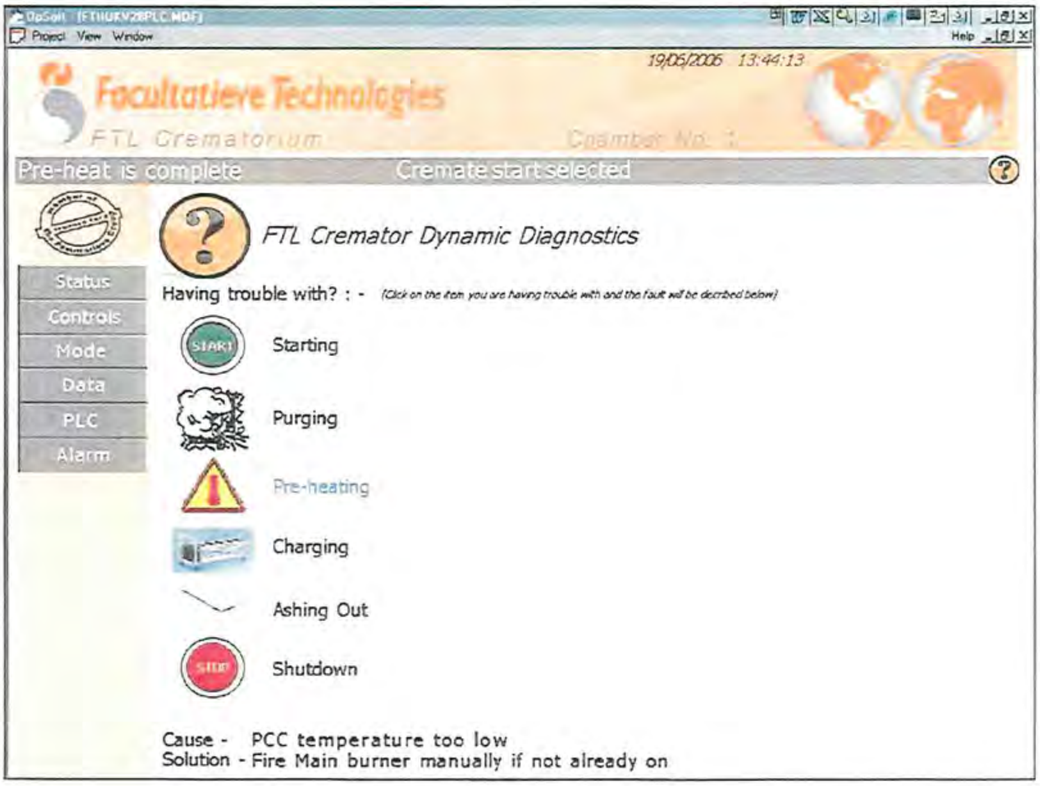
Dynamic Diagnostics (V28+)

A dynamic diagnostics screen has been added. This is accessed by clicking on the question mark on the right hand side of the status bar.

If you are having problems with any of the modes listed on the left hand side, then by simply clicking on the icon a Cause and Solution will be displayed at the bottom of the screen.



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Cremation Planning Calculator

On FTII screen V33+ a new feature has been added, a cremation planning calculator. This has been added as an aid to the efficient planning of cremations.

This is very simple to use. To access the calculator simply click on the calculator icon on the top right of any screen.

Set up

Firstly the individual crematorium data should be set, this only needs to be set once. The service interval should be entered; this is the time between the chapel services. Simply click on the blue box and enter the time, i.e. 00:45:00 for 45 minutes. The average cremation time should then be set; this would probably be around 80 minutes. Again, click on the blue box and enter the time, i.e. 01:20:00 for 80 minutes. Then the rake time can then set as per the other data. Finally set the 1st service time. The service slots will then automatically calculate. The calculator is now set up; these settings will now be remembered in the event of the PC being restarted.

Using the calculator

Click on the box to the right of the services you have for the day, a cross will appear to confirm the selection. Then press the calculate button. Green boxes will appear on the right to show the most efficient cremation times. A prompt will appear asking if the calculated times are to be used to automatically start the preheat. If yes is selected you will be prompted to enter the date for starting, click on the date button when it appears and put in the date i.e. 06/08/07. Finally a prompt will appear to select the autostart button. This can be selected or just left and set manually later as normal. The print button can be pressed to print out the calculated times. This gives a report with the times and space for comments and tick boxes so that the cremations can be checked off when complete.

A new calculation can be carried out at any time.

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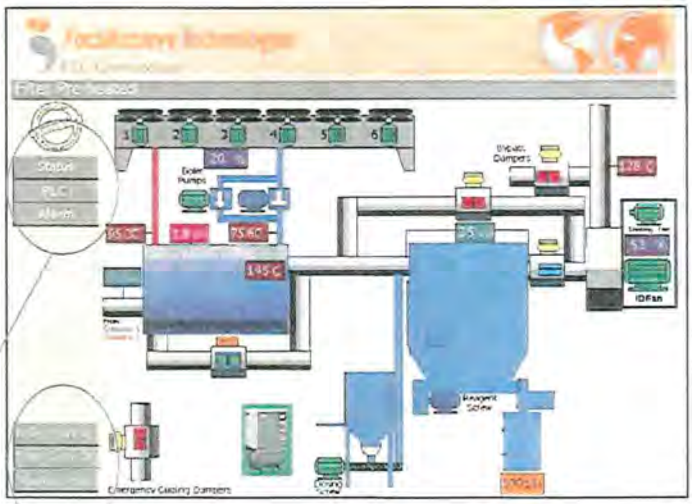
Mercury Abatement System SCADA Screen Description

The control screens on the cremator and filter system are run under a **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition (SCADA) package called Wing. These screens will be automatically activated on PC start up. They can be closed down by clicking on the cross in the top right hand corner of the screen (this will stop all data logging, trending and will delete any stored user information). They can also be restarted from the Cremator icon.

These screens communicate directly with the PLC and display various data items from the PLC. The screen can be closed and the PC shutdown without affecting the cremator control.

The screen has been developed over many years to make the cremation process as simple as possible for the operator.

The screen initially loaded is the main Status screen, shown below. All the main activities for normal running of the machine can be carried out from this screen.



The screen has a navigation bar on the left hand side. This controls access to all screens on the system. Simply by clicking or touching (if a touch screen is fitted) on the appropriate button the desired screen will be displayed. This navigation bar will be displayed on every page.

The filter does not have a control page, all controls are automatic. The machine is started when the cremator start is selected. There are 3 buttons these allow the operator to select the boiler and Filter cleaning on or off and allow for the selection of filter bypass.

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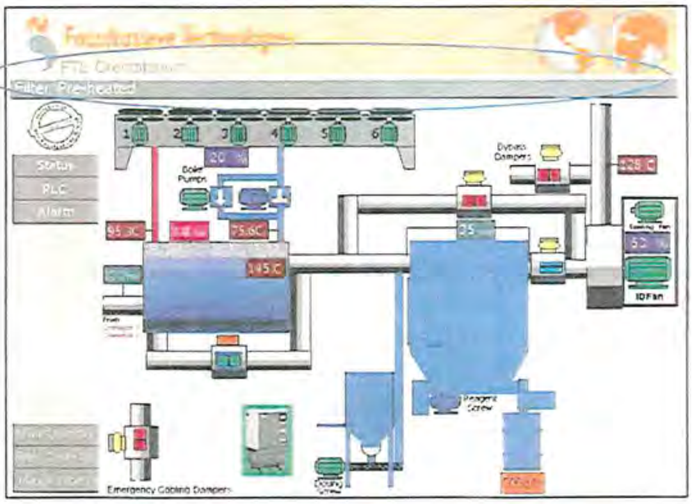
A Status bar is displayed at all times and on all screens, this gives various data about the status of the machine.

Various other data is displayed on the screen, including the temperatures and analytical data. The boxes that this data is displayed in will change colour to indicate that a parameter is out of normal operating range. This does not indicate an alarm condition but is designed to bring the operators attention to the parameter that is out of range.



The next button on the Navigation bar is the PLC page.

This screen is used purely for remote diagnostics.

The next button on the Navigation bar is the Alarm page.

The Alarm Screen

This screen lists all the alarms and displays their current status.

The alarms are grouped into categories due to their relevant severity. This is to make fault finding by an operator an easier task.

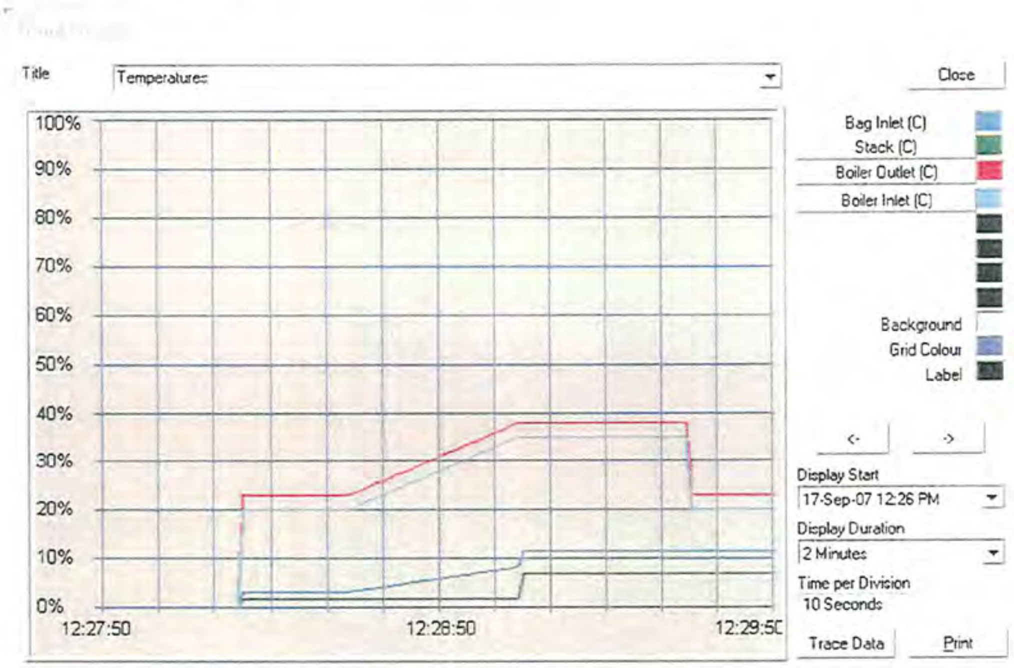
The alarm text is also colour coded depending on the importance of the alarm.

- If the alarm is clear then the text will be black
- If an alarm is active the text will go red.

If an alarm is acknowledged then the text will appear blue.

Trending

The system can trend all analytical information in real-time. The trend graphs can be viewed in real-time by the operator. Or they can be taken away and used for diagnostic purposes by an FTL engineer. All trend graphs can provide historical data and are automatically backed up with the reports at the end of each month.



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FACULTATIEVE TECHNOLOGIES LTD

TECHNICAL SPECIFICATION

High Speed Cremulator

Facultatieve Technologies

TECHNICAL SPECIFICATION

High Speed Cremulator

INTRODUCTION

The Facultatieve Technologies ***High Speed*** Cremulator has been specifically designed to cater for the specific needs of the modern day crematorium facility. The ***High Speed*** Cremulator is an advanced and reliable ash processor, designed for the exacting standards of today.

The ash cremulator's design **minimises** the human input to the ash processing, and is designed to minimise all dust emissions, so contributing to a **safer**, **healthier** and **cleaner** work place for all crematorium staff.

The Advanced Technical Features of the *High Speed* Cremulator include:-

- **Fast** and **efficient** ash **processing** times – **2 Minutes (repeated operation)**
- Separates **metal** parts **automatically**.
- The ***High Speed*** Cremulator ensures **100% of ashes 3.2** mm or less.
- Readily **accepts metal** components normally difficult to remove from the cremated remains.
- Accepts cremated remains directly from the cremator.
- Highly **Automated** Design.
- **Computerised** controls.
- **Minimum handling** of ash, cremator **ash pan** straight to **urn.**
- **Robust** fabrication, with a pleasing **aesthetic appearance.**
- **Low Noise** design.
- Designed for **ease of maintenance**, all moving parts and electric motors positioned for ease of access.

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- *Facultatieve Technologies Ltd recommends that the cremulator be supplied with an* ***integrated dust suppression*** *system, such as is fitted to our cremulated remains transfer cabinet. This cabinet comprises a high efficiency air* ***filter****, so ensuring that the equipment meets the health and safety requirements of current European regulations.*

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TECHNICAL PERFORMANCE

The design of the ***High Speed*** Cremulator gives rise to a highly automated ash cremulating process, requiring the minimum of operator input.

During operation, the ***High Speed*** Cremulator offers **fully automatic** operation. Typically the cremated remains can be taken directly utilising the cremator's stainless steel ash pan and placed directly into the ***High Speed*** Cremulator. From this point, the High Speed Cremulator **automatically separates all metallic** objects and processes the cremated remains. All the separated metallic objects are automatically deposited (returned) to the empty stainless ash pan. Facultatieve Technologies Ltd can achieve a separation efficiency of greater than 99.9%, resulting in less than 0.1% of the ash remaining with the metallic debris within the ash pan. At the end of the automatic process, the ash pan can be manually removed, and the metallic objects therein disposed of.

The design of the High Speed Cremulator ensures that 100% of all the cremated remains is 3.2mm or less in size.

Note Facultatieve Technologies would recommend manual removal of any large medical prosthetic instrument for improved equipment life, and reduced wear – however the ***High Speed*** cremulator will operate if charged (in error) with such a component.

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TECHNICAL DESCRIPTION

Construction Description

The cabinet and housing of the cremulator is fabricated from powder coated steel, to give an easily maintained cabinet finish.

General Specification of the cremulator :

Overall Dimensions

Height	**1.875** metres
Width	**1.10** metres
Depth (max)	**0.77** metres
Framework	Painted mild steel
Cabinet Finish	Powder coated mild steel
Inner Cabinet Finish	Brushed Stainless steel

The total weight of the equipment is approximately 550 kg.

For further information please refer to our detailed technical brochure

The cremulator housing is a purposed designed enclosure, fully lined with acoustic absorbent materials, to reduce noise emissions during operation.

If desired the cremulator cabinet can be supplied with low level storage for empty stainless steel ash pans.

Electrical Control System

The cremulator is supplied with a dedicated control system, based on an industrial standard Programmable Logic Controller, and is supplied fully wired and ready for operation.

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The control of the *High Speed* Cremator is controlled via an easy to use Human Machine Interface (**H.M.I.**), comprising an alpha – numeric liquid crystal display and tactile push buttons for extremely simple and highly efficient operation.

The equipment need only be connected to the local single phase (domestic) 220-240 Volt electrical supply via the supplied electrical fly lead.

Dust Suppression System - (Optional Additional Supply)

The dust suppression is based upon a high volume low suction handling unit incorporating a bag filter. No external air vent or chimney is required, all re-circulated air is filtered by a terylene needlefelt filter system, so ensuring low levels of dust emission from the equipment.

The filter system fitted is rated as 98% efficient at 10 micron particle sizing. Typically this performance gives rise to a dust emission from the equipment significantly lower than all current European legislation and requirements

The cremulator cabinet incorporates both low and high level extraction points, so ensuring efficient entrainment of dust particles within the extracted air volume. The movement of the air within the cabinet is from front to back, thus ensuring any dust is always drawn away from the operator.

Access for Maintenance

The need for access for maintenance has been carefully considered in the cremulator design, all moving parts, wear parts and electrical motors are positioned for ease of maintenance.

Facultatieve Technologies has a policy of continuous improvement, and therefore reserves the right to amend this technical specification without prior notice.

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FACULTATIEVE TECHNOLOGIES LTD

TECHNICAL SPECIFICATION

Cremated Remains Transfer Cabinet

Facultatieve Technologies

TECHNICAL SPECIFICATION

Cremated Remains Transfer Cabinet

The Facultatieve Technologies Ltd Cremated Remains Transfer Cabinet generally is designed to protect operating staff from inhalation of excessive dust during ash handling operations and minimise dust entering the working environment.

The unit comprises an open-fronted, ventilated hood positioned at an operating height available for use in the standing position with a dust filter unit housed beneath it in an integrated free-standing unit.

General Specification of the Cremated Remains Transfer Cabinet:

Overall Dimensions

Height	1,630 mm
Width	750 mm
Depth (max)	775 mm

The unit is constructed of powder coated mild steel in light grey (RAL 7047). The inner working surface is of brushed finish stainless steel and is to be provided with a 50mm diameter hole and flush fitting spigot complete with cover to allow any spillage of ash to be brushed through the hole and into a receptacle held below.

The front operating aperture is approximately 600mm wide and 500mm high with its lower edge approximately 980mm from the floor level. The lower cabinet, housing the filter unit is provided with double doors hinged on the outer edge and held closed with a suitable latch.

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The ventilated hood is fitted with an internal light to illuminate the work area controlled by a combined switch mounted on the outside of the hood, which also controls the filter unit. The unit is wired for 240v single phase with a 13amp plug for use with a normal socket.

The noise level of the unit has been measured at around 75dB(A) at 1 meter in a free field situation. The fully integrated freestanding unit incorporates a high volume extraction system using bag filter technology, which provides a face velocity of 0.5m/sec to allow for the open-fronted working area. A manually operated mechanical shaker is incorporated for dust removal.

The Cabinet is compliant with all relevant Health & Safety legislation including the following:

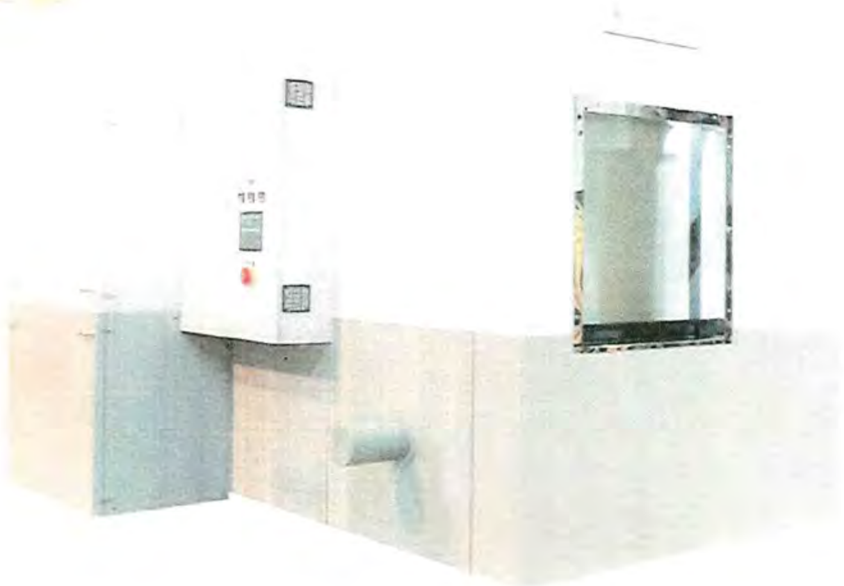
- Section 63 of The Factories Act 1961
- Section 2 of The Health & Safety at Work Act 1974
- HSE Guidance Note EH40 "Occupational Exposure Limits"
- HSE Guidance Note EH44 "Dust in the Workplace: General Principles of Protection."

Facultatieve Technologies
Cremation & Incineration Equipment

Technical Information

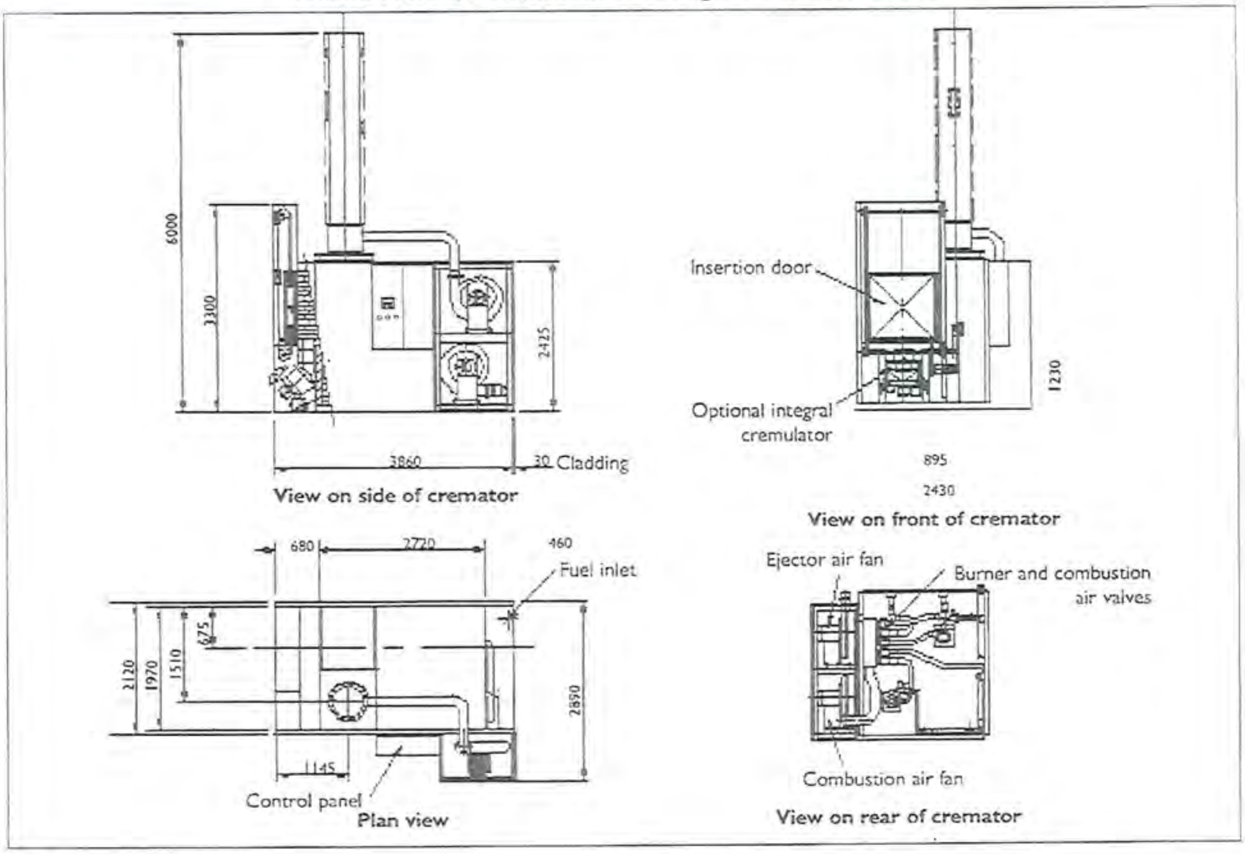
FT II - CREMATOR

member of the Facultatieve Group founded 1874



- ✓ Compact and quiet
- ✓ High capacity
- ✓ Fully automatic
- ✓ Modem link for on-line maintenance analysis and fault-finding
- ✓ Integrated ash cremulator (optional)
- ✓ Excellent environmental performance
- ✓ Low maintenance, with easy access to components
- ✓ Good price, high quality

Please refer to technical drawing for further details



FT II CREMATOR

Specifications

Height	3 300 mm
Width	2 120 mm
Length	3 860 mm
Weight	12 600 kg
Fuel	Natural Gas / LPG
Opening for installation	2 650 mm wide x 2 650 mm high

Electrical Characteristics

Combustion air fan	2 000 m³/h at 20 °C, 5,5 kW
Ejector air fan	2 000 m³/h at 20 °C, 5,5 kW
Control System	1,5 kW
Electrical Supply	50 Amps (Motor rated)
	3 x 400 Volts + neutral + earth - 50Hz

Fuel Consumption

Burner Ratings

Primary Burner	250 kW
Secondary Burner	300 kW
Natural Gas usage typically	20m^3 / cremation (excludes pre-heating of cremator)

LPG usage on request

Also available in double end format

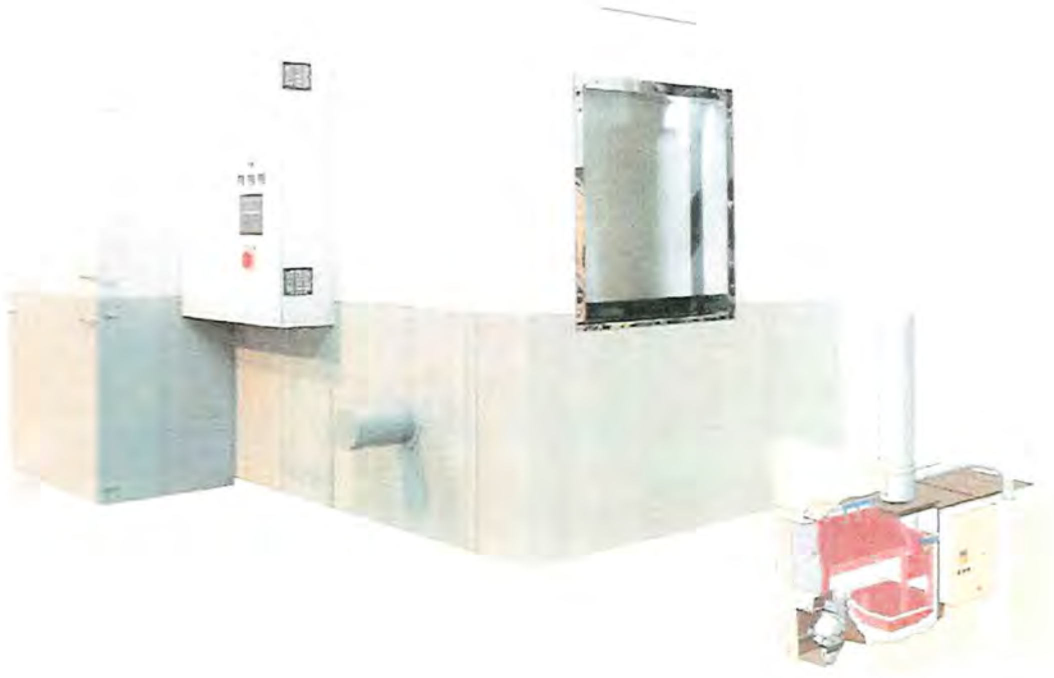
09/08-FTII-E

Facultatieve Technologies
Cremation & Incineration Equipment

Technical Information

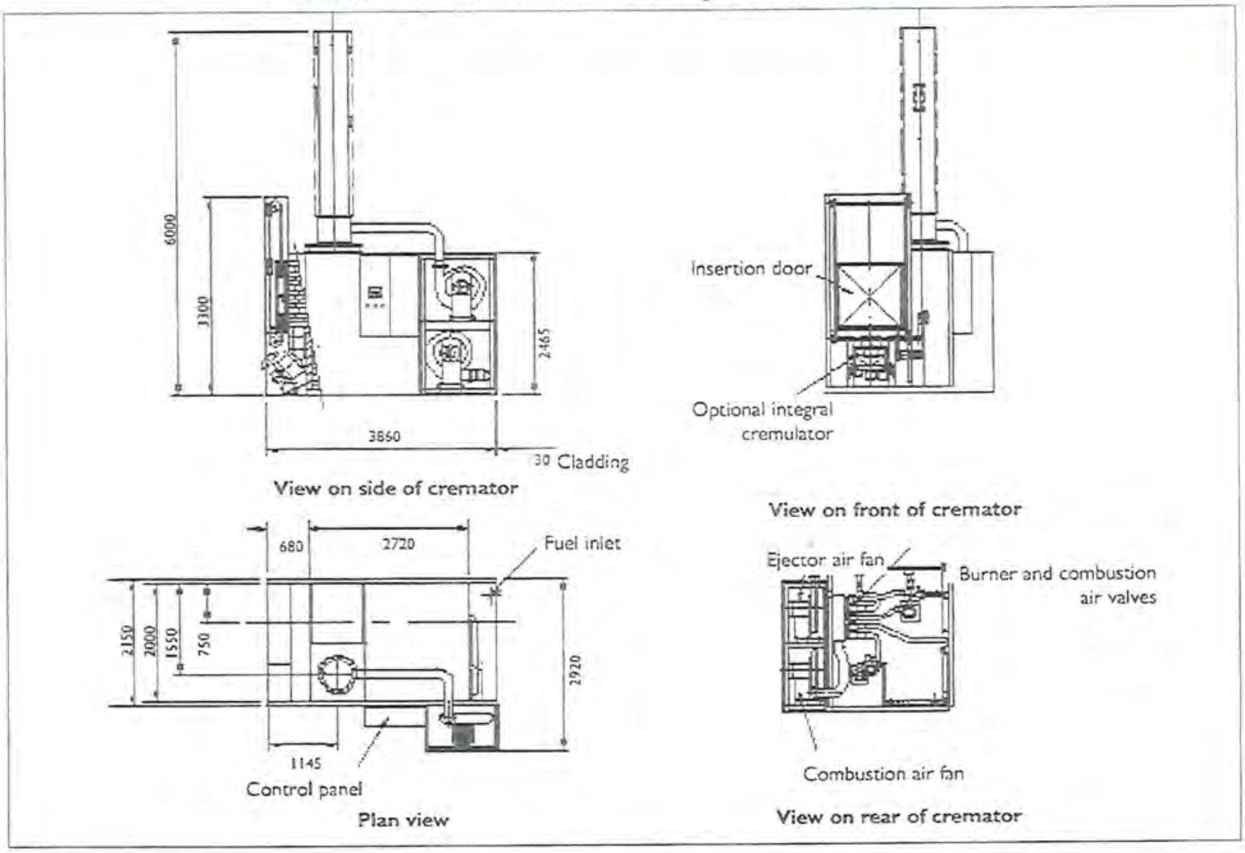
FT III - CREMATOR

member of the Facultatieve Group founded 1874



- ✔ Excellent Environmental Performance
- ✔ High Operational Capacity
- ✔ Accepts the largest of coffins – up to 1050 mm (43 inches) wide
- ✔ Fully Automatic – PLC based controls
- ✔ Modem Link – Remote Technical Support – on line fault diagnostics
- ✔ Highest Quality Design – Competitively priced
- ✔ Low Maintenance Requirements - Higher productivity
- ✔ Integrated Ash Cremulator available
- ✔ Compact, space saving design

Please refer to technical drawing for further details



FTIII Cremator
Specifications

Height	3300 mm
Width	2150 mm
Length	3860 mm
Weight	13 500 kg
Fuel	Natural gas / LPG / Oil
Opening for installation	2650 mm x 2650 mm high

Electrical Characteristics

Combustion Air Fan	2000 m^3/h at 20°C 5.5 kW
Ejector Air fan	2000 m^3/h at 20°C 5.5 kW
Control Panel	1.5 kW
Electrical Supply	50 Amps (motor rated)
	3 x 400 Volts+neutral+earth 50 Hz

Fuel Consumption

Burner ratings	
Primary Burner	250 kW
Secondary Burner	350 kW
Natural Gas usage	20 m^3 / cremation
	(excludes pre-heating of cremator)

LPG usage available on request.
Also available in double end format.

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09/08-FTIII-E

Facultatieve Technologies

Technical Information

FT Cremated Remains Transfer Cabinet

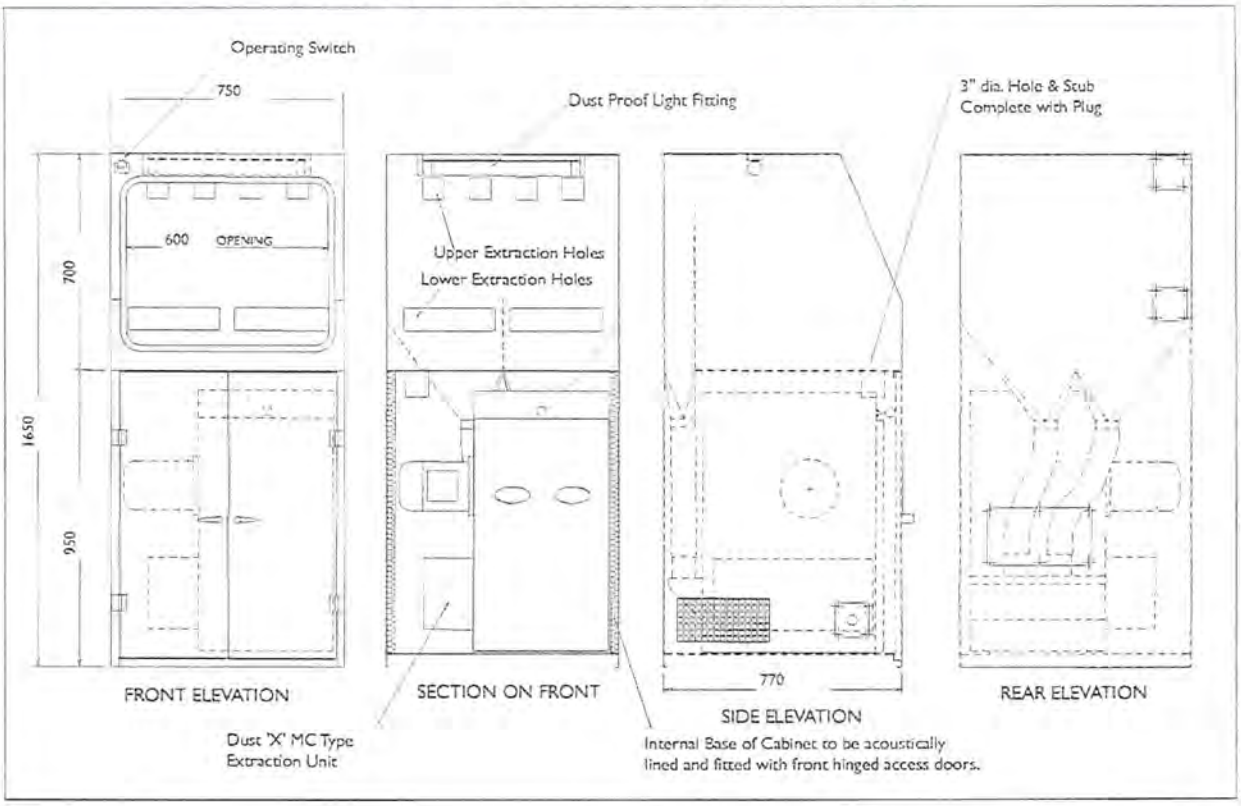
member of the Facultatieve Group founded 1874

The FT Cremated Remains Transfer Cabinet is a new and highly efficient unit which virtually eliminates fugitive airborne dust emissions created by normal ash handling operations. The high volumetric extract rate allows for an open-fronted working area without the restriction of gloves or arm slots. The unit – which of course complies with the relevant European standards and regulations – therefore contributes in an important way to a safe, healthy and pleasant working environment.

FT Cremated Remains Transfer Cabinet

- ✔ Excellent environmental performance
- ✔ High volume extraction system
- ✔ Industrial bag filter application
- ✔ Simple and quick to install
- ✔ Complies with relevant European standards
- ✔ No maintenance
- ✔ Compact and modern design
- ✔ Good price, high quality

Please refer to technical drawing for further details



FT Cremated Remains Transfer Cabinet

Basic dimensions:

Width:	750 mm
Depth:	775 mm
Height:	1,630 mm

Technical data:

Fan motor size:	1.1 kW, 220v, single phase
Nominal air volume extracted:	825 m^3/hr
Filter media & area:	Terylene Needlefelt, 2.5 m^2

The Cremated Remains Transfer Cabinet is constructed from steel and finished with light grey (RAL 7047) powder coating, with a hardwearing brushed stainless steel inner work surface.

Facultatieve Technologies gives advice and support on the whole cremation process. Our product range is extensive and we are therefore able to supply the ideal product in any situation. Facultatieve Technologies provides excellent support and maintenance services anywhere in the world.

Facultatieve Technologies is an international market leader in the design, construction and maintenance of cremators and incinerators and can supply reliable and fully automated equipment through its offices located in the Americas, China, the Czech Republic, France, Germany, The Netherlands and the UK as well as through a world-wide network of agents. Our products meet the most stringent environmental legislation.

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Non-contractual document. Facultatieve Technologies reserves the right to modify its products in order to make technical improvements.

09/08-ABU-E

Facultatieve Technologies

Technical Information

High Speed Cremulator

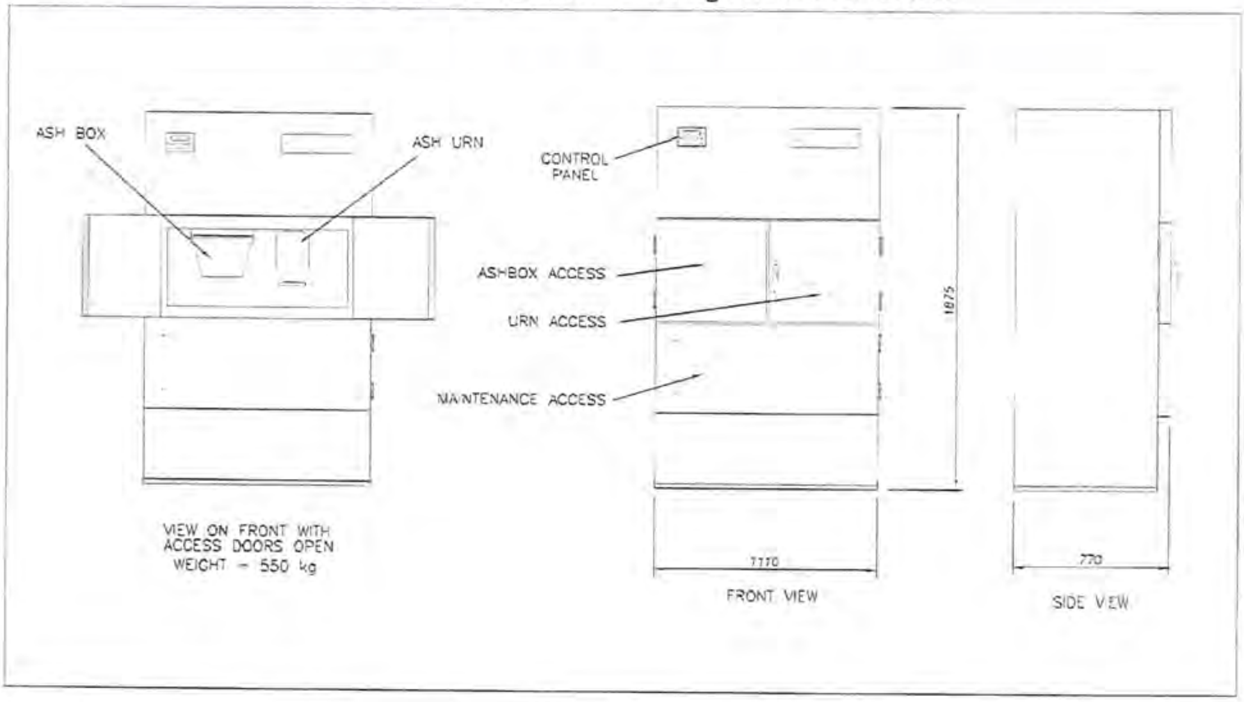
member of the Facultatieve Group founded 1874

The Facultatieve Technologies High Speed Cremulator has been specifically designed to cater for the specific needs of the modern day crematorium facility. The High Speed Cremulator is an advanced and reliable ash processor, designed for the exacting standards of today.

THE ADVANCED TECHNICAL FEATURES OF THE HIGH SPEED CREMULATOR INCLUDE:

- ✓ Fast and efficient ash processing times – 2 Minutes (repeated operation)
- ✓ Minimum handling of ash, cremator ash pan straight to urn
- ✓ Separates metal parts automatically
- ✓ The High Speed Cremulator ensures 100% of ashes 3.2 mm or less
- ✓ Accepts cremated remains directly from the cremator
- ✓ Highly Automated Design
- ✓ Computerised controls
- ✓ Robust fabrication, with a pleasing aesthetic appearance
- ✓ Low Noise design
- ✓ Designed for ease of maintenance
- ✓ Readily accepts metal components normally difficult to remove from the cremated remains

Please refer to technical drawing for further details



Technical Performance

During operation, the High Speed Cremulator offers fully automatic operation. Typically the cremated remains, can be taken directly from the cremator's stainless steel ash pan and placed directly into the High Speed Cremulator. From this point, the High Speed Cremulator automatically separates all metallic objects and processes the cremated remains. All the separated metallic objects are automatically deposited (returned) to the empty stainless ash pan. At the end of the automatic process, the ash pan can be manually removed, and the metallic objects therein disposed of.

Technical Data

Height	1.875 metres
Width	1.11 metres
Depth (max)	0.77 metres
Framework	Painted mild steel
Cabinet Finish	Powder coated mild steel
Inner Cabinet Finish	Brushed Stainless steel
Electrical Supply	220-240 V domestic supply
Controls	Programmable Logic Controller
Operated	via dedicated Human Machine Interface

The cremulator housing is a purposed designed enclosure, fully lined with acoustic absorbent materials, to reduce noise emissions during operation. The cremulator is supplied fully wired and ready for operation. The need for access for maintenance has been carefully considered in the cremulator design, all moving parts, wear parts and electrical motors are positioned for ease of maintenance.

Dust Suppression System - (Optional Additional Supply)

As an option, the cremulator can be supplied with our Cremated Remains Transfer Cabinet complete with an integrated dust suppression system, comprising a high efficiency air filter, meeting the requirements of current European regulations.

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Facultatieve Technologies
Cremation & Incineration Equipment

Technical Information

member of the Facultatieve Group founded 1874

Automatic Insertion System Type FDI

Fixed insertion table

Push Capacity = ca. 300 kg
E-motor = 0,9 kW

The automatic insertion system is perfectly designed for cremators with a flat hearth. Therefore it is not necessary to make use of the so-called support brick.

It is also possible to insert coffins with "feet".

The insertion table is installed in front of the insertion door and is fixed to the floor (Pic. 1). However it is also possible to design the insertion table in such a way that it can be moved laterally along the front of the cremators and in this way can be used for more then one cremator. (Pic. 2).

The system is clad with stainless steel panels equipped with isolation materials.

Mobile insertion table

The push system is equipped with three modules of a different length. With the use of these modules every type of coffin can be placed into the cremator to the right spot on the hearth.

The insertion cycle can be interrupted manually at any time in case of an unexpected failure.

The E-motor moves a chain, to which the insertion module is mounted.

Positioning switches permanently control the movement of the insertion pusher head.

The insertion process is (of course) synchronised with the opening of the insertion door.

The complete insertion cycle takes about 15 seconds.

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From: Paul Fretwell
Sent: Wed, 17 Feb 2021 11:18:43 +0000
To: MacKenzieF
Subject:FW: Crematorium - Duntrune

From: Paul Fretwell
Sent: 16 February 2021 12:31
To: BarnesA <BarnesA@angus. gov. uk> (BarnesA@angus.gov.uk) <barnesa@angus.gov.uk>
Subject: FW: Crematorium - Duntrune

Hi Andy

Please find below the email from Bruce at Cameron Ross with regard to the Transport Assessment and the impact of the Shank of Omachie approval.

Regards

Paul Fretwell

for @rchitects Scotland Ltd.

15 West High Street, Forfar, DD8 1BE

Mob. [redacted]

Tel. 01307 466480

www.scotland-architects.co.uk

From: Bruce A. Clark <BClark@cameronross.co.uk>
Sent: 13 February 2021 16:48
To: Paul Fretwell <paul@rchitects.org.uk>
Subject: RE: Crematorium - Duntrune

Paul,

I have reviewed the Transport Assessment undertaken for the Shank of Omachie Planning Applications referenced 15/01045/PPM and 19/00095/PPPM. Whilst there is some overlap in the junctions considered (Those on Kellas Road) within our own assessment the addition of the committed development flows would not change the conclusions of our own assessment. The conclusion of our own assessment showed that without the addition of committed development flows ie comparing the base traffic flows only showed there to be a less than 5% impact of the Kellas Drive traffic flows as a result of the crematorium traffic flows. As a result in accordance with the IHT guidelines there is no requirement for traffic capacity assessment of these junction to be undertaken which was accepted by both Angus Council□s Transport Planning officer and the Dundee City Council Transport Planning Officer. Neither whom thought it necessary to include the Shanks of Omachie site as a committed development. AS the Crematorium would be typically in use out with peak traffic hours then this and the fact that the main route under consideration being Kellas Drive had a less than 5% impact already shown then the exercise of adding the committed development flows does not change the conclusion of the TA for the crematorium that it has a negligible impact on the surrounding road network in fact it would only have the affect of further reducing the % impact of the crematorium traffic by increasing the existing flows to which the crematorium traffic cis being compared to.

The TA undertaken for the Shank of Omachie development concluded that the junction on Kellas Road had sufficient capacity for the development traffic which considered typical peak hour traffic times as a result of having a considerable residential element to it.

I trust this answers sufficiently planners request to have the TA consider the Shank of Omachie site I why I believe this to be a futile exercise in the sense the conclusion remain the same and would only help to reduce impact the crematorium has on the surrounding road network as the base traffic levels would be increased from those already considered and as we concluded the impact was so insignificant that junction modelling was not required then this case would be strengthened.

Regards

Bruce Clark B.Eng.(Hons.), C.Eng., M.I.C.E.
ASSOCIATE DIRECTOR

e BClark@cameronross.co.uk
t 01224 642400
m [redacted]

Aberdeen Inverness

cameronross.co.uk

From: Paul Fretwell <paul@rchitects.org.uk>
Sent: 08 February 2021 17:22
To: Bruce A. Clark <BClark@cameronross.co.uk>
Subject: FW: Crematorium - Duntrune

Hi Bruce

Will give you a call. Please see planners email below with regard to TA.

Regards

Paul Fretwell

for @rchitects Scotland Ltd.

15 West High Street, Forfar, DD8 1BE

Mob. [redacted]

Tel. 01307 466480

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From: MacKenzieF <MacKenzieF@angus.gov.uk>
Sent: 08 February 2021 16:31
To: Paul Fretwell <paul@rchitects.org.uk>
Subject: RE: Crematorium - Duntrune

Good Afternoon Paul,

Still awaiting SEPA response and am in discussion with Roads regarding their finalised response.

Something that has been noticed is the applicant□s Transport Assessment does not take account of the approved housing and leisure site at Shank of Omachie in terms of the □Committed Developments□ section. The TA should be updated to take account of this. I□ve also made the Roads Authority and Dundee City Council aware of this.

Kind Regards,

Fraser MacKenzie I Planning Officer (Development Standards) I Angus Council I 01307 492198 I mackenzief@angus.gov.uk I www.angus.gov.uk

From: Paul Fretwell <paul@rchitects.org.uk>
Sent: 05 February 2021 01:19

To: MacKenzieF <MacKenzieF@angus.gov.uk>
Subject: Crematorium - Duntrune

@rchitects
Chartered Architects

05 February 2021

Hi Fraser

Just wondered if you had received consultations from roads or SEPA yet?

Regards

Paul Fretwell

for @rchitects Scotland Ltd.

15 West High Street, Forfar, DD8 1BE

Mob. [redacted]

Tel. 01307 466480

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ISO 9001 Quality Management FS 547812 | ISO 14001 Environmental Management EMS 563106 | OHSAS 18001 Occupational Health & Safety Management OHS 563107

ethosenvironmental

TECHNICAL REPORT P8346.01

ASSESSMENT OF AIR QUALITY IMPACT: Proposed Cremation Facility, Duntrune

Prepared For

@rchitects Scotland Ltd.
15 West High Street, Forfar, DD8 1BE
Mob. 07860

Prepared By

***ETHOS* ENVIRONMENTAL LIMITED**
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MARCH 2021

DOCUMENT VERIFICATION

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<tr><td>Project Title</td><td colspan="2">P8346 Duntrune Air Quality</td><td colspan="2">Project Number
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<tr><td>Document Title</td><td colspan="2">P8346.01 Air Quality Impact Assessment</td><td>Date of Assessment
March 2021</td><td>Date of Report Issue
6 April 2021</td></tr>
<tr><td>Revision</td><td>Date Written</td><td>Filename</td><td colspan="2">P8346.01 Air Quality Impact Assessment</td></tr>
<tr><td rowspan="4">2.0</td><td rowspan="4">6/04/21</td><td>Description</td><td colspan="2">Version 2</td></tr>
<tr><td></td><td>Prepared By</td><td>Reviewed By</td></tr>
<tr><td>Name</td><td>B Gardner</td><td>Scott Carlin</td></tr>
<tr><td>Signature</td><td>[redacted]</td><td>[redacted]</td></tr>
</table>

EXECUTIVE SUMMARY

An assessment of the likely impact of air quality on residential receptors around the proposed site of the client's crematorium development at Duntrune has been undertaken.

A simple screening air quality assessment was used, utilising emission limit values for the process, along with typical efflux volume flows. A worst-case ADMS dispersion model was run assuming constant uni-directional wind direction, and modelling of ground level concentrations of NO_2, carbon monoxide, PM_{10} and mercury directly downwind of the source across a range of distances (0-250m) including those typical of the direct line-of-sight distance to the nearest three residential receptors (~180-200m). The worst-case downwind ground-level location (100m) was then used in the evaluation of impact

Baseline air quality data was obtained where available from Scottish Air Quality Network to allow comparison against existing baseline levels and relevant air quality standards and objectives.

The assessment demonstrated that:

- existing ambient levels of the relevant pollutants were less than 75% of the relevant air quality assessment level (AQAL) specified by LAQM/EPS Guidance, and
- simplified, worst-case downwind ground-level air quality concentrations would not exceed 5% of the AQAL

In summary, the overall air quality impact associated with the development – even conservatively assuming various worst-case conditions - can be assumed to be *negligible* and no further modelling evaluation of impact significance is considered to be merited. Consideration as to potential specific mitigation measures for air quality, is also not deemed to be warranted.

CONTENTS

1.0 INTRODUCTION

1.1 At the request of Mr Paul Fretwell, @rchitects Scotland Ltd, Forfar, an air quality impact assessment has been undertaken for the proposed crematoria development at agricultural land to north-east of Duntrune House, Duntrune.

1.2 The client is acting as agent for the developer.

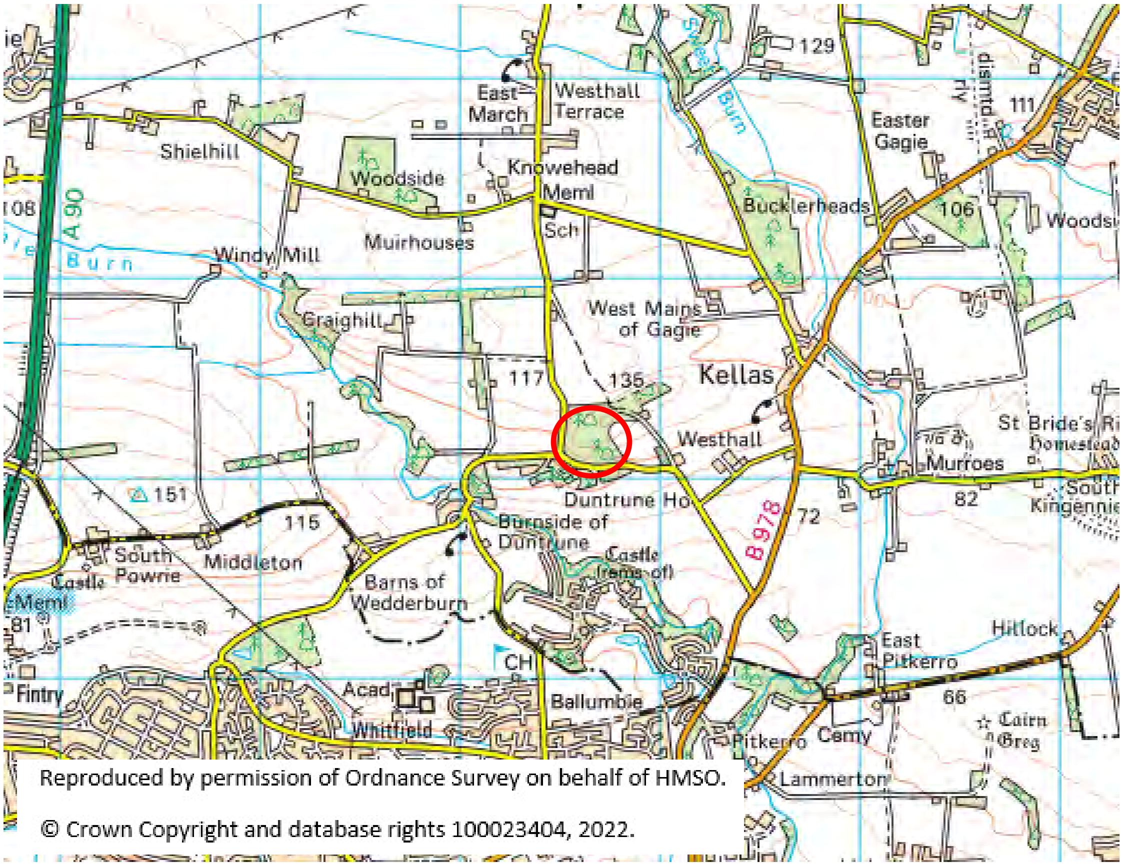
1.3 This assessment was undertaken by Dr Brian Gardner, Senior Consultant, Ethos Environmental Ltd. He holds first and research degrees in Environmental and Atmospheric Chemistry. He has worked as a health, safety & environmental consultant for 25 years and heads-up the company's air quality management consultancy services.

2.0 GENERAL BACKGROUND INFORMATION

2.1 The site is set in a rural location around 7km to the northeast of Dundee City Centre and around 0.5km to the east of the village of Burnside of Duntrune. The Site Location Plan is provided in Figures 1 and 2 below:

Figure 1. Site Location Plan (Satellite)

Figure 2. Site Location Plan (Mapping)



The proposed development is understood to have 120-seating capacity and is located across the southern half (approximately 2.0 Hectares) of ground (total 4.5 Hectares) owned by the developers. Figure 3 shows the site in closer detail and the proposed layout

Figure 3. Site and Development Layout

The site is surrounded by wooded areas to the north, east and west beyond which is generally agricultural land and to the south a road with agricultural land beyond that also.

The planning portal reference documentation relating to the site, the proposed development, and statutory consultation responses has been reviewed.

The Planning Officer has indicated that the development does not require submission of an Environmental Impact Assessment Report as required by regulation 5(1) and Schedule 4 of the Regulations. The *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017*.

The cremation operations and associated processes have the potential to give rise to air quality impacts and Angus Council, Housing, Regulatory and Protective Services has requested an assessment of:

a. air quality impacts in accordance with Local Air Quality Management Technical Guidance TG(16) and
b. potential odour nuisance impacts.

The air quality impacts are reported here (P8346.01); the odour impact assessment is reported separately (P8346.02)

3.0 ASSESSMENT SCOPE

3.1 Site Sensitivity

The crematorium is located to the west side of the development; the nearest receptors are estimated to be located at a distance of 213m to the east (A, two of) and 197m to the north (B, one of) of the crematorium stack emission point (C) as shown in Figure 4.

Figure 4. Location of nearest residential receptors at A (2 properties) and B (single property)

From review of satellite images (GoogleMap data, 2021) there are estimated to be approximately 200 dwellings located within 1000m of the development site (See blue radius, Figure 5); these are almost exclusively located to south and south-west of the site and in the upper distance range of 700-1000m.

Figure 5. **1000m radius (blue) around development source**

Preliminary review of the site of the proposed development does not indicate any sensitive receptors other than dwellings. There is a primary school at distance 1400m to north of the site. There is no air quality management area in the vicinity of the site and there are not considered to be any existing air quality impacts (eg odour, waste treatment) on these receptors, other than potential seasonal agricultural impact.

3.2 Traffic-related Air Quality Impacts

A preliminary review of the traffic impact assessment undertaken by Cameron & Ross (Ref: A/190889, March 2020) identifies that traffic impacts associated with the development are unlikely to be significant with respect to air quality impact and are therefore not included within the scope of this assessment.

3.3 Crematoria Air Quality Impacts

Crematoria plant emit a range of pollutants to atmosphere from a single emission point (stack) with no significant fugitive, or other, emission types of concern. The crematoria process will be regulated by SEPA the *Pollution Prevention and Control (Scotland) Regulations (2000) (As Amended),* and the main emitted pollutants of relevance to air quality impact have emission concentration limits assigned which will be regulated by emission testing at commissioning and thereafter a regular compliance emission monitoring programme.

Odour impacts are not regulated in this manner, nor are "nuisance" type impacts such as dust deposition and potential soiling of windows and washing (clothing) of neighbouring residents.

4.0 AIR QUALITY ASSESSMENT STRATEGY & METHOD

4.1 General

The current objectives adopted in Scotland for the protection of human health are based on the *Air Quality Standards (Scotland) Regulations 2010* for the purpose of Local Air Quality Management (LAQM)

Of prime concern as expressed by and agreed with the Planning Authority in this respect are four pollutants: Nitrogen Dioxide (NO_2), Carbon Monoxide, Particulate Matter (expressed as PM_{10}) and mercury. Table 1 summarises the air quality objectives as presented in Table 1-1 of Technical Guidance on Local Air Quality Management (TG16).

Table 1. Air Quality Objectives (from Table 1-1, Local Air Quality Management Technical Guidance TDG16)

Pollutant	Objective	Averaging Period	Obligation
Nitrogen dioxide (NO_2)	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	All local authorities
	40µg/m^3	Annual mean	All local authorities
Particulate Matter (PM_{10})	50µg/m^3 not to be exceeded more than 35 times a year	24-hour mean	All local authorities
	50µg/m^3 not to be exceeded more than 7 times a year	24-hour mean	Scotland only
	40µg/m^3	Annual mean	All local authorities
	18µg/m^3	Annual mean	Scotland only
Particulate Matter ($PM_{2.5}$)	Work towards reducing emissions/concentrations of fine particulate matter ($PM_{2.5}$)	Annual mean	England only
	10µg/m^3	Annual mean	Scotland only
Sulphur dioxide (SO_2)	266µg/m^3 not to be exceeded more than 35 times a year	15-minute mean	All local authorities
	350µg/m^3 not to be exceeded more than 24 times a year	1-hour mean	All local authorities
	125µg/m^3 not to be exceeded more than 3 times a year	24-hour mean	All local authorities
Benzene (C_6H_6)	16.25µg/m^3	Running annual mean	All local authorities
	5µg/m^3	Annual mean	England and Wales only
	3.25µg/m^3	Running annual mean	Scotland and Northern Ireland only
1,3-Butadiene (C_4H_6)	2.25µg/m^3	Running annual mean	All local authorities
Carbon Monoxide (CO)	10mg/m^3	Maximum daily running 8-hour mean	England, Wales and Northern Ireland only
	10mg/m^3	Running 8-hour mean	Scotland only
Lead (Pb)	0.5µg/m^3	Annual mean	All local authorities
	0.25µg/m^3	Annual mean	All local authorities

4.2 Modelling Scope

EA/SEPA has issued guidance on techniques for the assessment of air quality in the form of Local Air Quality Management Technical Guidance, TG(16).

This has been taken into account in considering an appropriate assessment strategy as follows.

- No assessment will be made for dust deposition given the distances to the nearest receptors and the pre-existing agricultural land-use in the area.

- No assessment will be made for traffic impacts on air quality given the low overall traffic volume impact anticipated.

- The air quality assessment does not include for the construction phase of the development.

4.3 Model Type and Parameters

The air quality assessment is not considered to warrant baseline or other air quality monitoring. Modelling has been undertaken on a screening basis, for assumed worst-case and typical volume throughputs using ADMS 5.0.0.1 dispersion modelling (Build number 5129 Licence No: A01-1616-C-ROADS-UK, valid to September 2021).

The emission limits for abated crematoria detailed in Process Guidance PG5 (Crematoria) are emission concentrations only with no limit applicable for the mass emission. The table 3 emission limits (non-abated) include a limit for mass emissions and uses a conversion factor assuming an efflux volume flow of 1500m^3/hour. For the purposes of this assessment we will use the more stringent Table 4 emission concentration limits (reproduced below at Table 2) and will assume the same volume flow factor to obtain mass emissions for inputting to the dispersion model.

Table 2. Emission Limits for Abated Crematoria (Table 4 to PG 5/12 Process Guidance Note (Crematoria))

Row	Substance	Mass emission limits per cremator	Concentration limits	Type of monitoring	Monitoring frequency
1	Mercury	n/a	50 micrograms/m^3	Periodic monitoring **(Note 1)**	Annual
2	Hydrogen chloride (excluding particulate matter)	n/a	30 mg/m^3 hourly average	Periodic monitoring	Annual
3	Total particulate matter	n/a	20 mg/m^3 hourly average	Filter leak monitor • Provide visual alarms and record levels and alarms • Set reference levels on commissioning (i.e. set levels at which alarms will activate) **Plus** Instrument health check - i.e. service according to manufacturer's instructions **Plus** Periodic monitoring • Set reference levels for continuous emission monitor (CEM) (i.e. set levels at which alarms will activate	Continuous **Plus** Annual **Plus** Every 3 years
For abated crematoria with a "multiple cremators/single abatement plant" configuration, the provisions of Row 4a apply. For abated crematoria with a "single cremator/single abatement plant" configuration, the provisions of either Row 4a **OR** Row 4b can apply but should be specified to the regulator at the earliest opportunity.					
4a	Carbon monoxide	n/a	100 mg/m^3 reported as 2 x 30-minute averages	Qualitative monitoring • Record data at 15 second intervals or less • Provide visual alarms and record alarm events **Plus** Periodic test: • Validation of continuous emissions monitor (CEM) output through comparison with periodic test results	Continuous **Plus** Annual

This conservatively uses emission concentration limits as the emission concentrations for the parameters shown in Table 3.

There is no emission limit value in PG5 for NO_2. As such we have used the limit expressed in DEFRA Waste Incineration Directive 2010 Guidance.

The process has capacity for 6 cycles per day and each cycle operates for a total of approximately 80 minutes. The client has advised however that typical daily average throughput is anticipated to be 3 cycles per day. For the purposes of the modelling we have assumed that emission concentrations equivalent to the emissions concentration limits will be being emitted constantly, with no correction for percentage of the reference period (eg 24 hour day, 365 day year) in which the process is operating. For those modelled air quality concentrations referenced over periods in excess of a typical cycle (eg 80 minutes), such as 24-hour averages or annual averages, the modelled assumptions therefore represent a significant simplification – and exaggeration – compared to real conditions.

Table 3. Modelling Parameters

Pollutant	Source
Carbon monoxide	Mass emission level of 150g/hour based on process volume flow rate assumptions (1500m^3/hour) and carbon monoxide emission concentration limit of 100mg/m3 [1]
PM_{10}	Mass emission level of 30g/hour based on process volume flow rate assumptions (1500m^3/hour) and total particulate emission concentration limit of 20mg/m3 [1]
NO_2	Mass emission level of 300g/hour based on process volume flow rate assumptions (1500m^3/hour) and 200mg/m^3 emission limit [2]
Mercury	Mass emission level of 75mg/hour based on process volume flow rate assumptions (1500m^3/hour) and 50ug/m^3 mercury emission concentration limit [1]

1. Table 4, PG 05/2
2. Value for Nitrogen monoxide (NO) and nitrogen dioxide (NO2), expressed as nitrogen dioxide for existing incineration plants with a nominal capacity exceeding 6 tonnes per hour or new incineration plants Par 4.50 Waste Incineration Guidance, 2010 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/201215/pb-13570-wid-guidance-201003.pdf)

Efflux gas velocity is assumed to be approximately 370°C based on review of stack emission monitoring reports for similar processes (Scientifics Report Ref@ 091121 *Stack emission monitoring report – Part 3,* as lodged in Planning Portal for Application 20/00830 on 2nd December 2020)

The stack height is assumed to be 10.0m as detailed in Building Plan layout. The stack dimensions are assumed to be 0.4m diameter with 15 m/s efflux velocity. A 0.3m surface roughness (agricultural areas maximum) is used in the model. There is no allowance made for local topography in the screening model.

For the screening model, instantaneous worst-case wind direction conditions are used, with meteorological dataset R91A-G representing a highly-localised westerly wind distribution (see Wind Rose image at Appendix 1) and modelling for ground-level concentrations at various distances (50-250m) directly downwind of the source including the distances of relevance to both residential receptors A and B (~200m). Baseline air quality levels are obtained from the Scottish Air Quality Network data, modelled for 2022. The resulting air quality impacts (baseline plus development source) are then variously evaluated by comparison against:

a. Air quality standards
b. Percentage increase over baseline levels

This is reported and evaluated at Section 5.0

5.0 DISPERSION MODELLING & EVALUATION

5.1 Modelling Results

As discussed at section 4.1, results are modelled for worst-case wind direction conditions using a highly-localised wind distribution with modelling for ground-level concentrations at various distances downwind of the source including the distances of relevance (~200m) to both residential receptors A and B.

The modelling for PM10 further conservatively assumes that all the total particulate material emitted can be classed as PM_{10}.

The model uses the emission limit values contained in the Process Guidance to obtain mass emission limits (for carbon monoxide, PM_{10} and Mercury). It should be noted that actual emission concentrations can be expected to be some margin lower than these limits.

It should additionally be noted that in referencing against annual or 24-hour average air quality standards, there is no weighting applied in this model to take into account periods when the crematorium is not in operation, though this is likely to be approximately:

50% of the working day
<20% of the 24 hour day, and
<20% of the annual period

Modelling for NO_2 assumes that all NO and NO_2 is expressed as NO_2. The model uses the emission concentration limit for NO_2 from waste incineration, in the absence of such a standard specifically for crematoria

Modelling results are shown in table 4 for a range of distances directly downwind

Table 4. Modelled ground-level concentrations of the target pollutants at various distances downwind of the stack point source

	Distance to Receptor				
Pollutant	**50m**	**100m**	**150m**	**180m**	**250m**
Carbon monoxide, ug/m^3	1.72	2.00	1.49	1.23	0.82
PM_{10}, ug/m^3	0.33	0.38	0.29	0.24	0.16
NO_2, ug/m^3	3.62	4.24	2.96	2.45	1.61
Mercury, ug/m^3	0.83×10^{-03}	0.96×10^{-03}	0.71×10^{-03}	0.59×10^{-03}	0.40×10^{-03}

These results therefore show the worst-case constant downwind concentrations; these conditions will obviously occur at the A&B receptor locations for significantly less than 50% of a year-round reference period.

5.2 Referencing

The results presented in Table 4 are referenced in Table 5 against a range of assessment criteria.

Table 5. Evaluation of modelled results

Pollutant	Assessment Criteria	Comment
Carbon monoxide	Air quality standard of 10,000 ug/m^3 running 8-hour mean	Worst-case modelled results at peak ground-level location (~100m downwind) are **0.02%** of the air quality criteria
PM_{10}	Air quality standard of 18ug/m^3 annual mean	Worst-case modelled results at peak ground-level location (~100m downwind) assuming all total particulate material is PM_{10} are **2.1%** of the air quality criteria
PM_{10}	Typical background level of 11ug/m^3 based on Scottish Air Quality Network Data [3]	Worst-case modelled results at peak ground-level location (~100m downwind) assuming all total particulate material is PM_{10} are **3.4%** of the background and will increase the background from **61 to 63%** of the air quality standard
NO_2	40ug/m^3 annual mean	Worst-case modelled results at peak ground-level location (~100m downwind) are **10%** of the air quality annual mean criteria
NO_2	200ug/m^3 1-hour average not to be exceeded more than 18 times per annum	Worst-case modelled results at peak ground-level location (~100m downwind) are **2%** of the 1-hour average air quality criteria
NO_2	Typical background level of 6.8 ug/m^3 based on Scottish Air Quality Network Data [3]	Worst-case modelled results at peak ground-level location (~100m downwind) are **65%** of the background and will increase the background from **17-27%** of the air quality standard
Mercury	Average background level 2.0 x 10^{-03} ug/m^3 (Brown et al, 2015 [1])	Worst-case modelled results at peak ground-level location (~100m downwind) are **<50%** of the UK average background level
Mercury	20ug/m^3 HSE Workplace exposure limit[2]	Worst-case modelled results at peak ground-level location (~100m downwind) are **<0.1%** of the workplace exposure limit

1. Richard J.C. Brown, Sharon L. Goddard, David M. Butterfield, Andrew S. Brown, Chris Robins, Chantal L. Mustoe, Elizabeth A. McGhee, Ten years of mercury measurement at urban and industrial air quality monitoring stations in the UK, Atmospheric Environment, Volume 109, 2015, Pages 1-8, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2015.03.003.
2. HSE Guidance Note EH40/2005, Jan 2020
3. Baseline air quality data for PM10 and NO_2: http://www.scottishairquality.scot/data/mapping?view=data

5.3 Evaluation

Environmental Protection Scotland and the Institute for Air Quality Management have published guidance (*Land-Use Planning & Development Control: Planning For Air Quality*) to assist in evaluation of air quality in planning and development control processes.

The modelled results can be interpreted against the relevant air quality objectives in terms of Table 6.3 to the EPS/LAQM Guidance. This is reproduced in Table 6 below

Table 6. Impact descriptors for individual receptors (from Table 6.3 to *Land-Use Planning & Development Control: Planning For Air Quality*)

Long term average Concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

This table should normally be used with modelled <u>annual</u> average concentrations. Modelled ground-level (Z=0) air concentrations across the site indicated *negligible* increase in levels of pollutants.

It can be seen from Table 5 that for carbon monoxide and PM_{10} existing ambient levels are less than 75% of the relevant air quality AQAL, and the modelled levels are less than 5% of the AQAL. As such the relevant impact descriptor for these parameters – even with various simplified worst-case scenarios – is *negligible*.

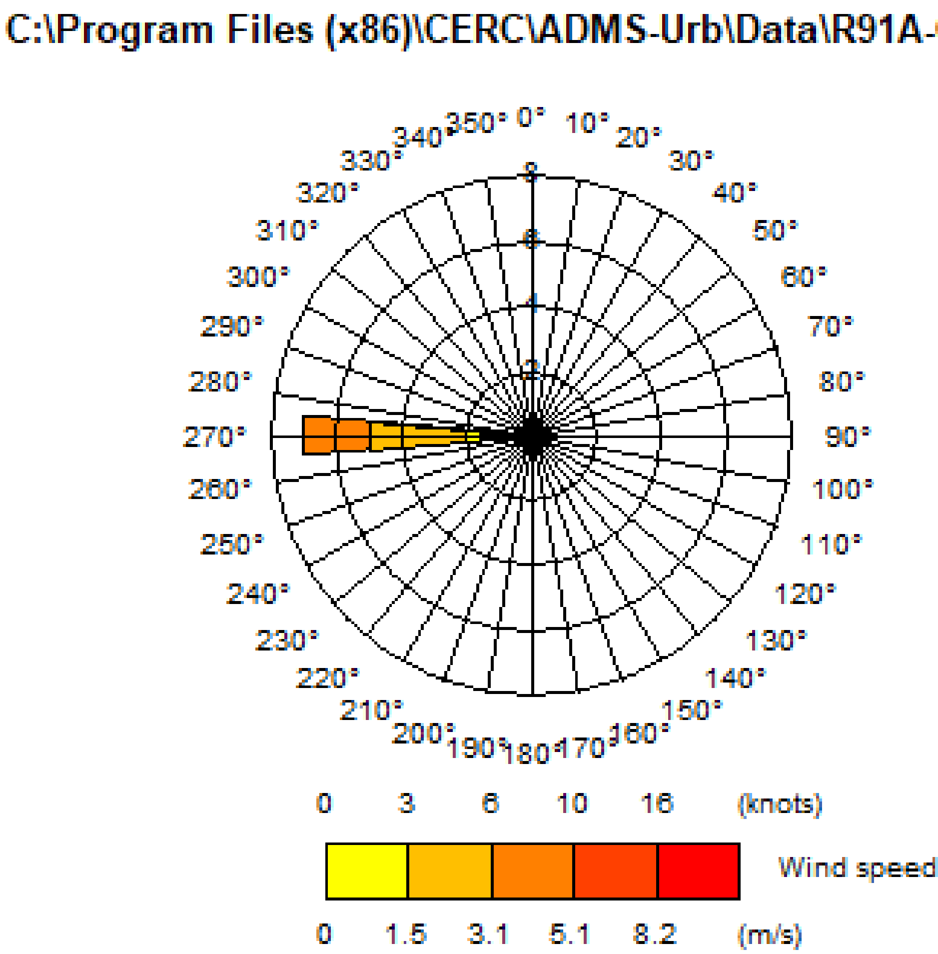
For NO_2, existing ambient levels are less than 75% (17%) of the relevant long-term air quality AQAL. The simplified worst-case air quality concentration used to date is 10% of the AQAL. If we introduce a more representative modelled concentration by assuming active cremation for only 8 hours per day (6 cycles at 80 minutes each) for 6 days per week (rather than 365 days x 24 hours), the worst-case ground-level concentration (100m distance) drops proportionately (28.5%) and the revised worst-case air quality concentration will therefore be 2.8% of the AQAL. As such the relevant impact descriptor for this parameter – even with a number of other simplified worst-case conditions – can be considered *negligible*.

For mercury the worst-case modelled air quality concentrations are less than 50% of the average UK background level. There is no formal long-term annual assessment level for mercury. We can however in the absence of such, adapt existing workplace exposure limit (WEL) criteria used for <u>occupational</u> exposure settings. These are published by the Health and Safety Executive (EH40).

We cannot use these directly, as these are meant to be applied for working exposure durations (ie 40 hours per week rather than potential 24 x 7 exposure), and are also applicable to a working population who are typically more healthy than the non-working population, which may include infants, elderly, immune-compromised etc. Traditionally an approximate 30-fold factor is used as a safety margin to account for these two factors when applying occupational exposure criteria to the environmental setting. Applying this to the 20ug/m^3 EH40 WEL results in an ad-hoc AQAL of 600ng/m^3. It can be seen that the worst-case (100m) ground-level modelled mercury concentration (1ng/m^3) is <5% of the ad-hoc AQAL. As such the relevant impact descriptor for this parameter – even with various simplified worst-case conditions – can be considered *negligible*.

In summary, the overall air quality impact associated with the development – even conservatively assuming various worst-case conditions - can be assumed to be *negligible* and no further modelling evaluation of impact significance is considered to be merited. Consideration as to potential specific mitigation measures for air quality, is also not deemed to be warranted.

APPENDIX 1. Wind Rose used to establish worst-case (downwind) concentrations



POST-APPLICATION CONSULTATION RESPONSE REPORT

POST APPLICATION CONSULTATION REPORT

ERECTION OF CREMATORIUM BUILDING AND ASSOCIATED PARKING, ACCESS, TURNING SPACE, LANDSCAPING AND BOUNDARY ENCLOSURES ON LAND NORTH EAST OF DUNTRUNE HOUSE, DUNTRUNE (REF: 20/00830/FULL)

April 2021

REPORT PREPARED BY EMAC PLANNING ON BEHALF OF DUNTRUNE LIMITED

CONTENTS:

1.0 Introduction

1.1 This Post-Application Consultation report has been prepared by Emac Planning to provide the applicants views on issues raised through consultee and third party representations received by Angus Council in response to the submission and advertisement of the following application for planning permission:

"ERECTION OF CREMATORIUM BUILDING AND ASSOCIATED PARKING, ACCESS, TURNING SPACE, LANDSCAPING AND BOUNDARY ENCLOSURES ON LAND NORTH EAST OF DUNTRUNE HOUSE, DUNTRUNE (REF: 20/00830/FULL)" on behalf of the applicant, Duntrune Limited.

1.2 It is our understanding that comments have been received from internal consultees and various interested third parties, both in support of and objecting to the proposals.

1.3 This report seeks to identify the main material planning issues raised through the various Statutory Consultee, Angus Council internal responses and external third party consultation responses and provides an assessment of each. As is common with applications for planning permission, there is to some degree overlap between consultee comments; Community Council comments and third party responses, although the intent within this report is to cover all relevant planning matters that have been raised.

1.4 At the time of writing there were a considerable number of objections and statements of support on the Angus Council planning portal and the applicant welcomes the interest that this new and exciting proposal has generated. Overall, the level of public interest from a well organised community is of course noted and appreciated, with both objections and statements of support submitted in response to the submission of the application. Local views, whilst encouraged through the consultation process, are of course only one consideration to be set alongside other planning issues and the planning authority can only consider objections or letters of support that raise relevant to planning issues. These can include, for example, the effect of the proposed development on traffic and parking, the appearance of the area, loss of significant landscape features, noise and disturbance, or adverse effect on privacy. Indeed, in our analysis of the submitted representations it is clear that many of the objectors have used similar generic lists as a guide to voice their concerns regarding the development. Many of the local supporters list positives such as the location; the associated community benefits to the area; the local economic benefits and the dearth of local crematoria provision.

1.5 In summary, it remains the applicants view that the matters raised by the various third party objectors do not have material weight and the proper and a rounded analysis of the Development Plan and relevant material considerations continue to support the approval of planning permission.

1.7 For ease of reference, this report therefore lists and analyses the 4 categories of respondent as follows.

- **Statutory Consultees;**
- **Angus Council Departmental Responses;**
- **Murroes and Wellbank Community Council; and**
- **Third Party Representations.**

2.0 Statutory Consultees

2.1 Statutory consultees submissions have been received and are responded to as follows:

- **Dundee City Council** (4th February 2021):
  - o The Transport Assessment has been reviewed and there are no comments from a roads perspective.
  - o *Response:* Noted.
  - o The application, located only 1km from the DCC boundary, does not raise

any issues of strategic significance.
  - *Response:* Noted.
  - Overall, DCC have no objections to the proposals.
  - *Response:* Noted.

- **Scottish Water** (22nd December 2020):
  - Confirmed no objection to the application and advisory notes provided on the various assessments required.
  - *Response:* Noted, no actions are required in relation to the Scottish Water consultation responses at this stage of the planning process.

- **SEPA:**
  - Whilst no response has been received, it is the applicants understanding that any new crematorium will require further authorization from SEPA under 5.1, Part B, © of the Pollution Prevention Control Regulations 2012 (PPC) "cremation of human remains". This is not a material planning consideration and therefore there is no requirement to await a response from SEPA.

3.0 Angus Council

3.1 Angus Council internal consultee responses have been posted on the portal and are responded to as follows:

- **EIA Screening Opinion** (not dated):
  - The proposal does not require the submission of an Environmental Impact Assessment Report.
  - *Response:* Noted.
- **Archaeology** (29th December 2020):
  - No archaeological mitigation required.
  - *Response:* Noted.
- **Traffic Manager, Roads** (19th January 2021):
  - Acknowledges the submission of the TA and advises that the application has been considered in terms of traffic generation and impact on the public road network including specific matters of pedestrian accessibility; cycling accessibility; public transport; road network and access; and parking. In conclusion, no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
  - *Response:* Noted, the applicant acknowledges and accepts the proposed conditions.
- **Environmental Health Officer** (11th January 2021):
  - An assessment should be undertaken in accordance with the Local Air Quality Management Technical Guidance TG(16) and should also consider potential odour impacts at sensitive locations.
  - *Response:* Ethos Environmental have now prepared an Air Quality Impact Assessment and an Odour Impact Assessment. In summary, the overall air quality impact associated with the development can be assumed as negligible and no further evaluation is merited and no potential specific mitigation measures for air quality are warranted. Regarding the likely impact of odour on residential receptors is not sufficiently significant to warrant recommendation of additional pro-active mitigation and control measures. Both documents have now been submitted in support of the proposals.

4.0 Murroes and Wellbank Community Council

4.1 Murroes and Wellbank Community Council (CC) commented on the proposal as below, with the applicants responses also set out below. Whilst not within their area, we note that Fintry Community Council also commented on the proposals in terms of matters associated with loss of residential amenity; inappropriate community use; concerns with regard to road traffic; and insufficient parking provision. With all due respect to Fintry Community Council, these matters are covered elsewhere within this report and do not require repetition here. With some overlap with the Fintry Community Council submissions, the following comments are therefore provided in response to the Community Council that covers the application area, i.e. Murroes and Wellbank Community Council (CC). Please also note, the CC submission included 7 numbered titles with bullets beneath, therefore for ease of reference, the same numbering / bullets are used to provide the applicants response.

- *CC:* As a Community Council, firmly believe in supporting the entrepreneur in developing new business opportunities in the local community.
- *Response:* Noted and appreciated.
- *CC:* Concerned about lack of amenity, the Angus Local Development Plan designation, traffic safety on local residents, public access, public transport provision, flooding, drainage provision and suitability of access roads in the surrounding area.
- *Response:* The concerns are noted and responded to in detail as follows.
- *CC: (1)* **Policy DS1, Development Boundaries & Priorities.** This proposal will bring suburbanisation to the countryside along with associated additional vehicles, mainly cars, due to the limited access by public transport, walking or cycling.
- *Response:* A Planning, Design and Access Statement was submitted with the application pack and specifically addresses LDP Policy DS1 and the proposals compatibility with that policy. In particular, the applicant has undertaken an appropriate test in satisfaction that there are no alternative sites available. Whilst this approach has been criticised by others, including Clyde & Co on behalf of Dignity Funerals Limited*, no alternative evidence has been submitted to dispute the findings as set out within the applicant statement. As a general comment at this point, it is of course notable that the Community Council and for example Clyde and Co, have submitted statements seeking to discredit the submitted evidence, including the diligently carried out sequential test, whilst offering no counter evidence of their own. It is of course open to objectors to present counter evidence regarding for example the approach the applicant has taken to a sequential test in accordance with Policy DS1, however they have apparently declined to produce an opposing position, instead relying on often vague allegations with no actual substance. The applicant continues to diligently prepare and submit the required information and more weight must therefore be given to the applicants professional submissions, unless counter positions are prepared and put forward for anlaysis. In short, the positions put forward by the Community Council, Clyde & Co and the various third party objectors are not supported by any reasonable professional analysis. No weight can therefore be given to the various subjective statements and the unsubstantiated opinions certainly cannot carry more weight than professional reports prepared on the various matters. * We note that a letter of objection has been submitted by Clyde & Co on behalf of Dignity Funerals Limited. We have little to say on that particular representation which should be seen in context. It is a representation submitted by the legal representative of a competing company which no doubt sees a commercial benefit in frustrating the grant of planning permission for a crematorium on the site.

- *CC:* The proposed development is located on a Greenfield site and is not in accordance with the policies of the Angus Local Development Plan (ALDP). **Policy TC9 Safeguard of land for Cemetery Use** confirms that land is reserved for cemetery purposes at Aberlemno, Dunnichen Cemetery, Kirkton of Auchterhouse, Liff and Panbride. This very significant and specific cemetery policy and wider Local Development Plan makes no requirement for a new crematorium in Angus which is already well served by the existing facility in Friockheim.
- *Response:* With respect, LDP Policy TC9 relates to safeguarding of land for cemetery use and has no relevance to a proposal for a crematorium. Regarding the requirement for a new crematorium, this is covered in detail in the submitted Planning, Design & Access Statement which demonstrates a need and demand for the facility and the significant reduction in journey times for local crematorium services compared to journey times to Friockheim, Dundee or even Perth & Kinross.
- *CC: (2)* **Traffic, Policy DS2 Accessible Development. Accessible to existing or proposed public transport networks;** This proposal does not provide suitable access to public transport with the nearest bus stop/bus route being 1.6Km from the development. There is no form of pedestrian access from the nearest public transport point to the proposed development.
- *Response:* People travelling to cremations, due to the upsetting nature of the event, generally do not travel by public transport and alternatively pre-arrange car sharing. Provision has however already been made on site for buses access and turning. Whilst the distance to walk to a bus stop is above the desired 400m, any funeral attendee would be making this journey as a one off. It would be expected that for those travelling to a funeral without access to a private car, a lift from a friend or family member, a taxi or a private coach would be the more usual modes of transport. Generally, funerals by their very nature tend to lend themselves to car sharing for attendees. In terms of staffing, there are only 4 full time staff associated with the crematorium therefore the impact of the lack of nearby bus services is considered to be minimal. In summary, the setting and general environs of a crematorium require that it is situated away from residential developments and as such, it is therefore difficult to locate this where there are existing regular and convenient bus services. Finally, as would be expected, when assessing the proposals the Councils Traffic Manager: Roads considered the question of access to public transport, noting that given the rural nature of the site there is little opportunity for crematorium staff or visitors to travel to and from the site by public transport. Reasonably, travel to the site by bus would therefore be via private hire, where parking would be clearly be available on site. The Councils Traffic Manager: Roads offered no objection to the proposals, subject to appropriate conditions. The position regarding public transport cannot therefore be considered a reasonable reason for refusal.
- **CC: Make provision for suitably located public transport infrastructure such as bus stops, shelters, lay-bys;** There is no provision for any public transport infrastructure as part of this proposed development.
- **Response:** As referenced in detail above, above, the Councils Traffic Manager: Roads has considered this aspect of the proposal and offered no objection; the lack of public transport provision cannot therefore be considered a reasonable reason for refusal.
- *CC:* **Allow easy access for people with restricted mobility;** There is no suitable access to the proposed development for individuals with restricted mobility other than motor vehicle. There is no suitable access from any of the built up areas surrounding the development.

- *Response:* The position regarding public transport access is referenced in detail above. Specifically regarding disabled access, 7 disabled parking bays will be required by condition, a condition proposed by and agreed with the Councils Traffic Manager: Roads, and the building will be wheelchair accessible.
- **CC: Adequate local road network capacity or where capacity can be made available;** The road network surrounding the proposed development is mainly narrow country roads with acute bends with poor visibility. The proposal to install passing places to accommodate traffic where in excess of 360 vehicles potentially attending this facility a day, will seriously impact school bus transport, local farming activities and residents going about their daily lives. The ingress and egress from the Kellas Road will be a significant safety concern due to the visibility, speed of traffic and blind summit. The build up of additional traffic at the Kellas Road/Drumgieth Road/Drumsturdy Road will only exacerbate the problem of traffic delays at this busy junction.
- **Response:** The submitted Transport Assessment assessed the surrounding road network in great detail, including traffic counts and speed surveys. Within the TA, anticipated trip generation was based on two similar crematoria developments at Friockheim, Angus and at 100 Acre Wood, Fife. Both very local and relevant comparators. In assessing the relevant submissions, the Councils Traffic Manager: Roads agreed and accepted that the anticipated aggregated traffic flows will be below a level that would be expected to cause capacity and queuing issues. The Traffic Manager: Roads therefore offered no objection in relation to anticipated impact on the local road network.
- **CC. (3) Policy DS3 Design Quality and Place making; Designing Places;** Concerns this development does not meet the six qualities of a successful place and in particular the development being well connected. This proposal does not provide connectivity for pedestrians, cyclist, provides NO options to use public transport safely and as such every attendee to the premises will require to use a motor vehicle and as such we feel the parking available is not suitable.
- **Response:** Matters in relation to connectivity for pedestrians, cyclists and public transport are considered above and also within the formal consultation response provided by the Councils Traffic Manager: Roads, who offered no objection to the proposals. With regard to the six qualities of successful place, a Planning, Design & Access Statement was submitted in support of the application and included a specific and detailed section which set out the design proposals. In formulating the proposals, clear direction was also taken from Angus Councils Design & Placemaking Supplementary Guidance (October 2018) which advocates a design led approach to developing proposals and the need to demonstrate an understanding of the site and its wider context. It also sets out specific design requirements to ensure that places meet the design qualities of distinct in character, safe and pleasant, well connected, adaptable and resource efficient. The Community Council do not set out how the proposals do not meet these requirements whereas the applicant has within the detailed design statement. Again, in particular we note that the Traffic Manager: Roads offered no objection regarding the criteria 'well connected'.
- **CC. Designing Streets;** Concerns are raised regarding the position over the narrow network of roads surrounding the facility and the capacity to sustain the increased level of traffic without significant widening of all C4 roads leading to the facility. Suitable pedestrian access is not part of this design proposal and therefore not providing safe/low cost access for people unable to drive.
- **Response:** As referenced above, the submitted Transport Assessment assessed the surrounding road network in great detail, including traffic counts, speed surveys and

pedestrian access. Within the TA, anticipated trip generation was based on two similar crematoria developments at Friockheim, Angus and at 100 Acre Wood, Fife. Both very local and relevant comparators. In assessing the relevant submissions, the Councils Traffic Manager: Roads agreed and accepted that the anticipated aggregated traffic flows will be below a level that would be expected to cause capacity and queuing issues. The Traffic Manager: Roads therefore offered no objection in relation to anticipated impact on the local road network or in relation to pedestrian links. The position of no objection is of course caveated with the recommendation that any consent granted shall include conditions relating, amongst other matters, to visibility splays and a proposed scheme of improvements to local public roads. The applicant has confirmed agreement with the proposed conditions.

- **CC (4) Policy DS4 Amenity; Air Quality;** Concern with the carbon emissions of the proposed boilers for this development. For every gas cremation Approx 245kg of carbon is released into the atmosphere and there for releasing hundreds of tonnes each year. The NOx emissions produced by crematorium has raised concerns and such emissions are a danger to public health especially children. There is also a concern with potential mercury pollution, which again is linked to health issues.
- **Response:** In respect of air quality, whilst data obtained from other installations was submitted, the Councils Environmental Health Officer requested that a detailed assessment of the potential impact of emissions to air and odour from the operation of the cremator be undertaken. As referenced above, the appropriate information has now been submitted and suitably demonstrates no adverse issues.
- **CC: Levels of odour, fumes and dust;** Concerns with the potential impact on the residents living in close proximity of the development and the impact of odours, burnt particles and fumes on gardens, washing and property. Not only from the proposed development, but the significant concentration of vehicles attending the premises on a daily basis.
- **Response:** Technical information regarding emissions and the cremator itself have been submitted within the application pack and present no material planning issues of concern.
- **CC: The effect and timing of traffic movement to, car parking and impacts on highway safety;** Concerns with the provision of onsite parking for large mourner groups and the impact on the surrounding residents, safety of road users when mourners are parking on the verges and on the sides of an already narrow carriageway, creating difficulties for local farmers, businesses and residents. Lack of suitable footpaths may result in visitors attending funerals who have no option but to walk from the nearest bus stops, the added danger of walking on 60mph roads, putting them and other road users at danger.
- **Response:** There will be no requirement for mourners to park on verges and / or on the side of the road. The proposed parking arrangements were assessed in the TA and the Councils Traffic Manager: Roads assessed the proposed parking arrangements and has offered no objection subject to a proposed condition setting out minimum rates for cycles; motorcyles; cars and disabled bays. The applicant has accepted the proposed condition.
- **CC: Residential amenity in relation to overlooking and loss of privacy;** Concerns for the residents surrounding the development who have set up home in this quiet tranquil location, to obtain some form of peaceful lifestyle and who now are going to potentially have imposed on them, hundreds of people parking outside their properties, looking into their homes and daily experiencing the upset of people having endured a personal loss.

- Response: The proposal ensures adequate parking and residential amenity will be assured through appropriate planning conditions relating to the treatment and maintenance of the site boundaries.
- **CC (5) Policy TC8 Community Facilities and Services;** The ALDP aims to ensure that new facilities are accessible and of an appropriate scale and nature for their location. This Crematorium proposal does not fulfil this policy due to the access availability and we feel the access routes via the road network fall short in providing safe access and egress for the users of the facility and the impact of local residents and businesses surrounding the facility.
- **Response:** Detailed responses regarding accessibility are set out above and the conclusion from the Councils Traffic Manager: Roads is of course that there will be no adverse impact for users of the facility, local residents or businesses.
- *CC: (***6) Policy PV11 Energy Efficiency;** Concerns this proposed development does not meet the ethos of reducing carbon output based on the methods of operating the facility, increase in car transport and as such will only increase the carbon output into the atmosphere. It is considered that the proposed development does not follow in line with Government reduction Green House gas targets.
- *Response:* This very generalised contention is simply not correct or accepted. The proposal will promote, enhance and add to biodiversity, it will include water and energy conservation measures such as waste heat recovery and passive solar gain and it will incorporate appropriate waste recycling, segregation and collection facilities and the applicant will seek to minimise waste by design and during construction. Regarding emissions, the requisite information has been submitted within the application pack and no materially detrimental position will be created.
- *CC:* **7. ALDP;** We consider this application is in conflict with the approved development plan, land designation, carbon reduction targets, connectivity, impact on the amenity of local residents and the safety of road users.
- *Response:* It remains the applicants position that the proposals have been well thought through and are entirely appropriate.

5.0 Third Party Representations

5.1 The following table sets out the prominent matters raised by interested third parties through the consultation process. Is should be noted that some of the representations are commercial objections by competing operators although in a spirit of cooperation, very little reference is made to that fact below, with equal weighting of response given to each. Similarly, the statements of support are provided with equal weighting.

5.2 As noted above, the level of public interest from a well organised community is of course noted and appreciated, with both objections and statements of support lodged in response to the submission of the application.

5.3 Whilst it is impractical to respond to each individual point raised / respondent, the following table seeks to identify the main issues raised through the various third party consultation responses and provide the applicants comments on each.

COMMENT	RESPONSE
The Principle of Development / Location	
Object to the principle of any development on the site.	The site is promoted as a windfall site, i.e. a site which has become available for development unexpectedly during the life of the development plan and so is not identified individually in the plan.
The site is not allocated for the proposed use within the Angus LDP.	As above, the site is promoted as a windfall site, i.e. a site which has become available for development unexpectedly during the life of the development plan and so is not identified individually in the plan.
Support for the principle of development as an essential facility.	Noted and agreed.
The proposed site is well situated to serve the growing population in the Monifieth / Broughty Ferry / South Angus area.	Noted and agreed.
The site location is appropriately positioned close to Pitkerro Cemetery, which when built the plan recognised the potential for a crematoria to be built in the vicinity.	Noted and agreed.
Development Plan	
TAYplan Policy 1 Locational Priorities: Proposals for development in the countryside should be assessed against the need to avoid suburbanisation and unsustainable patterns of development. No landscape assessment has been submitted.	The position of the building nestles within the general fall of the site. This combined with the surrounding landscape, trees, etc screen the proposals completely from the west round to the east. Viewing from the adjacent road is screened by a new dry-stone wall and hedge / tree planning. The site is further screened by the mature trees to the south of the road. Additional native tree planting is incorporated into the proposals particularly to the east, screening the proposals further from this angle and further enhancing the sense of enclosure. The position of the crematorium building within the site has been carefully chosen, so that it nestles within a natural landscape. Its location within the site will mean that it is not visible from the west, north or east and is barely visible from the south. Views from the south will be from distant vantage points and will be mostly obscured by trees along public roads. The principal view into the site will be when passing on the adjacent road along the south side of the site, which will be glimpse views through the proposed planting and screened by a new drystone wall and hedging. The proposals are therefore considered acceptable from a landscape impact perspective and no further landscape assessment is required.

LDP Policy DS1 Development Boundaries and Priorities: Development of greenfield sites will only be supported where no suitable and available brownfield sites capable of accommodating the proposed development are available. The site is not allocated for the proposed development.	An appropriate assessment was carried out, the detail of which is included in the submitted Planning and Design Statement. The site is promoted as a windfall site, i.e. a site that has become available for development unexpectedly during the life of the development plan and so is not identified individually in the plan.
LDP DS4 Amenity: Development will not be permitted where there is an unacceptable adverse impact on the surrounding area or the environment or amenity of existing or future occupiers of adjoining or nearby residents, including traffic movements to and from the site.	There are only three dwellings within 300m of the crematorium building. With the nearest dwelling some 183 meters away and the intervening mature woodland means that the site will not be directly visible from any dwelling houses or the surrounding areas. Proposed traffic movements have been assessed by Angus Council Roads and found to be acceptable.
LDP TC8 Community Facilities and Services requires that these should be accessible and of an appropriate scale and nature for the location.	Detailed responses regarding TC8 criteria and accessibility are set out above and the conclusion from the Councils Traffic Manager: Roads is of course that there will be no adverse impact for users of the facility, local residents or businesses.
LDP TC9 Safeguard of land for Cemetery Use confirms locations reserved for cemetery purposes. The policy makes no requirement for a new crematorium therefore there is no need.	With respect, LDP Policy TC9 relates to safeguarding of land for cemetery use and has no relevance to a proposal for a crematorium. Regarding the requirement for a new crematorium, this is covered in detail in the submitted Planning, Design & Access Statement which demonstrates a need and demand for the facility and the significant reduction in journey times for local crematorium services compared to journey times to Friockheim, Dundee or even Perth & Kinross.
LDP TC15 Employment Development governs class 4, 5 or 6 development outwith development boundaries and will only support where the scale and nature of the development is in keeping with the character of the local landscape and pattern of development.	Policy TC15 does not apply in the consideration of a proposal for a crematorium.
LDP PV6 Development in the Landscape allows for development which has an adverse effect on landscape in selected contexts; and should minimise adverse impacts where appropriate through mitigation.	The position of the building nestles within the general fall of the site. This combined with the surrounding landscape, trees, etc screen the proposals completely from the west round to the east. Viewing from the adjacent road is screened by a new dry-stone wall and hedge / tree planning. The site is further screened by the mature trees to the south of the road. Additional native tree planting is

	incorporated into the proposals particularly to the east, screening the proposals further from this angle and further enhancing the sense of enclosure. The position of the crematorium building within the site has been carefully chosen, so that it nestles within a natural landscape. Its location within the site will mean that it is not visible from the west, north or east and is barely visible from the south. Views from the south will be from distant vantage points and will be mostly obscured by trees along public roads. The principal view into the site will be when passing on the adjacent road along the south side of the site, which will be glimpse views through the proposed planting and screened by a new drystone wall and hedging. The proposals are therefore considered acceptable from a landscape impact perspective.
Traffic / Sustainable and Safe Transport / Parking	
Traffic counts were not taken at appropriate times.	The Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
Lack of accessibility by walking, cycling and by public transport. No mitigtion is proposed for any of these elements. LDP Policy DS3 Design Quality and Placemaking states that proposals should be well connected, where development connects pedestrian, cyclists and vehicles with the surrounding area and public transport, the access and parking requirements of the Roads Authority are met and the principles set out in Designing Streets are addressed.	The Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
The surrounding roads are narrow and subject to use by farm vehicles.	The Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
Note that Angus Council have requested an increase in overspill parking and this should be provided.	This has been provided and the Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
Appropriate visibility splays should be conditioned.	The Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.

LDP Policy DS2 Accessible Development requires development proposals to demonstrate that they are accessible to public transport; easy access for people with restricted mobility; safe and pleasant for walkers and cyclists; located where local road network capacity exists of can be made.	The Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
Residential Amenity	
Loss of residential amenity by virtue of traffic disruption, noise and general disturbance.	Please refer to the detailed responses provided above in response to the Community Councils queries regarding residential amenity.
Conflict with the 1902 Act	
To avoid conflict with the Act, the applicant should clearly evidence that there are no properties within 200 yards of the proposed development; or it has obtained express consent in writing from the owners of any such properties to the construction of the Proposed Development.	Please refer to the detail in the Planning and Design Statement.
Alternative Sites	
LDP Policy DS1 requires an assessment of alternative sites. The assessment undertaken is wholly inadequate. The assessment should apply beyond the south angus area and has only carried out a high level assessment of the housing land and employment land audits.	With all due respect, the professional respondent, either mistakenly or intentionally, misinterprets the policy. The policy requires an assessment of sites that are suitable and available, it does not require an assessment of all sites within Angus. Neither does it require an assessment of sites outwith an operating area. Acting on behalf of Dignity Funerals Limited, the competing operator makes accusations of alternative sites being available without carrying out any analysis to prove the case. It should be noted that the only reason that we reference the respondent for this comment is that they have the capacity to carry out an alternative analysis. The fact that they have not speaks for itself. This is an objection seeking to present unsubstantiated doubt rather than robust contradictory evidence.
Inappropriate rural location and an urban setting would be better.	The 'Federation of Burial and Cremation Authorities', which is the principal representative of burial and cremation authorities states the following in its guidance: A minimum of two hectares, approximately five acres, per estimated 1,000 cremations per annum is recommended to provide sufficient space for the crematorium, gardens of remembrance, traffic circulation, parking, and a modest amount of space around the building. Ideal sites are rarely to be located in urban areas and it is emphasised that suitability of setting is of

	greater importance than its location in close proximity to population centres. Site selection should be aimed at achieving quietness and seclusion. A woodland or parkland setting, or an area of undulating ground with good natural features and mature trees, would enable the establishment of a good natural setting with a minimum of horticultural treatment. Previously developed land can often prove unsuitable, due to land contamination, which is unacceptable for the interment of ashes, or due to the presence of residential property within 200 yards. There is a growing recognition that new crematoria will be built in a countryside location close to the urban fringe. With detailed reference to this guidance, the proposals are clearly entirely appropriate within their rural context.
Need Case	
The need case has no suitably been demonstrated.	This is disputed, the detail of which is included within the submitted Planning and Design Statement.
There is spare capacity at Dundee crematorium and Friockheim crematorium.	This is disputed, the detail of which is included within the submitted Planning and Design Statement.
Dundee crematorium is 85 years old with a chronic lack of parking and little opportunity to expand; this regularly causes parking queuing and overspill to adjacent neighbouring residential streets.	Noted and agreed.
Creating an additional crematoria towards the east of Dundee will much better serve the City and south angus as a whole and distribute access to this vital facility more evenly, reducing journey times and increasing sustainability.	Noted and agreed.
Economic Benefits	
The economic benefits have been overstated.	There is absolutely no justification provided for this statement, which is disputed and the detail of the applicants position is included within the submitted Planning and Design Statement.
The proposed crematoria is ideally positioned in close proximity to hotel and function room facilities within a 10 minute drive and to various accommodation providers, thereby benefiting the local economy and sustaining local employment	Noted and agreed.

and income.	
Direct employment will benefit through construction and the long-term operational jobs.	Agreed.
Ecology / Trees	
Loss of further habitat patronised by local wildlife such as red squirrels and birds of prey.	The site is limited to the agricultural field and as such does not provide a diverse wildlife habitat. The proposals will increase habitat diversity.
Impact on Trees	The existing trees out with the site will be unaffected by the proposals. Extensive additional tree planting has been included in the proposals.
Miscellaneous	
An increase in number of vehicles on local narrow roads has potential to cause problems for local horse owners and make it difficult for them to exercise their horses safely on the road.	The Traffic Manager, Roads has no objection to the application subject to recommended conditions covering matters regarding access / visibility splays; improvements to public roads including passing places; and parking.
Whilst planning consent for housing rightly considers and often stipulates the increase in schooling, health care and other amenities to support the growth of population in an area, so it must apply that a consistent attitude to funeral and crematoria provision which are equally essential requirements of any community.	Agreed.

6.0 **Conclusion**

6.1 In conclusion, this report demonstrates the support of statutory consultees and the various internal Angus Council Departments. There are no outstanding matters that cannot be covered by appropriate condition.

6.2 Responses are also provided above to the representations made by the Community Council and the prominent matters raised by third parties. In summary, it remains the applicants view that the concerns raised by the Community Council and third parties are not supported by any planning evidence and the relevant material considerations, subject to appropriate conditions, continue to support the approval of planning permission.

From: Paul Fretwell
Sent:30 Apr 2021 18:27:52 +0100
To: Fraser MacKenzie
Cc:PLNProcessing
Subject: Proposed Crematorium - Burnside of Duntrune - ref. 20/00830/FULL
Attachments: Planning & Design Statement.pdf, 906 Rev 1 - Visibility Splays Sheet 3.pdf, Crem Post App Report.pdf, P8346 Air Quality Assessment Report Duntrune Crematorium.pdf, P8346.02 Odour Assessment Report Duntrune Crematorium.pdf, PD01 Rev C - Building & Ext works.pdf, PD02 Rev C - Site Plan.pdf, PD06 Rev C - Road Access.pdf

@rchitects
Chartered Architects

30 April 2021

Hi Fraser

Apologies in the delay in getting back to you. However as discussed previously we felt it would be beneficial to all that we pulled together a package of information rather that drip feed it to you.

Attached is the relevant updated / new information as previously discussed. Additionally and specifically in relation to some of the queries raised we would loke to provide the additional following comments:

Local Availability

On the 9th of Feb the earliest available booking at for Dundee Crematorium was 26th. February.

Drive time analysis Report

While we do not agree with the conclusions drawn the current likely total annual cremations for the proposed site stated in the report are approximately 538, which the operator would be highly satisfied with in terms of their business plan and viability of the proposals. The report however fails to recognise both the projected year on year growth in deaths and the local situation both in terms of the draw beyond the limited and more urban and in this instance arbitrary half hour travel time used. The impact of the rural location, topography, road infrastructure etc. have significant effect on draw. The report provided does not even include Forfar or Kirriemuir as a potential demand location. Additionally, factors relating to costs and size limitations will potentially further increase the demand; as will also the fact that the next crematorium north of the area considered in the report is the crematorium at Crathes (nearly 46 miles away, over an hour by car) extending the potential catchment area potentially as far as Laurencekirk particularly when considering accessibility and road infrastructure. This also applies to the area of Angus north of Dundee and also into Perth and Kinross.

Traffic Counts and Speed/Link Flow Surveys

While traffic counts can be lower in school holidays. If a higher base flow was assumed this would only lessen the percentage impact of the development on the surrounding road network in comparison to the existing traffic flows and therefore the conclusion that no further junction assessment is required as a result of a low percentage increase on the local road network would still remain the conclusion of the TA. The speed survey results if higher traffic volumes were encountered would likely only reduce the 85% tile speeds however only a marginal difference could be expected which again would not alter the conclusions drawn from the speed survey results which were used to agree the visibility splay requirements with Angus Council.

Traffic Distribution

The distribution model used in the TA was accepted by both Angus Council Traffic Team and Dundee City Council Development Roads Team. It would not be expected that an alternative distribution would greatly affect the conclusion of the TA.

Traffic Generation

The Paragraph 4.6 and 4.7 are not inconsistent. There will be a minimum of a 1hour gap between services as maintained by the operator☐s procedures and explained in paragraph 4.6. As this is the gap between services it would be expected that within the minimum 1 hour period between services that those arriving for the next funeral and those leaving after the previous funeral could occur within a one hour period and hence for robustness these trips were added together into what would be considered to be a robust peak hour traffic generation for the development. Where large funerals are expected the gap between services would commonly be expected to be increased although these are not expected to occur with any great frequency.

Road Layout

The proposed road layout drawings also mitigate the impact of the development traffic by the provision of road widening along the frontage and 5 No new passing places within the single track roads. This of course enhances the safety of the surrounding road network for existing road users as well as those generated by the development. The location and extent of new passing places has been agreed with Angus Council Traffic Team. The extent of the road network assessed, and distribution was agreed with Angus Council Traffic Team.

Regards

Paul Fretwell

for @rchitects Scotland Ltd.

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SEDA AECB the sustainable building association THE ROYAL INCORPORATION OF ARCHITECTS IN SCOTLAND CHARTERED PRACTICE

TECHNICAL REPORT P8346.02

ODOUR IMPACT ASSESSMENT: Proposed Cremation Facility, Duntrune

Prepared For

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MARCH 2021

DOCUMENT VERIFICATION

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<tr><td></td><td>Prepared By</td><td>Reviewed By</td></tr>
<tr><td>Name</td><td>B Gardner</td><td>Scott Carlin</td></tr>
<tr><td>Signature</td><td>[redacted]</td><td>[redacted]</td></tr>
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EXECUTIVE SUMMARY

An assessment of the likely impact of odour on residential receptors around the proposed site of the client's crematorium development at Duntrune has been undertaken.

The proposed cremator technology incorporates a number of pollutant abatement technologies covering particulate and vapour-phase species, which can be expected to have a significant impact on the controlled odour releases from the process. Fugitive emissions are considered to be negligible.

A simple semi-quantitative screening air quality assessment was used, utilising standard "FIDOL" scoring system in accordance with Institute of Air Quality Management (IAQM) guidance.

The assessment concluded that the aggregated odour impact - for worst-case constant operation of the facility (6 cycles per day) - is small and the receptor sensitivity is high, resulting in an overall *slight adverse* impact magnitude.

IAQM guidance indicates that this is not sufficiently *significant* to warrant recommendation of additional pro-active mitigation and control measures specific to odour within this design and planning phase.

CONTENTS

1.0 INTRODUCTION

1.1 At the request of Mr Paul Fretwell, @rchitects Scotland Ltd, Forfar, an air quality impact assessment has been undertaken for the proposed crematoria development at agricultural land to north-east of Duntrune House, Duntrune, Angus.

1.2 The client is acting as agent for the developer.

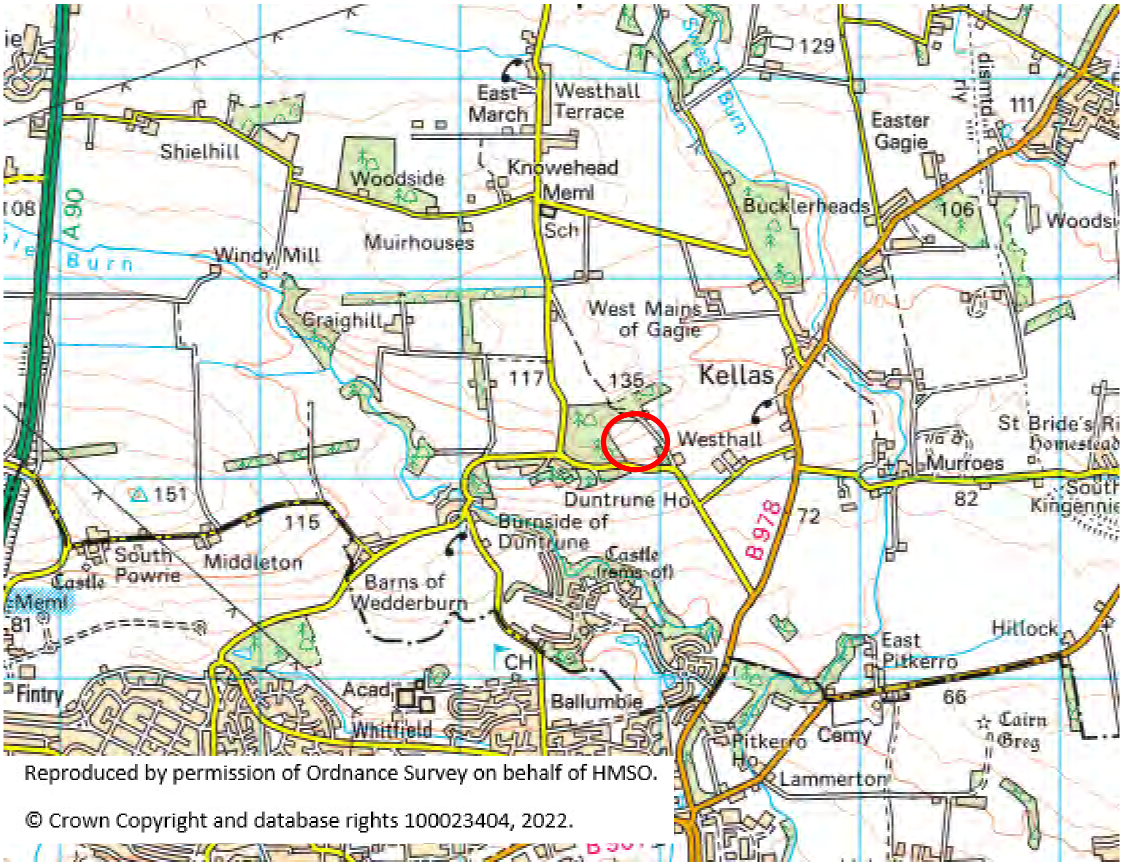
1.3 This assessment was undertaken by Dr Brian Gardner, Senior Consultant, Ethos Environmental Ltd. He holds first and research degrees in Environmental and Atmospheric Chemistry. He has worked as a health, safety & environmental consultant for 25 years and heads-up the company's air quality management consultancy services.

2.0 GENERAL BACKGROUND INFORMATION

2.1 The site is set in a rural location around 7km to the northeast of Dundee City Centre and around 0.5km to the east of the village of Burnside of Duntrune. The Site Location Plan is provided in Figures 1 and 2 below:

Figure 1. Site Location Plan (Satellite)

Figure 2. Site Location Plan (Mapping)



he proposed development is understood to have 120-seating capacity and is located across the southern half (approximately 2.0 Hectares) of ground (total 4.5 Hectares) owned by the developers. Figure 3 shows the site in closer detail and the proposed layout

Figure 3. Site and Development Layout

The site is surrounded by wooded areas to the north, east and west beyond which is generally agricultural land and to the south a road with agricultural land beyond that also.

The planning portal reference documentation relating to the site, the proposed development, and statutory consultation responses has been reviewed.

The Planning Officer has indicated that the development does not require submission of an Environmental Impact Assessment Report as required by regulation 5(1) and Schedule 4 of the Regulations. The *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017*.

The cremation operations and associated processes have the potential to give rise to air quality impacts and Angus Council, Housing, Regulatory and Protective Services has requested an assessment of:

a. air quality impacts in accordance with Local Air Quality Management Technical Guidance TG(16), and
b. potential odour nuisance impacts.

The odour impact assessment is reported here (P8346.02); the air quality impact assessment is reported separately (P8346.01)

3.0 REGULATION & GUIDANCE

SEPA has published specific guidance on assessment of odour (SEPA, Odour Guidance, January 2010). This addresses primarily odour in relation to environmental permitting (eg PPC) and does not relate specifically to odour and planning.

The Institute of Air Quality Management (IAQM) has published more recent guidance (updated 2018) which more clearly addresses odour issues within the planning process (Bull et al [2018]. *IAQM Guidance on the assessment of odour for planning* – version 1.1, Institute of Air Quality Management, London. www.iaqm.co.uk/text/guidance/odour-guidance-2018)

4.0 ODOUR ASSESSMENT SCOPE & METHOD

4.1 Site Sensitivity

The crematorium is located to the west side of the development; the nearest receptors are estimated to be located at a distance of 213m to the east (A, two of) and 197m to the north (B, one of) of the proposed crematorium stack emission point (C) as shown in Figure 4.

Figure 4. Location of nearest residential receptors at A (2 properties) and B (single property)

From review of satellite images (GoogleMap data, 2021) there are estimated to be approximately 200 dwellings located within 1000m of the development site (See blue radius, Figure 5); these are almost exclusively located to south and south-west of the site and in the upper distance range of 700-1000m.

Figure 5. 1000m radius (blue) around development source

Preliminary review of the site of the proposed development does not indicate any sensitive receptors other than dwellings with limited exceptions. There is a hotel at 300m distance to west of site (Duntrune House). There is a primary school (Murroes Primary) at distance 1400m to north of the site.

There is no air quality management area in the vicinity of the site and there are not considered to be any existing odour impacts (eg waste treatment) on these receptors, other than potential seasonal agricultural impact.

The odour air quality assessment was undertaken in accordance with IAQM guidance on the assessment of odour for planning (Ver 1.1, 2018).

Air quality odour sampling/olfactory analysis, dispersion modelling or other quantitative assessment strategy was not considered appropriate. Initial review of the location and nature of the operations suggested also low likelihood (risk) of adverse odour effects. The site topography is not considered to discourage dispersal of emissions with a gentle gradient rising from south-east to north west of the immediate environs.

Specifically, the relatively low nuisance typically associated with crematoria odours, indicated that a single qualitative/semi-quantitative predictive assessment tool would suffice in providing sufficient weight of evidence without recourse to a formal modelling or monitoring approach.

The approach involved identifying the components of a source-pathway-receptor model for the development as follows:

- Baseline odour characteristics for the site and environs
- Potential site odour sources, characterised under FIDOL criteria (see section 5)
- Site meteorological characteristics (wind direction primarily) including pathway dispersion and dilution
- Nearest odour-sensitive receptors, characterised in terms of likely sensitivity

The assessment concludes with an evaluation of the overall odour *magnitude* and the likely risk of adverse *impacts* arising. A semi-quantitative scoring/ranking system is utilised for this.

5.0 ODOUR IMPACT ASSESSMENT

5.1 General

Review of the development layout (Site and Building Plans, lodged on planning portal file 20/00830 on 27 November 2020 and 2 December 2020) and process technology (Facultatieve, Technical Information A-C, lodged 2 December 2020) indicates that the main odour emission source will be the cremulator process exhaust emission stack. There will be negligible opportunity for fugitive emissions.

The technology incorporates a range of particulate-phase and vapour-phase abatement technologies for specific pollutants potentially present in either or both phases. The plant includes a range of temperature, oxygen and flue gas monitoring sensors and controls in support of this.

The client anticipates an average daily throughput of 3 cycles per day. The plant is designed to have capacity for a total of 6 cycles per day, each of which requires up to approximately 80 minutes to complete.

No specific odour control or mitigation measures have been identified as warranted by the client at this stage. Process Guidance PG5/2 (Crematoria) does not consider odour management plans or monitoring programmes as appropriate requirement for routine operation except as part of a mitigating response in the event of complaints arising.

5.2. Potential odour sources (existing and proposed)

There are not considered to be any significant potential existing odour sources associated with the existing site or environs.

It is understood that the site and local community otherwise has no particular known history of odour or more generally air quality complaints whether informally/anecdotally, or whether formally logged. From cursory review of the extensive range of responses in the Angus Council Planning Portal to the application it does not appear as if odour is a pertinent concern of the community.

There are no commercial receptors within 1000m, except for one hotel, and the nearest residential receptors are located in areas bounded by agricultural land-use activities. As such the pre-existing odour profile of the environs is not considered to be pristine: occasional odour impacts associated with application of manures, slurries, silage effluent etc must be expected. It is concluded that an odour-free environment cannot be reasonably considered a high-priority element of the overall area amenity.

It should be noted that crematoria did attract some small measure of notoriety for emissions to atmosphere in the 1980s and 1990s prior to widespread upgrade in abatement technologies following the 1990 Environmental Protection Act. Much of this also related to complaints of visible smoke rather than odour, or which exacerbated perceived odour impacts.

5.3 Odour Assessment

For the purposes of odour assessments, odours are typically described in terms of " FIDOL" factors (see Table 1).

Table 1. Description of the FIDOL Factors (reproduced from IAQM Odour Guidance, 2018)

Frequency	How often an individual is exposed to odour
Intensity	The individual's perception of the strength of the odour
Duration	The overall duration that individuals are exposed to an odour over time.
Odour unpleasantness	Odour unpleasantness describes the character of an odour as it relates to the 'hedonic tone' (which may be pleasant, neutral or unpleasant) at a given odour concentration/ intensity. This can be measured in the laboratory as the hedonic tone, and when measured by the standard method and expressed on a standard nine-point scale it is termed the hedonic score.
Location	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The 'Location' factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

This assessment evaluates the odour impact on the residential receptors located at locations A & B (see Figure 4)

5.3.1 Frequency

In terms of frequency of exposure, it is noted that the cremation process requires approximately 80 minutes per cycle. It is considered unreasonable to assume consistent odour emission for all parts of the cremation cycle. Additionally, while the facility has capacity for 6 cycles per day, the developer is assuming a typical average throughput of 3 cycles per day. Full production can be expected to be a relatively rare occurrence therefore

Additionally, given the distance to nearest receptors, the impact frequency will be majorly impacted by dispersion and dilution of odours.

This assessment did not incorporate site-specific meteorological data. Nevertheless, prevailing wind directions for the site are assumed to be south to south-west, which can be expected to disperse any odour emissions for a significant proportion of the time in the direction of the nearest residential receptors in the immediate proximity (A, B)

5.3.2 Intensity

In terms of intensity, it is noted that the nearest receptors are located at distance 197-213m from the stack source. As such, dispersal and dilution of the odour concentration before reaching ground-level at the receptor will be very significant under nearly all meteorological conditions.

Air quality modelling (see report P8346.01 Table 4, page 15) suggests that likely worst-case distance downwind from the emission point will be approximately 100m. The distance to the three closest receptors is such that - when downwind - the average long-term ground-level air quality concentrations (of both particulate and vapour-phase pollutants) will typically be approximately 60% of the worst-case downwind location identified.

5.3.3 Duration

In terms of duration of exposure, any potential loss of amenity associated with odour will occur for at most 28.5% of the week (6 days per week at 8 hours per day) and will not occur outwith working hours. On the basis of the discussion regarding frequency factor, this factor is assumed to be further reduced for the majority of the time that the plant is not operating at capacity. On the basis of the above discussion the duration parameter is classed as potentially *low-to-medium.*

5.3.4 Odour Unpleasantness

In terms of odour unpleasantness, SEPA 2010 Guidance provides a summary of industrial processes in three categories of odour unpleasantness. This is reproduced at our Table 2 below.

Table 2. Relative offensiveness of industrial process odours (Reproduced from Table 2, SEPA Guidance on Odour, 2010)

Relative offensiveness of odour	Indicative criterion of significant pollution[note 2]
More offensive odours: Activities involving putrescible wastes Processes involving animal or fish remains Brickworks Creamery Fat & Grease Processing Waste water treatment Oil refining Livestock feed Factory	1.5 OU_E/m^3 (1.0 OUE $/m^3$)[note 3]
Odours which do not obviously fall within a high or low category: Intensive Livestock rearing Fat Frying (food processing) Sugar Beet Processing	3 OU_E/m^3 (2.5 OUE $/m^3$)[note 3]
Less offensive odours (but not inoffensive): Chocolate Manufacture Brewery Confectionary Fragrance and Flavourings Coffee Roasting Bakery	6 OU_E/m^3 (5.5 OUE $/m^3$)[note 3]

Note 1: Reference: EA H4 Guidance Appendix 6.
Note 2: Odour Units (OUE) as 98th percentile of hourly averages.
Note 3: Local adjustment for hypersensitive populations (odour generated a high level of complaint) - Reference: EA H4 Guidance Appendix 6.

Reference to this guidance would suggest that this odorous process would be reasonably classed in the *medium* category on the basis that while the inherent objective offensiveness of the odour is low, there can be an understandable subjective unpleasantness associated with the knowledge of the odour origins.

No potential cumulative odour effects are anticipated to arise associated with other similar odour sources in the vicinity.

A simple scoring system is used in this assessment to try and semi-quantitatively take into account all the "FIDO" factors incorporated above. This provides a range from 1 (low) to 5 (high) of scoring options for each factor, which are therefore given similar relative weightings. This is shown in Table 3.

Table 3. Scoring

Factor	Score	Main considerations
Frequency	2	Daytime operations only further offset by distance to receptors/meteorological dispersion benefits
Intensity	2	Distance to receptors/meteorological dispersion benefits; prevailing wind direction; relatively low distinctiveness of odour type
Duration	2	Daytime operations, occasionally constant, offset by distance to receptors/meteorological dispersion benefits
Offensiveness	2	Medium category

An overall average score of 2 is obtained by this means. IAQM Guidance (2018) suggests that the overall odour impact obtained in this manner can be described along a spectrum as follows:

1- Negligible
2 - Small
3 - Medium
4 - Large
5 - Very Large

As such the impact can be concluded to be *Small*.

The fifth "FIDOL" factor (location) is discussed in section 5.4.

5.4. Odour-sensitive receptors

The nearest receptors are considered to be primarily residential. There are estimated at 1 dwelling within 200m and two just outwith 200m of the proposed emission source location, predominantly in prevailing downwind direction (north to east quadrants). No receptors within 1000m are considered to have specific odour sensitivities. Odour impacts outwith 200m radius are considered highly unlikely.

IAQM Guidance (IAQM, 2018) provides a summary criteria for evaluating receptor sensitivity (reproduced at Table 4) which would indicate that the receptor should be classed as "high-sensitivity".

Table 4. Receptor sensitivity to odours (Reproduced from IAQM Guidance, London 2018)

High sensitivity receptor	Surrounding land where: • users can reasonably expect enjoyment of a high level of amenity; and • people would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium sensitivity receptor	Surrounding land where: • users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or • people wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Low sensitivity receptor	Surrounding land where: • the enjoyment of amenity would not reasonably be expected; or • there is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial use, farms, footpaths and roads.

5.5 Odour Impact Assessment: Summary

it is concluded that the Relative Odour Exposure (Impact) is *Small* and the Receptor Sensitivity is *High.*

IAQM Guidance (Table 3) provides a means for combining these two aggregated factors to give the final *magnitude* of the odour effect. This is reproduced in Table 5 below.

Table 5. IAQM suggested descriptors for magnitudes of odour effects (Reproduced from IAQM 2018 Guidance)

		Receptor Sensitivity		
		Low	**Medium**	**High**
Relative Odour Exposure (Impact)	**Very Large**	Moderate adverse	Substantial adverse	Substantial adverse
	Large	Slight adverse	Moderate adverse	Substantial adverse
	Medium	Negligible	Slight adverse	Moderate adverse
	Small	Negligible	Negligible	Slight adverse
	Negligible	Negligible	Negligible	Negligible

This would suggest a "slight adverse" impact magnitude. The IAQM guidance suggests that a magnitude greater than "slight adverse" should be considered *significant,* and where odour effects are initially assessed as *significant*, details of appropriate further mitigation and control measures should be developed that could allow the proposal to proceed without causing significant loss of amenity.

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 It is concluded that the aggregated odour impact for worst-case constant operation of the facility (6 cycles per day) is small and the receptor sensitivity is high, resulting in an overall *slight adverse* impact magnitude.

6.2 This is considered insufficiently *significant* to warrant recommendation of further pro-active mitigation and control measures within this design and planning phase.

PROPOSED CREMATORIUM

BURNSIDE OF DUNTRUNE, BY DUNDEE, ANGUS

Rev A MARCH 2020

PLANNING DESIGN & ACCESS STATEMENT

@rchitects
Chartered Architects

LOCATION

The site is located to the south of Angus, north of Dundee and to the east of the A90. It is provided with good transport links to the surrounding area and beyond via both the A90, to the west and the B978 (Kellas Road) to the south and east. The A90 provides trunk road links to the north through Angus and beyond. To the south it connects to Dundee, Perth and the M90. The site also readily connected to the A92 providing link up the east coast of Angus and beyond. The site is discreetly located and is well suited to the nature of this type of use.

This type of development is not suitably located within existing settlements or development boundaries for two main reasons. Firstly the requirements of the Crematorium Act which I have covered. This requires a site of around 2 acres (preferably with space for possible future expansions of the landscape / memorial use). The site also needs to allow the crematorium not to be built closer than 200 yard from a dwelling house and no closer than 50 yards from a public highway (considerable distances). Both of which criteria the current proposals just meet. It also says a suitable site should preferably already benefits from existing landscaping such as mature trees, hedgerows and advantageous to benefit from pleasant views. A crematoria needs an appropriate and sensitive setting in relation to its use. Due to these requirements this use is not suited to available sites (brownfield or greenfield) within the existing development boundaries of the existing settlements, as such and in accordance with Policy DS1 there are no suitable and available brownfield sites capable of accommodating the proposed development. This type of land use was historically located on the rural edges of settlements and the only other crematoria in Angus is located in a likewise rural location. Secondly the proposed crematorium is strategically located in south Angus in relation to the surrounding settlements The surrounding area has a population of approximately 265,529 people with about 20% of these aged 65 or over. The dispersed settlement characteristics of this area of Angus and good access makes this site a logical choice.

SITE

Site History

Currently the site is covered with rough grassland but is not being farmed regularly due to its relative low quality and difficult terrain for modern farming practices. Through checking of the Macaulay Land Capability for Agriculture (LCA) classification it has been demonstrated that any development of the site would not constitute a loss of prime agricultural land.

The site measures 1.98 hectares (Red Line) and the total area of ground owned by the applicants (Blue Line) measures 4.51 hectares.

The ground slopes from north west to south east and the site is bounded to the south by the public road. The north west and east of the site is walled with a dry-stone wall with an established woodland beyond. The remaining area of ground in the client's ownership will be brought into appropriate management as part of these proposals.

Access to the site is to be gained from the adjacent road running along the south side of the site.

DESCRIPTION OF PROPOSALS

The crematorium building is designed to face directly towards the entrance with the ground rising gently towards the access. The floor area of the crematorium is 496 sq. m. and in terms of the building, its size and general arrangement are dictated by its function. The entrance and reception hall are to the front (east) with the main hall directly behind. The cremator and servicing are then to the rear (west) of the building. To the north are the offices with the public exit point to the south where there are the most views from the site.

The position of the building nestles within the general fall of the site. This combined with the surrounding landscape, trees etc. screen the proposals completely from the west round to the east. Viewing from the adjacent road is screened by a new dry-stone wall and hedge / tree planning. The site is further screened by the mature trees to the south of the road. Additional native tree planting is incorporated into the proposals particularly to the east, screening the proposals further from this angle and further enhancing the sense of enclosure.

The position of the crematorium building within the site has been carefully chosen, so that it nestles within a natural landscape. Its location within the site will mean that it is not visible from the west, north or east and is barely visible from the south. Views from the south will be from distant vantage points and will be mostly obscured by trees along public roads.

The principal view into the site will be when passing on the adjacent road along the south side of the site, which will be glimpse views through the proposed planting and screened by a new drystone wall and hedging.

There are only three dwellings within 300m of the crematorium building. With the nearest dwelling some 183 metres away and the intervening mature woodland means that the site will not be directly visible from any dwelling houses or the surrounding areas. The site entrance itself includes a feature stone entrance wall, and gates, which will be locked when the crematorium is closed.

The crematorium building is rectangular in shape with a predominantly natural slate roof and clad elevations. The size, shape and layout of the crematorium building is largely dictated by its function with the reception area to the front of the building, the main hall within the middle part of the building and cremator area to the rear of the building. The administrative areas are to the north giving control over and access to the public areas as well as the service access and cremator area. The stack is on the rear roof section and projects above the roof level minimally.

The site will incorporate an internal one-way road, parts of which can be used as overspill parking when there is a large service. There will be 127 car parking spaces, 7 of which will be for disabled drivers, and there will be space coaches to pull up and wait. A planted garden and memorial garden will be located to the front and south of the crematorium building incorporating grassed areas, memorials and flower/shrub beds. Staff car parking including electric vehicle charging will be located to the rear of the crematorium building as will the service area and accessed along with the service area to the north of the building. A simple agricultural stob and wire fence will define the northerly perimeter of the crematorium site and the applicants intend to undertake some additional native tree planting out with the site, but still within land in their ownership.

Services will take place primarily during the week (between 9am to 5pm), however there may be some services on a Saturday. From figures obtained from the intended operator It is unlikely that there will be any more than 4 services per day, however it is likely that the average will be 3 services per day. By the purpose of its use the crematorium can be considered a community facility that will satisfy an established demand in the area.

The proposed crematorium is strategically located in relation to the surrounding settlements. The surrounding area has a population of approximately 265,529 people with about 20% of these aged 65 or over. This type of land use was historically located on the rural edges of major settlements. Due to the nature of its use it is obviously not suited to residential, commercial or employment areas and this combined with the dispersed settlement characteristics of this area of Angus and good access makes this site a logical choice. These proposals are well served by the existing road infrastructure and a proposed crematorium in this location will reduce journey times compared to the existing alternatives.

The proposals make best use of the existing landforms, walls, trees and woodland. Maintaining the privacy of both the users and the nearby neighbours. The high-quality design and scale of the proposals fit well with the landscape and will not have any significant impact on surrounding properties or existing land uses. The development of the crematorium will not affect the viability or vitality of the existing villages or town centres and to the contrary has the potential to benefit some of the established businesses in the area.

DESIGN PROPOSALS

Site Context

Rural and Agricultural Context

Buildings and structures in the area of Burnside of Duntrune and the wider context of Angus have historically used a mixture of natural stone and timber materials sourced locally from quarries and locally grown timber. The roofs are generally finished using either stone and slate tiles, with some old corrugated roof materials. Modern agricultural developments however utilise a mixture of quick build products mainly of steel structures with corrugated metal and timber panels. This area, like most of rural Angus shows this palette of materials along with simple traditional building forms. The local boundaries to the fields and properties are traditionally made of local field stone and sandstones, either mortared or more commonly as dry-stone walling, more recently stob and wire fencing has been used. Trees planting to edges with pockets of woods are also common providing shelter for both crops and wildlife against the prevailing winds.

Site Strategy

- Shelter from prevailing winds by the existing wood: building siting to utilise natural defence and nestle into the landscape.
- Use existing strong boundary enclosure: use woodland and wall enclosure to reduce impact of building.
- Main views to south: building position to take advantage of these while keeping its visual impact low.
- Sloping site: use logical floor level to maintain views and minimise site impact/parking impact and allow for a natural run of drainage. Use the site to help with the processional arrival. Visually separation from the public areas of the service access.
- Desire lines and geometry: maximise approach aspect to the building by approach leading to main elevation when turning into the site. Use aspect towards views to generate circulation routes.

Concept and Precedence

The main concept is to create a modern crematorium which reflects the traditional simple agricultural forms that are typical of this area of Angus. The form will be softened in the landscape through the use of form, large overhanging roof and the use of traditionally referenced materials expressed with an appropriate high-quality to the public areas. Cladding, Slate roof and glulam timber frame.

Design

The design of the internal roads and in particular the route to the entrance canopy has been developed to satisfy the ceremonial needs of the congregation. The landscaping design is a very important part of the crematorium and it will serve three essential functions:

- it will provide a calm, contemplative, beautiful environment as a setting for the crematorium building.
- it will provide a focus on the natural environment within and beyond the site.
- it will provide a context for the crematorium building.

Public toilets are provided close to the entrance and disabled visitors have easy access. The main hall is light and airy and affords views from the site. The administration space and cremator equipment is housed to the rear of the building together with the filtration plant.

The stack is discretely located towards the rear of the crematorium building and protrudes only 1.25 metres above the ridge of the roof. Technical information on emissions and the cremator itself have been submitted as separate documents in support of the proposal.

Foul and surface water drainage will be dealt with by way of treatment plant and soakaway. A separate Drainage Proposal Report has been submitted in support of the proposal.

Heating for the crematorium building will be provided predominantly by waste heat recovery, with any shortfall made up by a boiler running on gas.

Ground Floor Plan

East Elevation

Materials

Walls - Grey Cladding

Frame - Timber Glulam

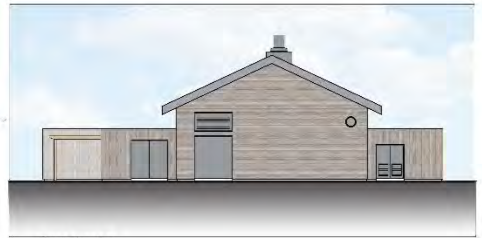
Roof - Main Roof Slate with Grey Aluminium Perimeter

Flat Roof - Grey Single Ply Membrane

Windows/Doors - Grey Aluclad Windows

North Elevation

South Elevation



West Elevation

Access and Transport:

These proposals are very well served by the existing road infrastructure and a proposed crematorium in this location will reduce journey times compared to the existing alternatives. The roads department has no objection to the proposals. While there is currently no bus passing the access to the site there are local bus services running past both end of the road servicing the proposals and the design incorporates facilities to allow buses to access the facilities which may be hired privately.

Due to the nature and type of the proposed crematorium journeys are made by private car or occasionally by private hire bus. A cremation is attended by family and friends and this combined with the emotional nature of such an activity public transport is not used. Car sharing is however very high and tends to be arranged by the family and friends directly. As such this type of proposals do not demand or justify the need for public transport links, in accordance with Policy DS2. This is also influenced by the location requirements discussed previously. The transport assessment previously agreed also reflects this and adequate parking provision has been included accordingly.

While each council obviously has differing local plans, these are generally in line with the relevant national policies and where relevant TAYplan. Within the last few years similar crematoria have been approved in both Fife and Aberdeenshire in rural locations out with the development boundaries for the exact same reasons as referred to above.

The methodology applied for the TA was agreed with Angus roads department prior to the survey work and the TA carried out. The figures in TA are based on a worst case. Local industry experience suggests an average of approx. 50 attendees per funeral (3 per car). Therefore, based on an average of 3 cremations a day, 6 days a week, this would result in just 300 car journeys per week. These figures also tally with The Federation of Burial and Cremation Authorities figures which estimates that no more than 30 mourners will attend in 50% of cremation services, and only on exceptional occasions does the number exceed eighty. The above figures also do not account for the substantial proportion of unattended cremations.

Unattended cremation figures (Pharos Statistics) 2019 -

Dundee 200 No

Crathes 288 No

Friokheim 8No (This exceptionally low figure would appear to reflect a business model rather than demand).

Using the Dundee figures of 200 No unattended funerals would further reduce anticipated car journeys per week to 236.

The TA provided gives a robust assessment of the surrounding road network and an extensive area of the local road network has been reviewed within the TA given the fact that funerals occur out with what is the peak periods for the surrounding road network. Mitigation has been put in place to counter the additional traffic movements on the surrounding road network by provision of 5No new passing places and by enhancing existing junction visibility by tree/shrub clearing at the unclassified Road/B978 Kellas Road junction. The road will be widened over the site frontage to the width agreed with the Angus Council Traffic Team, improving the road for all users over that which is currently in place.

Public Transport

People travelling to cremations, due to the upsetting nature of the event, generally do not travel by public transport. Due to this people tend to pre-arrange car sharing. Provision has however already been made on site for buses.

Given the nature of the development being a crematorium travel via public transport is not typically a desired means of travel to a funeral. Whilst the distance to walk to a bus stop is above the desired 400m any funeral attended would be making this journey as a one off. It would be expected that for those travelling to a funeral without access to a private car either their own or a lift from a friend or family member would be able to arrange a taxi or a private coach. Funerals also by their nature tend to lend themselves to car sharing for attendees. There is only 4 full time staff associated with the crematorium therefore the impact of the lack of nearby bus services is very small. The nature of a crematorium is that it is required to be situated away from residential developments and therefore it is difficult to locate this where there are good bus services.

National records of Scotland (Angus)

Current Population

On 30 June 2019, the population of Angus was 116,200. 27,790 were aged over 65. Between 1998 and 2019, the population of Angus increased by 5.8% with the 65 to 74 age group seeing the largest percentage increase (+47.5%).

Dundee has a population of nearly 30,000 larger than Angus. However, Angus has a considerably larger proportion of its population aged 65 and over giving it an older age profile.

Population Projections

The average age of the population of Angus is projected to increase as the baby boomer generation ages and the 75 and over age group is projected to see the largest percentage increase (+30.3%).

Deaths

In 2019, there were 1,410 deaths in Angus. This is a 3.1% increase from 1,367 deaths in 2018.

In Angus, the standardised death rate increased from 9.6 per 1,000 population in 2018 to 9.9 in 2019. In comparison, the rate in Scotland overall decreased from 10.8 to 10.6

Cremation Statistics

Year	2016	2017	2018	2019
Dundee	1,708	1,876	1,783	1,765
Friockheim	832	878	864	877
Total	2,540	2,754	2,647	2,642

Nationally in 2019, 26% of crematoria declined a large coffin due to inherent limitations and 60.8 % were holding over bodies for cremation.

Funeral Poverty - Local Demand

Costs and appropriate local competition – The Pharos Statistics 2020 Cremation Fee League Table As at 1st January 2020 show Dundee and Friockhiem as the most expensive crematoria in Scotland at £1050 and the joint highest in the UK out of 291 locations. Crathes, as the next nearest crematorium to the north charges only £795.00 and Perth only £788.00. Cost offering is anticipated to be more in line with the national average rather than the high costs offered in the area currently.

The Competition and Markets Authority (CMA) raised concerns over aspects of the industry including low numbers of crematoria providers in local areas, and difficulty for new companies to enter the market due to the planning regime and high fixed costs. This led to an investigation in 2019.

This in summary confirmed that while the prices of private sector crematoria are often significantly higher than those of crematoria operated by local authorities, the profitability analysis indicates that customers of both private and local authority facilities have been paying too much, with the former overpaying by at least £115 per cremation and potentially as much as £210 on average, while the latter are overpaying by at least £80 per cremation and potentially as much as £170 per cremation on average we consider that the upper end of these ranges is more probable than the lower end.

The issue is so pressing locally that In July 2019 the report 'Funeral Poverty in Dundee' concluded that with regard to crematorium facilities in the area:

Additional crematorium facility: To improve choice for the consumer, Dundee City Council could actively consider the addition of another cremation facility.

The CMA (2019: 89) found the average drive time to the closest crematoria was 34 minutes for the nine most expensive crematoria – almost double the time for the nine least expensive crematoria. In addition, two thirds of these more expensive crematoria had no other crematoria within a 30 minute drive time, compared to just one in nine of the least expensive. This crudely suggests prices can be kept artificially higher where competition is lower.

The CMA report suggests that there are low numbers of crematoria in any given area because only a small number may profitably operate given the fixed demand in a local market. It suggests 800 - 1,000 cremations per year are required to be viable. Given there are approximately 1,800 deaths in Dundee per annum, if the surrounding areas were included, there could be potential for an additional crematorium capacity. This would require Dundee City Council to consider more fully the 'need', liaise within Departments such as the Planning Dept. to assess potential applications, and potentially consider involving itself actively within a development.

The Cremation Act (1902) & The Cremation (Scotland) Regulations 2019

The Cremation (Scotland) Regulations 2019 only deal with how crematoria should be operated and how a cremation should be carried out. While the relevant 1902 act has recently been repealed in Scotland.

The 'Federation of Burial and Cremation Authorities', which is the principal representative of burial and cremation authorities however refers to the 1902 Act in its relevant requirements and goes on to state the following in its guidance:

A minimum of two hectares (approximately five acres) per estimated 1,000 cremations per annum is recommended to provide sufficient space for the crematorium, gardens of remembrance, traffic circulation, parking, and a modest amount of space around the building.

Ideal sites are rarely to be located in urban areas and it is emphasised that suitability of setting is of greater importance than its location in close proximity to population centres.

Site selection should be aimed at achieving quietness and seclusion. A woodland or parkland setting, or an area of undulating ground with good natural features and mature trees, would enable the establishment of a good natural setting with a minimum of horticultural treatment.

Ideal sites are rarely to be located in urban areas and it is emphasised that suitability of setting is of greater importance than its location in close proximity to population centres.

Previously developed land can often prove unsuitable, due to land contamination, which is unacceptable for the interment of ashes, or due to the presence of residential property within 200 yards. There is a growing recognition that new crematoria will be built in a countryside location close to the urban fringe.

The recommendations also separately refer to the 1902 Act directly in terms of its recommendations for proximity to dwellings and public highways.

Section 5 of the Cremation Act 1902 states that: "No crematorium shall be constructed nearer to any dwelling house than two hundred yards, except with the consent, in writing, of the owner, lessee, and occupier of such house, nor within fifty yards of any public highway, nor in the consecrated part of the burial ground of any burial authority.

The Cremation Act (1902)

The Cremation Act (1902) states that a crematorium cannot be built closer than 200 yards from a dwelling house, without the written consent of the owner and occupier. The Act also states that no new crematorium can be built closer than 50 yards from a public highway. A minimum of 2 hectares is normally required for a crematorium and the site needs to be close to a main road. A site which already benefits from existing landscaping such as mature trees, hedgerows is considered most suitable, and ideally the site should be flat or slightly sloping and pleasant views are considered advantageous.

Emissions

All UK crematoria must operate under the Secretary of State's Process Guidance for Crematoria which gives guidance on the ‘Best Available Techniques’ aimed at providing a strong framework for consistent regulation under the statutory Local Air Pollution Prevention and Control (LAPPC) regime in England and Wales, Scotland and Northern Ireland. In Scotland this requires an application to SEPA under Pollution Prevention and Control (Scotland) Regulations 2000; for a permit to operate, which only if satisfactory will be issued. As such it is this legislation that will ultimately asses and regulate the appropriateness of these proposals in terms of Emissions.

This process will ensure the facility operates to the highest possible standards to avoid polluting the atmosphere. SEPA carry out a twice-yearly inspection to ensure that it is operating under the terms of the permit. The crematoria will also operate under the auspices of the Federation of Burial and Cremation Authorities (FBCA) and will also be subject to six monthly inspections by Robert Swanson QPM, the Inspector of Crematoria for Scotland who operates on behalf of the Scottish Government.

With the state-of-the-art equipment used and the additional regulatory requirements placed on crematoria ensure emissions are not an issue. Cremations take place at very high temperatures, above 850 degrees centigrade and as a result there are very low levels of emissions. A tall stack is not required, and the vent is to expel primarily air only. Emissions data has been provided and emissions are regulated and controlled by SEPA under the Pollution Prevention and Control (Scotland) Regulations (2000) (As Amended).

Relevant legislation relating to emissions for this proposal - the Pollution Prevention Control Regulations 2012
The new crematorium will require authorisation from SEPA under 5.1, Part B, (c) of the Pollution Prevention Control Regulations 2012 (PPC) "cremation of human remains". The regulations require the new installation to meet ‘Best Available Techniques’. Including the following:

- The aim should be to prevent any visible airborne and odorous emissions from any part of the process. Emissions from cremations should in normal operation be free from visible smoke.
- All other releases to air, other than condensed water vapour, should be free from persistent visible emissions. All emissions to air should be free from droplets
- All new crematoria to be fitted with mercury abatement.

Planning Position

The site is sustainably located in relation to the relevant population centres, which in turn will significantly reduce journey times for crematorium services, compared to journey times to Friockheim, Dundee or even Perth & Kirkcaldy.

There is only one other crematoria in Angus, one in Dundee one in Perth and approval has been granted for one south of St. Andrews in Fife. It is contended that the location proposed for the crematorium will draw mainly from people located in the south of Angus and the North and East of Dundee is strategically located to serve the settlements and communities. Likewise, its location within the road network means that travelling times / distances are minimal particularly during peak traffic periods and if the weather is poor. A crematorium is not able or suited to be located within an existing settlement, because of the requirements laid down in the Crematoria Act (1902) and also the travelling distances required and difficulties with access. In any event the dispersed settlement characteristic of this part of Angus makes the site a logical choice. The crematorium is considered to be a community facility that will help satisfy the demand in the area to the benefit of the local communities.

A crematorium at Burnside of Duntrune will not on its own, or cumulatively, affect the vitality and viability of town and local centres. It is likely that the crematorium will benefit established businesses in the vicinity, such as hotels, guest houses, food establishments, taxi firms etc. The scale, design and fit of the crematorium within the landscape, will mean that it will have negligible direct or indirect impact on surrounding properties or land uses and due to the topography of the site and existing tree cover, there will either be no views of the crematorium or only very limited views. In any event, the design of the crematorium and the use of materials and landscaping, will mean that it will fit comfortably within the rural environment.

The proposed crematorium will make a positive contribution to the quality of its immediate environment. It will create a community facility with an established sense of place using high quality of built design and landscaping. It will promote, enhance and add to biodiversity, it will include water and energy conservation measures such as waste heat recovery and passive solar gain, it will incorporate appropriate waste recycling, segregation and collection facilities and the applicant will seek to minimise waste by design and during construction.

The crematorium and its setting demonstrate a high standard of architectural design which fits well with the local environment. It makes best use of the prevailing landform, trees, hedgerow s and woodland. The proposal provides both a formal and informal landscape context for the crematorium. Access and parking arrangements are safe, and the design incorporates facilities for coaches and those with disabilities and impaired mobility. The personal privacy and amenity of nearby householders will be maintained.

The accompanying Transport Assessment acknowledges that due to the nature of the crematorium, most journeys will be by private car. However, the local road network has sufficient capacity to accommodate increased car journeys, particularly as they will mostly be made out with peak periods. Sufficient car parking spaces have been made available and any rare unusually large services can be accommodated using overspill parking along the internal road.

It is contended that there is a need for a crematorium to serve this area as demonstrated by demographics and population projections The proposed countryside location is strategically situated to serve all of the surrounding communities equally, and it is considered that the location is both sustainable and of community benefit.

It is considered that local services will benefit from such a land use and the crematorium is very much seen as a community facility which will benefit the local community and provide a local service.

Pre-Application Consultation

Pre-submission enquiries were undertaken with Angus Council to determine whether the principle of a Crematorium on the subject land would be complaint with Planning Plan policy and other material considerations.

From those pre-application enquiries the following has been prior agreed with Angus Council Planning and Roads Services.

- The submitted Transport Assessment is acceptable.
- The application site is not on prime quality agricultural land.

In terms of compatibility with development plan policy, pre-application liaison also recognised that there are matters relating to public transport accessibility and sequential testing of the proposals, both of which required to be addressed through an appropriate application for planning permission.

Planning Policy

Applications for planning permission require to be determined in accordance with national planning policy and the development plan unless material considerations indicate otherwise.

Scottish Planning Policy 2010

Scottish Planning Policy (February 2010) states that the planning system has a significant role in supporting sustainable economic growth in rural areas.

The aim of the planning system should be to enable development in all rural areas, which supports prosperous and sustainable communities whilst protecting and enhancing environmental quality. The strategy for rural development should respond to the specific circumstances in an area whilst reflecting the overarching aim of supporting diversification and growth of the rural economy. Development plans should therefore promote economic activity and diversification in all rural areas and developments that provide employment or community benefits should be encouraged.

All new development should respond to the specific local character of the location, fit in the landscape and seek to achieve high design and environmental standards. Planning authorities should also be realistic about the availability or likely availability of alternatives to access by car as not all locations can be served by public transport (SPP paragraphs 92 to 96).

The Development Plan

The development plan comprises of TAYplan, approved in October 2017, and the Angus Local Development Plan, adopted in September 2016.

TAYplan 2017

Policy 1 of the Approved TAYplan Strategic Development Plan advises that, in adherence with the sequential approach, development should, in the first instance, take place within settlements. However, TAYplan also states that Local Development Plans may also provide for some development in rural areas if it genuinely contributes to the objectives of TAYplan and meets specific local needs or supports regeneration of the local economy.

Angus Local Development Plan 2016

The site is not covered by any specific policies and it is not affected by any local, national or international landscape, environmental, ecological or geological designations. The proposed crematorium therefore requires to be considered against more general, but relevant, policies contained within the Local Plan.

Policy DS1 Development Boundaries and Priorities states that all proposals will be expected to support the delivery of the Development Strategy, which put very simply promotes the re-use of brownfield sites within settlement boundaries over greenfield sites out with settlement boundaries.

Whilst it has been suitably demonstrated that the site is not on prime quality agricultural land, it is also however recognised that it is a greenfield site within a rural location. However, there are various layers to Policy DS1 that have to be recognised and assessed as not all scenarios can be anticipated through the Development Plan.

Specifically out with development boundaries, proposals will be supported where they are of a scale and nature appropriate to their location and where they are in accordance with other relevant policies. Development on unallocated greenfield sites, such as the subject land, can therefore be supported where there are no suitable and available brownfield sites capable of accommodating the proposed use within a settlement boundary.

In terms of carrying out an exercise to identify any possible alternative brownfield locations within settlements that are capable of accommodating the proposed use, it is material to note that there are no new crematorium sites identified / allocated within the Angus Local Development Plan. Most notably, Policy TC9 safeguards land for cemetery use at various locations throughout Angus, but no sites are identified for additional crematorium uses.

In terms of other possible sites, i.e. that are identified within the ALDP, Policy DS1 is very clear that sites allocated for specific uses, i.e. housing, employment, open space, etc will be safeguarded for the uses as set out within the plan. The reason for this policy is to ensure the maintenance of effective housing and employment land supply and for these sites not to be taken for other uses.

To therefore satisfy the exercise of proving that there are no alternative sites for crematorium uses within settlement boundaries, a survey therefore requires to identify a possible site within a South Angus settlement boundary, i.e. Carnoustie & Barry, Monifieth and other small settlements as follows:

- Is not allocated for any other uses.
- Is technically deliverable, i.e. access, infrastructure, etc.
- Has a willing landowner.
- Has a minimum area of 2 hectares.
- Is not closer than 50 yards to a public highway yet close to a main road.
- And is not closer than 200 yards to an existing dwelling house.

Additionally, it is preferable that the site benefits from existing landscape features such as mature trees, hedgerows, and is flat or slightly sloping, i.e. not only has the site to be appropriate in all other aspects of deliverability and availability, it is also appropriate in planning terms.

In terms of accessibility, it is acknowledged that a crematorium bears similarities with non-residential institution uses, which, among other things, include community and cultural facilities that attract significant numbers of people. The development plan applies a town centre first policy for proposals for this type of use and, for a building of the proposed size, the applicant may be required to submit relevant assessments (including retail / town centre impact, transport and sequential assessments) where it is considered that the proposal may have a significant impact on the vibrancy, vitality and viability of any of the town centres in Angus.

In the case of this application, clearly retail and town centre impact assessments are not applicable / required; however Transport and Sequential Assessments are acknowledged requirements.

The Transport Assessment was prior submitted and agreed with the Councils Roads Service. It is submitted again as part of the application pack.

Regarding the requirement for a sequential test, as set out above, key information required includes details on any alternative sites considered and the reasons for discounting these sites. The reasons can include operational and amenity considerations, but the link between these reasons and the site selection must be clearly demonstrated.

The most relevant information base for such a sequential test lies within the housing and employment land audits, both prepared by Angus Council; and from any further surveys carried out by the applicant.

Sequential Test

The following therefore seeks to demonstrate that the site is the most sequentially preferable location for the proposed development; with no other brownfield opportunities within any of the South Angus settlements available, suitable and viable to accommodate the proposals.

Angus Employment Land Audit 2019

Monifieth: No suitable sites, either greenfield or brownfield are identified.

Carnoustie & Barry: The audit identifies land at 3 locations.

- **Carlogie:** 15.00 ha of identified employment land with infrastructure constraints identified. This is a greenfield site, therefore it is not a reasonable alternative location to the application site.

- **Pitskelly:** 10.00 ha of identified employment land with infrastructure constraints identified. This is a greenfield site, therefore it is not a reasonable alternative location to the application site.

- **Panmure Industrial Estate:** 3 small and physically separate brownfield sites of 0.08; 0.09; and 0.22 ha are identified and classed as brownfield. All are listed as constrained as not currently being marketed. Notably, the Panmure Industrial Estate, including the above 3 sites, is all within 200 yards of existing dwelling houses.

Angus Housing Land Audit 2020

Monifieth: The audit identifies 5 sites / locations, all of which are either too small, within proximity of residential properties or greenfield sites.

- **Milton Mill:** 1.20 ha brownfield site currently under construction.
- **Former Seaview PS:** 0.88 ha brownfield site currently under construction.
- **Victoria Street West:** 16.30 ha greenfield site currently under construction.
- **Former Panmure Hotel:** 0.38 ha brownfield site currently under construction.
- **Panmure Church:** 0.12 ha brownfield site currently under construction.

Carnoustie & Barry: The audit identifies 5 sites / locations, 4 of which are noted as constrained; all of which are either too small, within proximity of residential properties or greenfield.

- **Land at Pitskelly**: 9.76 ha greenfield site.
- **Former Social Club, Barry Road**: 1.00 ha constrained brownfield site.
- **Greenlaw Hill:** 1.70 ha constrained brownfield site.
- **Woodside / Pitskelly:** 2.50 ha constrained brownfield site within 200 yards of existing residential properties.
- **Panmure Industrial Estate:** 3.70 ha constrained brownfield site within 200 yards of existing residential properties.

South Angus HMA Landward: There are no suitable sites within the remainder of the South Angus Housing Market Area identified within the Audit due to matters of size, location, deliverability, status and proximity to existing residential properties.

Other Potential Brownfield Opportunities identified by the applicant, i.e. not identified within either the Employment or Housing Land Audits

The South Angus HMA consists of the main settlements of Carnoustie & Barry and Monifieth. Within the Landward area, Newtyle is identified as a rural service centre and there are various other small settlements that have village boundaries such as Newbigging, Monikie, Wellbank, etc.

The ALDP recognises, in relation to brownfield opportunities in Carnoustie, that whilst the plan supports the development of vacant, underused and brownfield sites within the defined settlement boundary, the availability of brownfield land and property is extremely limited and sizeable opportunities are more or less restricted to those identified in the above audits. This is primarily due to past developments at the former driving range, the former Maltings and the site of the former Kinloch Primary School. Our own survey of potential brownfield sites has therefore failed to identify any brownfield opportunity sites of at least 2 ha and at least 200 yards from existing residential properties.

At **Monifieth**, the ALDP also supports the development of vacant, underused and brownfield sites within the defined settlement boundary, however the supply has again been extremely limited to the sites identified in the above audits. Recent re-development opportunities including Ashludie Hospital and Milton Mill have taken up any potentially significant supply and again our own survey of potential brownfield sites has therefore failed to identify any brownfield opportunity sites of at least 2 ha and at least 200 yards from existing residential properties.

Similar to the conclusions from the above audits, from our survey, there are also no suitable sites within any of the small settlements boundaries identified within the **Landward** South Angus Housing Market Area which could deliver a brownfield opportunity site of at least 2 ha and is at least 200 yards from existing residential properties.

In accordance with the requirements of ALDP Policy DS1, it has therefore been suitably demonstrated that potential brownfield sites within South Angus settlement boundaries have been researched and there are no sites available or suitable within a development boundary that would re-use or make better use of vacant, derelict or under-used brownfield land or buildings.

In summary, there are therefore no sites of sufficient size within any of the South Angus Housing market Area settlement boundaries of sufficient size to meet the requirements of the proposal, or have the necessary profile required in terms of relationship to existing residential properties, residential amenity, etc.

Notwithstanding the clearly demonstrated lack of brownfield opportunity sites within identified settlement boundaries, it remains the applicants view that a land use such as a crematorium is not well suited to an urban area and the dispersed settlement / rural characteristics of this part of South Angus makes the site a logical choice.

Accessibility

The site is centrally located within the South Angus Area, directly accessible to its target catchment area and therefore sustainably located. When compared to current Crematorium locations, the location of the site will therefore provide important savings on journey times and journey miles.

Policy DS2 Accessible Development of the ALDP requires development proposals to demonstrate, according to scale, type and location, that they are or can be made accessible to existing or proposed public transport networks.

Due to its rural location and the type of proposal there is clearly little scope / reason to provide public transport infrastructure when the proposal is not on a direct bus route. There is however potential for people to travel to the site by private bus and the site layout is designed to have adequate space for buses.

Potential bus lay-bys could be accommodated in close proximity to the site although as there is currently no direct bus route, or indeed any known commercial plans to divert services past the site, this would merely result in redundant hard standings at the site entrance and require the removal of additional trees and hedgerows, to no good effect. As one of the matters raised by the Planning Department in pre-application dialogue was to minimise the impact on trees at the site entrance, the site access has therefore been designed without significant hard standings for unscheduled bus stops.

As also noted above, SPP states that planning authorities should be realistic about the availability or likely availability of alternatives to access by car as not all locations can be served by public transport. It is respectfully suggested that this is the case with this proposal.

Finally, it is contended that the South Angus location proposed for the crematorium is strategically located to serve the principal settlements and communities. Likewise, its location within the strategic and local road network means that travelling distances are minimal. A crematorium on the subject land is therefore preferable to a site within a South Angus settlement location.

Conclusion

The provision of a crematorium at Burnside of Duntrune will provide a significant benefit to the local community and it has been demonstrated that, there is a need for a countryside location and there is no loss of prime agricultural ground. The site is accessible and sustainably located and has been carefully chosen in relation to the surrounding local population centres. The location of the site does not offend the development plan policy or Scottish Government policy. In fact, it provides an appropriate land use which will be of direct and indirect benefit to the local community. There are no technical impediments to the proposal, and it will have no detrimental impact on the closest residential properties, of which there are few. The crematorium building and associated landscaping will enhance the landscape character and biodiversity of the area. The crematorium building includes sustainable construction methods, use of materials and high standards of energy conservation and efficiency.

AC29

Ecology and Protected Species Report

Plot of Land
Burnside of Duntrune.
Dundee
DD4 0PJ

May 2021

Figure 1. Site Plan.

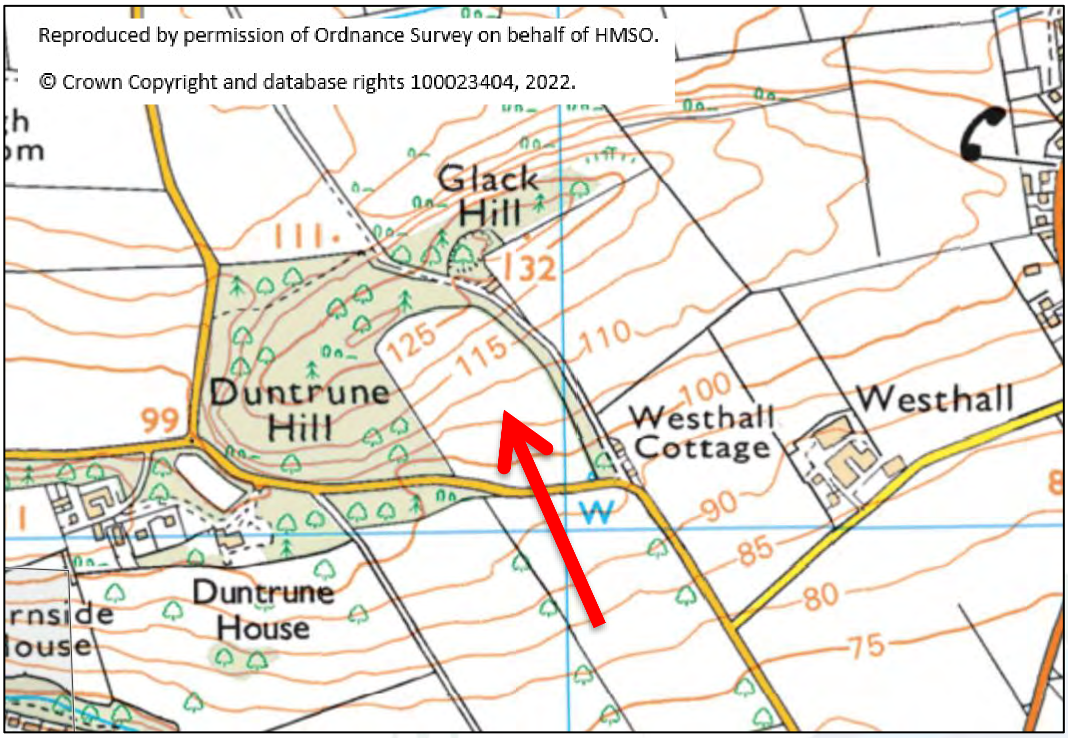


Figure 2. Site Location

Introduction

1.1 Licensed bat worker and ecologist Dr Garry Mortimer was commissioned in April 2021 by to carry out an ecology and protected species assessment on a small plot of land at Burnside of Duntrune, Dundee DD4 OPJ (Figures 1 & 2). This survey is as required by Council in regards to a potential planning application.

1.2 This report has been undertaken in accordance with the 'Guidelines for Ecological Impact Assessment in the UK' (Chartered Institute of Ecology and Environmental Management (CIEEM), 2018).

1.3 This report identifies approaches likely to be required, subject to formal consultation with Scottish Natural Heritage, Local Planning Authorities and other relevant parties.

1.4 Legislative context

A number of sites, habitats and species are protected under European and UK legislation, and may present constraints to site development.

Principal legislation and guidance which will be considered are:

- Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the Habitats Directive) 1992;
- Conservation (Natural Habitat &c.) Regulations 1994 (as amended);
- The Wildlife and Countryside Act 1981 (as amended);
- The Nature Conservation (Scotland) Act 2004;
- Protection of Badgers Act 1992;

1.5 Species that are protected include bats, badgers, otters, water voles, red squirrels and great crested newts. Protected sites and habitats include Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA) and Special Areas of Conservation (SAC).

1.6 Badgers

Both badgers and their setts are protected by law. The Protection of Badgers Act 1992 (Scottish Version) brings together all of the previous legislation specific to badgers (except their inclusion on Schedule 6 of the 1981 Wildlife and Countryside Act as amended Nature Conservation (Scotland) Act 2004). As a result it is an offence to:

- Willfully kill, injure, possess or cruelly ill-treat a badger, or attempt to do so;
- To intentionally or recklessly interfere with a sett;
- To disturb a badger when it is occupying a sett;
- Damage or destroy a sett;
- To obstruct access to, or any entrance of a badger sett.

A badger sett is defined in the legislation as '*any structure or place, which displays signs indicating current use by a badger*'. *'Current use*' does not simply mean 'current occupation' and for licensing purposes it is defined as *'any sett within an occupied badger territory regardless of when it may have last been used'*. A sett therefore, in an occupied territory, is classified as in current use even if it is only used seasonally or occasionally by badgers, and is afforded the same protection in law.

Site Description

1.7 The site at Burnside of Duntrune comprises a small field set in a rural area north of Dundee (Figures 1 & 2). Adjacent, to the west of site is Duntrune Hill, a mature deciduous/mixed woodland and to the south is a minor road. The field is rough grassland, no trees, buildings or water are present within the field (Figures 3-4).

Figure 3. Grass field looking north.

Figure 4. Grass land with woodland around western edge.

METHODOLOGY

1.8 Data Study

A data search was done with SNH Site Link to identify any designated ecological sites along the route.

1.9 Field Survey

Field surveys were carried out in April 2021 in good weather conditions.

RESULTS

1.10 Ecological Sites within 2km of Site

Ecological feature	Zone of impact from site boundary	Sites
Internationally designated sites (SPA, Ramsar)	Within 2km	None
Nationally designated sites (SSSI, NNR)	Within 1km	None
Locally designated sites (LNR, WS)	Within 1km	None

PROTECTED SPECIES

1.11 Birds

Generally, ornithological surveys or desktop surveys are required to assess potential impacts of birds throughout the year, which could arise due to:

- Potential loss, fragmentation and degradation of bird habitats arising from the construction of the water mains route.

1.12 Given the homogenous habitat of a rough grass fields and lack of suitable breeding habitat it is considered that the proposed construction would have a negligible significance of impact on any breeding species likely to be present.

1.13 Species present in nearby woodland and hedgerows would include common passerines that are recorded locally as common residents or summer visitors whose populations are not threatened and are in favourable conservation status in Scotland. None would be specially protected.

1.14 Mitigation

No mitigation needed.

1.15 Protected Mammals

No suitable habitat exists on site in the footprint for otter, bats, great crested newt or any other European Protected Species.

1.16 Results

No signs of any EPS were recorded.

1.17 Mitigation

No mitigation needed.

1.18 Badgers

No signs of badger were recorded, however they are known to be widespread in the general area. It would be expected that they traverse across site occasionally.

1.19 Mitigation

If a badger sett is found within a 30m corridor of the construction footprint when work commences then suspend work in the immediate area and contact an Ecological Consultant to assess the situation.

DISCUSSION

1.20 The purpose of this survey was to gain an understanding of the potential ecological issues that may arise during any development at the site. The survey comprised a walkover of the site to evaluate the likely presence of protected species and or habitats. Specific searching was carried out for these protected species and an evaluation of the potential habitat.

1.21 The construction footprint area is a grazing field with no trees, buildings or water present.

1.22 The site was surveyed for signs of protected mammals, European Protected Species and bats following recognised methodology. No signs were recorded of any protected species.

1.23 No nationally or internationally protected habitats were identified in the assessment.

CONCLUSION

1.24 The site at Burnside of Duntrune is considered poor from an ecology viewpoint.

1.25 It is considered that no protected species or habitats are present on site.

1.26 Badgers are widespread in the general area and if new setts are found within a 30m zone of the construction footprint when work commences then workforce will need to contact GLM Ecology or an Ecological Consultant to assess the situation.

1.27 In my professional opinion the proposed construction work would have no adverse impact on any protected species or habitats and that no further survey work is required.

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DISCLAIMER

This report has been prepared by Dr Garry Mortimer of GLM Ecology, with all reasonable skill and care within the terms of the agreement with the client. Dr Mortimer disclaims any responsibility to any parties in respect of matters outside this scope.

Best efforts were made to meet the objectives of this study through desktop study and field survey.

Information supplied by the client or any other parties and used in this report is assumed to be correct and GLM Ecology accepts no responsibility for inaccuracies in the data supplied.

It should be noted, that whilst every endeavour is made to meet the client's brief, no site investigation can guarantee absolute assessment or prediction of the natural environment. Numerous species are extremely mobile or only evident at certain times of year and habitats are subject to seasonal and temporal change.

GLM Ecology accepts no responsibility to third parties who duplicate, use, or disclose this report in whole or in part. Such third parties rely upon this report at their own risk.

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FS 547812 EMS 563106 OHS 563107

TECHNICAL REPORT P8346.01

ASSESSMENT OF AIR QUALITY IMPACT: Proposed Cremation Facility, Duntrune

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MARCH 2021

DOCUMENT VERIFICATION

Project Title	P8346 Duntrune Air Quality	**Project Number**	
		P8346	
Document Title	P8346.01 Air Quality Impact Assessment	**Date of Assessment**	**Date of Report Issue**
		March 2021	6 April 2021

Revision	Date Written	Filename	P8346.01 Air Quality Impact Assessment	
2.0	6/04/21	Description	Version 2	
			Prepared By	Reviewed By
		Name	B Gardner	Scott Carlin
		Signature	[redacted]	

Revision	Date Written	Filename	P8346.01 Air Quality Impact Assessment	
3.0	5/07/21	Description	Version 3: incorporating changes at section 5.2 and new section 5.4 in response to SEPA comments	
			Prepared By	Reviewed By
		Name	B Gardner	Scott Carlin
		Signature	[redacted]	

EXECUTIVE SUMMARY

An assessment of the likely impact of air quality on residential receptors around the proposed site of the client's crematorium development at Duntrune has been undertaken.

A simple screening air quality assessment was used, utilising emission limit values for the process, along with typical efflux volume flows. A worst-case ADMS dispersion model was run assuming constant uni-directional wind direction, and modelling of ground level concentrations of NO_2, carbon monoxide, PM_{10} and mercury directly downwind of the source across a range of distances (0-250m) including those typical of the direct line-of-sight distance to the nearest three residential receptors (~180-200m). The worst-case downwind ground-level location (100m) was then used in the evaluation of impact

Baseline air quality data was obtained where available from Scottish Air Quality Network to allow comparison against existing baseline levels and relevant air quality standards and objectives.

The assessment demonstrated that:

- existing ambient levels of the relevant pollutants were less than 75% of the relevant air quality assessment level (AQAL) specified by LAQM/EPS Guidance, and
- simplified, worst-case downwind ground-level air quality concentrations would not exceed 5% of the AQAL

In summary, the overall air quality impact associated with the development – even conservatively assuming various worst-case conditions - can be assumed to be *negligible* and no further modelling evaluation of impact significance is considered to be merited. Consideration as to potential specific mitigation measures for air quality, is also not deemed to be warranted.

CONTENTS

1.0 INTRODUCTION

1.1 At the request of Mr Paul Fretwell, @rchitects Scotland Ltd, Forfar, an air quality impact assessment has been undertaken for the proposed crematoria development at agricultural land to north-east of Duntrune House, Duntrune.

1.2 The client is acting as agent for the developer.

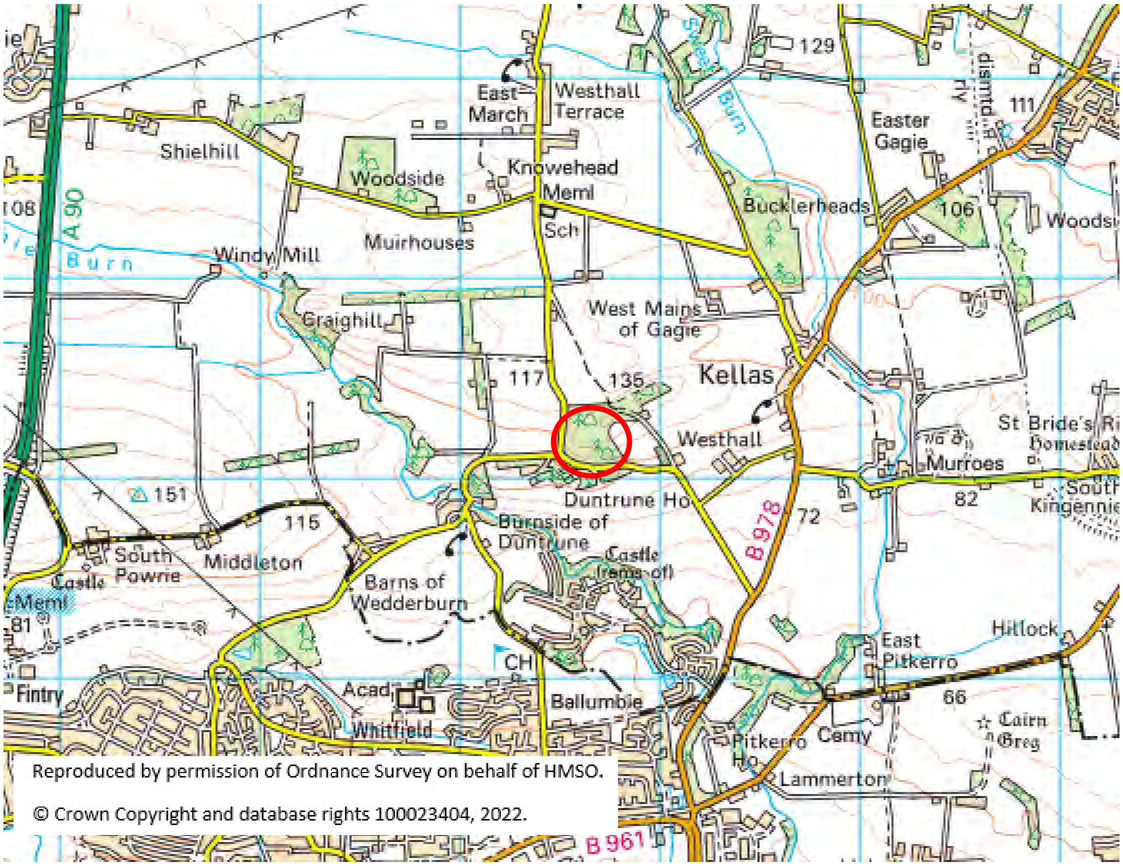
1.3 This assessment was undertaken by Dr Brian Gardner, Senior Consultant, Ethos Environmental Ltd. He holds first and research degrees in Environmental and Atmospheric Chemistry. He has worked as a health, safety & environmental consultant for 25 years and heads-up the company's air quality management consultancy services.

2.0 GENERAL BACKGROUND INFORMATION

2.1 The site is set in a rural location around 7km to the northeast of Dundee City Centre and around 0.5km to the east of the village of Burnside of Duntrune. The Site Location Plan is provided in Figures 1 and 2 below:

Figure 1. Site Location Plan (Satellite)

Figure 2. **Site Location Plan (Mapping)**



The proposed development is understood to have 120-seating capacity and is located across the southern half (approximately 2.0 Hectares) of ground (total 4.5 Hectares) owned by the developers. Figure 3 shows the site in closer detail and the proposed layout

Figure 3. Site and Development Layout

The site is surrounded by wooded areas to the north, east and west beyond which is generally agricultural land and to the south a road with agricultural land beyond that also.

The planning portal reference documentation relating to the site, the proposed development, and statutory consultation responses has been reviewed.

The Planning Officer has indicated that the development does not require submission of an Environmental Impact Assessment Report as required by regulation 5(1) and Schedule 4 of the Regulations. The *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017*.

The cremation operations and associated processes have the potential to give rise to air quality impacts and Angus Council, Housing, Regulatory and Protective Services has requested an assessment of:

a. air quality impacts in accordance with Local Air Quality Management Technical Guidance TG(16) and
b. potential odour nuisance impacts.

The air quality impacts are reported here (P8346.01); the odour impact assessment is reported separately (P8346.02)

3.0 ASSESSMENT SCOPE

3.1 Site Sensitivity

The crematorium is located to the west side of the development; the nearest receptors are estimated to be located at a distance of 213m to the east (A, two of) and 197m to the north (B, one of) of the crematorium stack emission point (C) as shown in Figure 4.

Figure 4. Location of nearest residential receptors at A (2 properties) and B (single property)

From review of satellite images (GoogleMap data, 2021) there are estimated to be approximately 200 dwellings located within 1000m of the development site (See blue radius, Figure 5); these are almost exclusively located to south and south-west of the site and in the upper distance range of 700-1000m.

Figure 5. 1000m radius (blue) around development source

Preliminary review of the site of the proposed development does not indicate any sensitive receptors other than dwellings. There is a primary school at distance 1400m to north of the site. There is no air quality management area in the vicinity of the site and there are not considered to be any existing air quality impacts (eg odour, waste treatment) on these receptors, other than potential seasonal agricultural impact.

3.2 Traffic-related Air Quality Impacts

A preliminary review of the traffic impact assessment undertaken by Cameron & Ross (Ref: A/190889, March 2020) identifies that traffic impacts associated with the development are unlikely to be significant with respect to air quality impact and are therefore not included within the scope of this assessment.

3.3 Crematoria Air Quality Impacts

Crematoria plant emit a range of pollutants to atmosphere from a single emission point (stack) with no significant fugitive, or other, emission types of concern. The crematoria process will be regulated by SEPA the *Pollution Prevention and Control (Scotland) Regulations (2000) (As Amended),* and the main emitted pollutants of relevance to air quality impact have emission concentration limits assigned which will be regulated by emission testing at commissioning and thereafter a regular compliance emission monitoring programme.

Odour impacts are not regulated in this manner, nor are "nuisance" type impacts such as dust deposition and potential soiling of windows and washing (clothing) of neighbouring residents.

4.0 AIR QUALITY ASSESSMENT STRATEGY & METHOD

4.1 General

The current objectives adopted in Scotland for the protection of human health are based on the *Air Quality Standards (Scotland) Regulations 2010* for the purpose of Local Air Quality Management (LAQM)

Of prime concern as expressed by and agreed with the Planning Authority in this respect are four pollutants: Nitrogen Dioxide (NO_2), Carbon Monoxide, Particulate Matter (expressed as PM_{10}) and mercury. Table 1 summarises the air quality objectives as presented in Table 1-1 of Technical Guidance on Local Air Quality Management (TG16).

Table 1. Air Quality Objectives (from Table 1-1, Local Air Quality Management Technical Guidance TDG16)

Pollutant	Objective	Averaging Period	Obligation
Nitrogen dioxide (NO_2)	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	All local authorities
	40µg/m^3	Annual mean	All local authorities
Particulate Matter (PM_{10})	50µg/m^3 not to be exceeded more than 35 times a year	24-hour mean	All local authorities
	50µg/m^3 not to be exceeded more than 7 times a year	24-hour mean	Scotland only
	40µg/m^3	Annual mean	All local authorities
	18µg/m^3	Annual mean	Scotland only
Particulate Matter ($PM_{2.5}$)	Work towards reducing emissions/concentrations of fine particulate matter ($PM_{2.5}$)	Annual mean	England only
	10µg/m^3	Annual mean	Scotland only
Sulphur dioxide (SO_2)	266µg/m^3 not to be exceeded more than 35 times a year	15-minute mean	All local authorities
	350µg/m^3 not to be exceeded more than 24 times a year	1-hour mean	All local authorities
	125µg/m^3 not to be exceeded more than 3 times a year	24-hour mean	All local authorities
Benzene (C_6H_6)	16.25µg/m^3	Running annual mean	All local authorities
	5µg/m^3	Annual mean	England and Wales only
	3.25µg/m^3	Running annual mean	Scotland and Northern Ireland only
1,3-Butadiene (C_4H_6)	2.25µg/m^3	Running annual mean	All local authorities
Carbon Monoxide (CO)	10mg/m^3	Maximum daily running 8-hour mean	England, Wales and Northern Ireland only
	10mg/m^3	Running 8-hour mean	Scotland only
Lead (Pb)	0.5µg/m^3	Annual mean	All local authorities
	0.25µg/m^3	Annual mean	All local authorities

4.2 Modelling Scope

EA/SEPA has issued guidance on techniques for the assessment of air quality in the form of Local Air Quality Management Technical Guidance, TG(16).

This has been taken into account in considering an appropriate assessment strategy as follows.

- No assessment will be made for dust deposition given the distances to the nearest receptors and the pre-existing agricultural land-use in the area.

- No assessment will be made for traffic impacts on air quality given the low overall traffic volume impact anticipated.

- The air quality assessment does not include for the construction phase of the development.

4.3 Model Type and Parameters

The air quality assessment is not considered to warrant baseline or other air quality monitoring. Modelling has been undertaken on a screening basis, for assumed worst-case and typical volume throughputs using ADMS 5.0.0.1 dispersion modelling (Build number 5129 Licence No: A01-1616-C-ROADS-UK, valid to September 2021).

The emission limits for abated crematoria detailed in Process Guidance PG5 (Crematoria) are emission concentrations only with no limit applicable for the mass emission. The table 3 emission limits (non-abated) include a limit for mass emissions and uses a conversion factor assuming an efflux volume flow of 1500m^3/hour. For the purposes of this assessment we will use the more stringent Table 4 emission concentration limits (reproduced below at Table 2) and will assume the same volume flow factor to obtain mass emissions for inputting to the dispersion model.

Table 2. Emission Limits for Abated Crematoria (Table 4 to PG 5/12 Process Guidance Note (Crematoria))

Row	Substance	Mass emission limits per cremator	Concentration limits	Type of monitoring	Monitoring frequency
1	Mercury	n/a	50 micrograms/m^3	Periodic monitoring **(Note 1)**	Annual
2	Hydrogen chloride (excluding particulate matter)	n/a	30 mg/m^3 hourly average	Periodic monitoring	Annual
3	Total particulate matter	n/a	20 mg/m^3 hourly average	Filter leak monitor • Provide visual alarms and record levels and alarms • Set reference levels on commissioning (i.e. set levels at which alarms will activate) **Plus** Instrument health check - i.e. service according to manufacturer's instructions **Plus** Periodic monitoring • Set reference levels for continuous emission monitor (CEM) (i.e. set levels at which alarms will activate	Continuous **Plus** Annual **Plus** Every 3 years
For abated crematoria with a "multiple cremators/single abatement plant" configuration, the provisions of Row 4a apply. For abated crematoria with a "single cremator/single abatement plant" configuration, the provisions of either Row 4a **OR** Row 4b can apply but should be specified to the regulator at the earliest opportunity.					
4a	Carbon monoxide	n/a	100 mg/m^3 reported as 2 x 30-minute averages	Qualitative monitoring • Record data at 15 second intervals or less • Provide visual alarms and record alarm events **Plus** Periodic test: • Validation of continuous emissions monitor (CEM) output through comparison with periodic test results	Continuous **Plus** Annual

This conservatively uses emission concentration limits as the emission concentrations for the parameters shown in Table 3.

There is no emission limit value in PG5 for NO_2. As such we have used the limit expressed in DEFRA Waste Incineration Directive 2010 Guidance.

The process has capacity for 6 cycles per day and each cycle operates for a total of approximately 80 minutes. The client has advised however that typical daily average throughput is anticipated to be 3 cycles per day. For the purposes of the modelling we have assumed that emission concentrations equivalent to the emissions concentration limits will be being emitted constantly, with no correction for percentage of the reference period (eg 24 hour day, 365 day year) in which the process is operating. For those modelled air quality concentrations referenced over periods in excess of a typical cycle (eg 80 minutes), such as 24-hour averages or annual averages, the modelled assumptions therefore represent a significant simplification – and exaggeration – compared to real conditions.

Table 3. Modelling Parameters

Pollutant	Source
Carbon monoxide	Mass emission level of 150g/hour based on process volume flow rate assumptions (1500m^3/hour) and carbon monoxide emission concentration limit of 100mg/m3 [1]
PM_{10}	Mass emission level of 30g/hour based on process volume flow rate assumptions (1500m^3/hour) and total particulate emission concentration limit of 20mg/m3 [1]
NO_2	Mass emission level of 300g/hour based on process volume flow rate assumptions (1500m^3/hour) and 200mg/m^3 emission limit [2]
Mercury	Mass emission level of 75mg/hour based on process volume flow rate assumptions (1500m^3/hour) and 50ug/m^3 mercury emission concentration limit [1]

1. Table 4, PG 05/2
2. Value for Nitrogen monoxide (NO) and nitrogen dioxide (NO2), expressed as nitrogen dioxide for existing incineration plants with a nominal capacity exceeding 6 tonnes per hour or new incineration plants Par 4.50 Waste Incineration Guidance, 2010 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/201215/pb-13570-wid-guidance-201003.pdf)

Efflux gas velocity is assumed to be approximately 370^{o}C based on review of stack emission monitoring reports for similar processes (Scientifics Report Ref@ 091121 *Stack emission monitoring report – Part 3,* as lodged in Planning Portal for Application 20/00830 on 2nd December 2020)

The stack height is assumed to be 10.0m as detailed in Building Plan layout. The stack dimensions are assumed to be 0.4m diameter with 15 m/s efflux velocity. A 0.3m surface roughness (agricultural areas maximum) is used in the model. There is no allowance made for local topography in the screening model.

For the screening model, instantaneous worst-case wind direction conditions are used, with meteorological dataset R91A-G representing a highly-localised westerly wind distribution (see Wind Rose image at Appendix 1) and modelling for ground-level concentrations at various distances (50-250m) directly downwind of the source including the distances of relevance to both residential receptors A and B (~200m). Baseline air quality levels are obtained from the Scottish Air Quality Network data, modelled for 2022. The resulting air quality impacts (baseline plus development source) are then variously evaluated by comparison against:

a. Air quality standards
b. Percentage increase over baseline levels

This is reported and evaluated at Section 5.0

5.0 DISPERSION MODELLING & EVALUATION

5.1 Modelling Results

As discussed at section 4.1, results are modelled for worst-case wind direction conditions using a highly-localised wind distribution with modelling for ground-level concentrations at various distances downwind of the source including the distances of relevance (~200m) to both residential receptors A and B.

The modelling for PM10 further conservatively assumes that all the total particulate material emitted can be classed as PM_{10}.

The model uses the emission limit values contained in the Process Guidance to obtain mass emission limits (for carbon monoxide, PM_{10} and Mercury). It should be noted that actual emission concentrations can be expected to be some margin lower than these limits.

It should additionally be noted that in referencing against annual or 24-hour average air quality standards, there is no weighting applied in this model to take into account periods when the crematorium is <u>not</u> in operation, though this is likely to be approximately:

50% of the working day
<20% of the 24 hour day, and
<20% of the annual period

Modelling for NO_2 assumes that all NO and NO_2 is expressed as NO_2. The model uses the emission concentration limit for NO_2 from waste incineration, in the absence of such a standard specifically for crematoria

Modelling results are shown in table 4 for a range of distances directly downwind

Table 4. Modelled ground-level concentrations of the target pollutants at various distances downwind of the stack point source

	Distance to Receptor				
Pollutant	**50m**	**100m**	**150m**	**180m**	**250m**
Carbon monoxide, ug/m³	1.72	2.00	1.49	1.23	0.82
PM_{10}, ug/m³	0.33	0.38	0.29	0.24	0.16
NO_2, ug/m³	3.62	4.24	2.96	2.45	1.61
Mercury, ug/m³	0.83×10^{-03}	0.96×10^{-03}	0.71×10^{-03}	0.59×10^{-03}	0.40×10^{-03}

These results therefore show the worst-case constant downwind concentrations; these conditions will obviously occur at the A&B receptor locations for significantly less than 50% of a year-round reference period.

5.2 Referencing

The results presented in Table 4 are referenced in Table 5 against a range of assessment criteria.

Table 5. Evaluation of modelled results

Pollutant	Assessment Criteria	Comment
Carbon monoxide	Air quality standard of 10,000 ug/m^3 running 8-hour mean	Worst-case modelled results (PC) at peak ground-level location (~100m downwind) are 2.0ug/m3. There is insufficient ambient data to express this on top of background levels as Predicted Environmental Concentration (PEC). The process contribution (PC) represents **0.02%** of the air quality criteria
PM_{10}	Air quality standard of 18ug/m^3 annual mean	Worst-case modelled results at peak ground-level location (~100m downwind) assuming all total particulate material is PM_{10} (PC) are 0.4ug/m3. This is **2.2%** of the air quality criteria
PM_{10}	Typical background level of 11ug/m^3 based on Scottish Air Quality Network Data [3]	Worst-case modelled results at peak ground-level location (~100m downwind) assuming all total particulate material is PM_{10} is 4.2ug/m3. This is **3.6%** of the background, will give a Predicted Environmental Concentration (PEC) of 11.4ug/m3 , and will increase the background from **61 to 63%** of the air quality standard
NO_2	40ug/m^3 annual mean	Worst-case modelled results at peak ground-level location (~100m downwind) (PC, process contribution) are 4.2ug/m3. This represents **10%** of the air quality annual mean criteria
NO_2	200ug/m^3 1-hour average not to be exceeded more than 18 times per annum	Worst-case modelled results at peak ground-level location (~100m downwind) (PC) are **2.1%** of the 1-hour average air quality criteria
NO_2	Typical background level of 6.8 ug/m^3 based on Scottish Air Quality Network Data [3]	Worst-case modelled results at peak ground-level location (~100m downwind) will raise the ambient level to 11ug/m3 (Predicted Environmental Concentration, PEC). The PC is **62%** of the background level and will increase the background as a percentage of the annual mean air quality standard from 17% to 27%
Mercury	Average background level 2.0 x 10^{-03} ug/m^3 (Brown et al, 2015 [1])	Worst-case modelled results at peak ground-level location (~100m downwind) are 1 x 10^{-3} ug/m^3 (PC), and approximately 50% of the UK average background level. This will result in a PEC of 3.0 x 10^{-03} ug/m^3 **,**
Mercury	20ug/m^3 HSE Workplace exposure limit[2]	Worst-case modelled results at peak ground-level location (~100m downwind) will deliver a PEC that is approximately **~0.15%** of the workplace exposure limit. See discussion below for interpretation.

1. Richard J.C. Brown, Sharon L. Goddard, David M. Butterfield, Andrew S. Brown, Chris Robins, Chantal L. Mustoe, Elizabeth A. McGhee, Ten years of mercury measurement at urban and industrial air quality monitoring stations in the UK, Atmospheric Environment, Volume 109, 2015, Pages 1-8, ISSN 1352-2310, https://doi.org/10.1016/j.atmosenv.2015.03.003.
2. HSE Guidance Note EH40/2005, Jan 2020
3. Baseline air quality data for PM10 and NO_2: http://www.scottishairquality.scot/data/mapping?view=data

5.3 Evaluation

Environmental Protection Scotland and the Institute for Air Quality Management have published guidance (*Land-Use Planning & Development Control: Planning For Air Quality*) to assist in evaluation of air quality in planning and development control processes.

The modelled results can be interpreted against the relevant air quality objectives in terms of Table 6.3 to the EPS/LAQM Guidance. This is reproduced in Table 6 below

Table 6. Impact descriptors for individual receptors (from Table 6.3 to *Land-Use Planning & Development Control: Planning For Air Quality*)

Long term average Concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

This table should normally be used with modelled annual average concentrations. Modelled ground-level (Z=0) air concentrations across the site indicated *negligible* increase in levels of pollutants.

It can be seen from Table 5 that for carbon monoxide and PM_{10} existing ambient levels are less than 75% of the relevant air quality AQAL, and the modelled levels are less than 5% of the AQAL. As such the relevant impact descriptor for these parameters – even with various simplified worst-case scenarios – is *negligible*.

For NO_2, existing ambient levels are less than 75% (17%) of the relevant long-term air quality AQAL. The simplified worst-case air quality concentration used to date is 10% of the AQAL. If we introduce a more representative modelled concentration by assuming active cremation for only 8 hours per day (6 cycles at 80 minutes each) for 6 days per week (rather than 365 days x 24 hours), the worst-case ground-level concentration (100m distance) drops proportionately (28.5%) and the revised worst-case air quality concentration will therefore be 2.8% of the AQAL. As such the relevant impact descriptor for this parameter – even with a number of other simplified worst-case conditions – can be considered *negligible*.

For mercury the worst-case modelled air quality concentrations (Process Contributions) are less than 50% of the average UK background level. There is no formal long-term annual assessment level for mercury. We can however in the absence of such, adapt existing workplace exposure limit (WEL) criteria used for occupational exposure settings. These are published by the Health and Safety Executive (EH40). We cannot use these directly, as these are meant to be applied for working exposure durations (ie 40 hours per week rather than potential 24 x 7 exposure), and are also applicable to a working population who are typically more healthy than the non-working population, which may include infants, elderly, immune-compromised etc. Traditionally an approximate 30-fold factor is used as a safety margin to account for these two factors when applying occupational exposure criteria to the environmental setting. Applying this to the 20ug/m^3 EH40 WEL results in an ad-hoc AQAL of 600ng/m^3. It can be seen that the worst-case (100m) ground-level modelled mercury concentration (1ng/m^3) is <5% of the ad-hoc AQAL. As such the relevant impact descriptor for this parameter – even obtained with a range of simplified worst-case conditions – can be considered *negligible*.

In summary, the overall air quality impact associated with the development – even conservatively assuming various worst-case conditions - can be assumed to be *negligible* and no further modelling evaluation of impact significance is considered to be merited. Consideration as to potential specific mitigation measures for air quality, is also not deemed to be warranted.

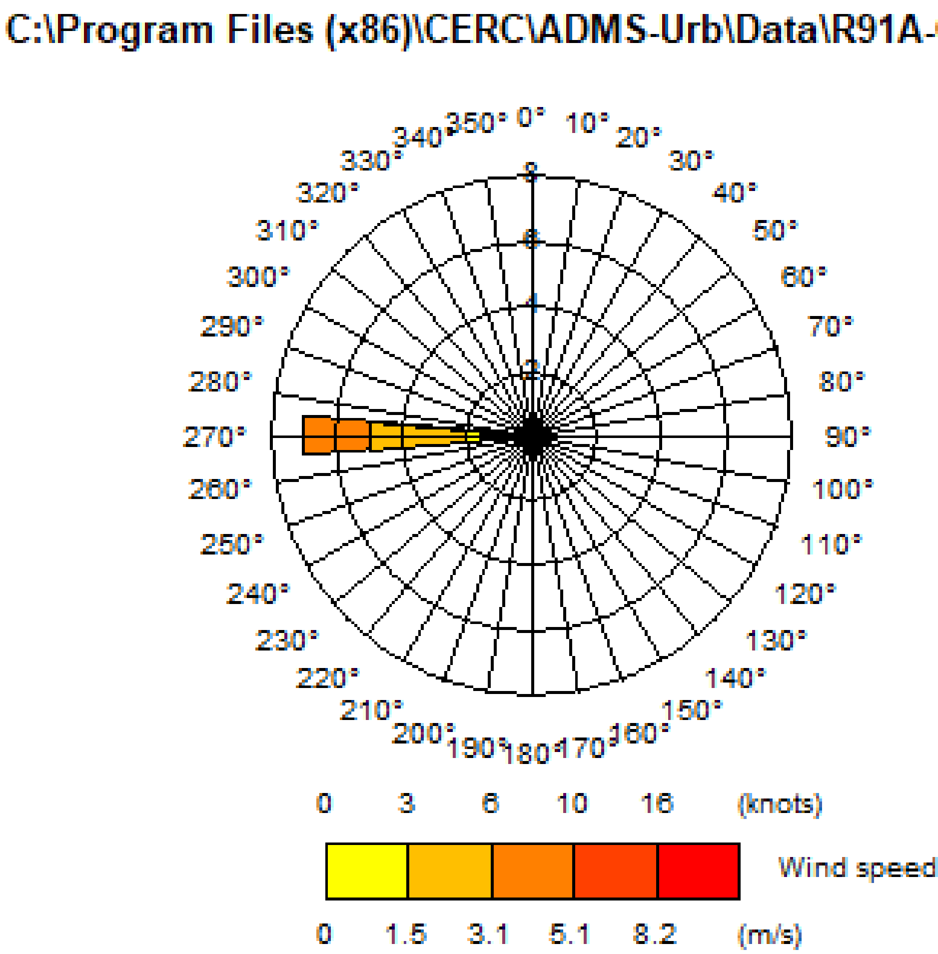
5.4 Stack Height Assessment

The screening assessment scope does not include for advising the client on optimum stack height - which can be subject to other planning complications (visual intrusion) – or under best available technique criteria.

The screening assessment reported here relates to the 10m stack height proposed by the client. The scoping study indicated that the 10m stack height - combined with the proposed abatement technology – could be expected to readily satisfy BAT requirements.

The subsequent screening assessment indicates negligible air quality impact despite a number of major worst-case assumptions. As such there is considered to be no technical merit in evaluating impact for proposals with greater stack height options, and no environmental benefit (in terms of air quality) in evaluating the impact from reduced stack heights.

APPENDIX 1. Wind Rose used to establish worst-case (downwind) concentrations



ethosenvironmental e2

Document:	P8346.04 Air Quality/Odour Assessment: Response to SEPA comments (28 May 2021)
Project:	Erection of Crematorium Building and associated Parking, Access, Turning Space, Landscaping and Boundary Enclosures, Land North East Of Duntrune House, Duntrune
Ref No:	20/00830/FULL
Client:	Paul Fretwell @rchitects-scotland Ltd
Prepared by:	Dr B Gardner, Senior Consultant
Date:	5th July 2021

1.0 Background

Senior Planning Officer for SEPA has made a number of comments (28 May) in response to the air quality assessment report for the above project. These comments are detaile din section 2 with our responses.

A revised (Ver3) version of the report is attached incorporating changes at sections 5.2 and a new section 5.4.

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2.0 Consultant Response

Our responses to these comments are made as follows:

SEPA Comment	Consultant Response
Based on the information available to us, we lodge a **holding objection** to this application because there is insufficient information to demonstrate that the proposed stack height has been suitably assessed to ensure it accords with the principle of Best Available Techniques (BAT). The proposed stack is assumed by us to be 10m based on building design plans, but a stack height assessment should form part of the Air Quality Impact Assessment (AQIA) for BAT purposes	An initial scoping exercise identified that a screening model would be appropriate for the modelling scenario. If this delivered results of any significance other than negligible impact, then a fuller modelling assessment could be undertaken if required. The AQ assessment methodology was previously agreed with the client and confirmed with the regulator by them. The screening assessment method uses a number of significantly worst-case modelling parameters as proposed in the original methodology proposal; results from this are still able to comfortably confirm that the 10m stack height scenario results in negligible impact, even under these worst-case modelling conditions. Arguably, from the scoping exercise the emission-receptor scenario would not have even warranted a formal modelling exercise and could have been addressed by means of simpler modelling to still robustly demonstrate negligible impact. For avoidance of doubt, the worst-case modelling parameters used are as follows: **1. Emission concentrations** The assessment assumes that emission concentrations are equal to the emission concentration limit of PG 5/12 Process Guidance Note (Crematoria), (rather than 10-50% of the limit as can often be the real-world conditions with the proposed abatement) **2. Pollutant Form** The assessment assumes that all of the total suspended particulate emission is present as PM10;

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modelling for NO_2 assumes that all NO and NO_2 is expressed as NO_2.

3. Emission Pattern

The process has capacity for 6 cycles per day and each cycle operates for a total of approximately 80 minutes. The client has advised however that typical daily average throughput is anticipated to be 3 cycles per day. For the purposes of the modelling we have assumed that emission concentrations (equivalent to the emissions concentration limits) will be being emitted constantly, with no correction for percentage of the reference period (eg 24 hour day, 365 day year) in which the process is operating.

For those modelled air quality concentrations referenced over periods in excess of a typical cycle (eg 80 minutes), such as 24-hour averages or annual averages, the modelled assumptions therefore represent a significant simplification – and very significant exaggeration - of actual long-term mass emissions in the model, compared to real conditions, ie at least 6-times higher than real.

4. Meteorology

For the screening model, instantaneous worst-case wind direction conditions are used, with meteorological dataset R91A-G representing a highly-localised westerly wind distribution (see Wind Rose image at Appendix 1).

It must be stressed that the ground-level concentrations obtained directly downwind of source using this model are then applied to receptors in any compass direction from the source. In this assessment we only explicitly apply it to the three nearest receptors which are by some margin closer than the next set of receptors (typically at distance >500m) as discussed at section 3.1 to the report. Careful reading of the report would confirm therefore that the model does allow evaluation of impact on all receptors, but the scoping exercise indicated that specific modelling for each receptor site was not warranted, and the results obtained are considered to be consistent with that.

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	5. Distance The model outputs (see Table 4) ground-level concentrations downwind of the source under worst-case conditions of uni-directional wind direction across a range of distances (0-250m) including those typical of the direct line-of-sight distance to the nearest three residential receptors (~180-200m). The maximum modelled ground-level air concentration was found to occur at a distance of approximately 100m. This value was then used for the evaluation of impact at receptors, rather than the value for the distance from source to specific receptor. Ignoring all the other worst-case assumptions made (1-4), it is highly unlikely that this worst-case value will be found at any of the receptors for any significant period of time compared to the duration of any relevant reference period. **6. Evaluation** The modelled results are interpreted against the relevant air quality objectives in terms of Table 6.3 to the EPS/LAQM Guidance (see Table 6 in report). Evaluation using all of the above the worst-case parameters (1-5 above) allows ready conclusion that there will be <u>negligible</u> air quality impact for PM10, CO and mercury. For NO_2, the simplified worst-case air quality concentration used to date is 10% of the AQAL. If we introduce a more representative modelled concentration by assuming active cremation for only 8 hours per day (6 cycles at 80 minutes each) for 6 days per week (rather than 365 days x 24 hours), the worst-case ground-level concentration (100m distance) drops proportionately (28.5%) and the revised worst-case air quality concentration will therefore be 2.8% of the AQAL. As such the relevant impact descriptor for this parameter – even with all other simplified worst-case conditions – can be considered *negligible*. **7. Summary** In summary, the conclusions from the scoping exercise – that a “screening” modelling strategy was

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	appropriate and that more sophisticated modelling exercise would not be warranted – are borne out by the modelled outputs. The overall air quality impact associated with the development – even conservatively assuming various worst-case conditions - can be assumed to be *negligible* and no further modelling evaluation of impact significance is considered to be merited. Consideration as to potential specific mitigation measures for air quality, is also not deemed to be warranted. As such the assessment is considered to include a stack height assessment for the proposed stack height and there is considered to be no merit under BAT in exploring additional height options as these will deliver negligible improvements in ground-level air quality impact. The report has been revised to include a new section (5.4) clarifying this.
We would request clarification over the receptors. The approach taken to assessment differs from the norm as the applicant has not assessed compliance with air quality standards (AQS) at receptors, rather they have assessed it at the location of highest impact.	The assessment differs from the norm as this is a screening assessment. It does however specifically assess compliance with AQS at the closest receptors, and does so for worst-case conditions, and assuming the receptors are constantly downwind of the source. As such the modelled results can be applied directly to any receptor and will therefore be even more worst-case for those at greater distance from source than either those with the maximum concentration (100m) or those receptors specifically discussed. The negligible nature of the modelled impact – despite a number of worst-case modelling inputs – strongly suggests that the scoping assumptions and screening assessment strategy is appropriate and that explicit application of the assessment to other receptors (at greater distance and in any compass direction from source) is not warranted.
1. How many receptors are within the scope of the study? Please provide a table of receptors	Receptors within 1000m are discussed at section 3.1.

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showing distance from proposed site and type (residential or other). The applicant states that there are dwellings within 800 - 1000m from the site – have these been included in the assessment? If not please provide a justification for exclusion.	In this screening model, compass direction of receptor from source is ignored using the worst-case assumption that each receptor is downwind of the source at all times. Specific assessment is made for the three significantly closest receptors. This simplification (and gross exaggeration of impact) still allows the screening to demonstrate <u>negligible</u> impact, such that more resolved assessment for other receptors at greater distance Is not considered to be merited (as was assumed at the scoping stage). If this screening model had indicated <u>moderate</u> or even <u>slight</u> impact (as defined in Table 6.3 to *Land-Use Planning & Development Control: Planning For Air Quality*) then we would have explicitly extended the model to other receptors and considered use of site-specific met data and other parameters, rather than worst-case simplifications.
2. Table 5 needs to be amended to show PC, PEC and % of the AQS at each receptor within the scope of the study	The worst-case modelled contributions (PC) are provided at Table 4, with the maximum obtained at any downwind distance (at 100m) used for the interpretation at Table 5 The predicted environmental concentration (PEC) is discussed at Table 5 as a percentage of the AQS. I have amended the table to make this more explicit
3. A stack height assessment should be carried out and included in the AQIA for BAT purposes	The assessment relates to the proposed 10m stack height and indicates negligible AQ impact but for avoidance of doubt I have clarified this in a separate section 5.4 titled “Stack Height Assessment”
4. Please confirm which site the meteorological data is from. We recommend 5 years met data is used for AQIA with the ‘worst case’ concentrations reported. It appears only 1 year’s data has been used in this case and the year isn’t specified.	The initial scoping exercise identified remote likelihood of air quality impact necessitating resolution for specific sources, or site -specific met data. Instead a simpler screening model was proposed but using a number of significantly conservative model inputs. The screening modelling method proposed was passed to the regulator for approval prior to commencement of the work.

Asbestos Noise & Vibration Occupational Hygiene Environmental Monitoring

ISO 9001 Quality Management FS 547812 ISO 14001 Environmental Management EMS 563106 OHSAS 18001 Occupational Health & Safety Management OHS 563107

UKAS TESTING 2146 UKAS INSPECTION 177 Accredited Contractor Registered

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	The model does not use site-specific met data. Instead synthetic data representing constant uni-directional wind was used to model the instantaneous downwind concentrations applicable for use with receptors at any compass point. The simplified screening model approach was validated by the negligible air quality impacts modelled, despite the important worst-case assumptions used.

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Cameron + Ross

A/190889

PROPOSED CREMATORIUM
BURNSIDE OF DUNTRUNE
ANGUS

TRANSPORTATION ASSESSMENT
REV – 03
(Amendments in Red Text)

SEPTEMBER 2021

FM & G BATCHELOR
KINNELLS MILL
FRIOCKHEIM
ANGUS
DD11 4UL

CAMERON + ROSS
CONSULTING ENGINEERS
15 VICTORIA STREET
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CONTENTS

REVISION SCHEDULE

Rev No.	Description of Amendment	Prepared By	Approved By	Date
-	Draft Issue	B. Clark	R. Gibb	Jan 2020
01	Issue to Angus Council for Comment	B.Clark	R.Gibb	Feb 2020
02	Response to Angus Council Traffic Team Comments	B.Clark	R.Gibb	March 2020
03	Public Transport Info Updated	B.Clark	R.Gibb	Sep 2021

A/190889 – PROPOSED CREMATORIUM, BURNSIDE OF DUNTRUNE

1.0 INTRODUCTION

1.1 Cameron + Ross have been appointed by FM & G Batchelor to prepare a Transportation Assessment (TA) to support a planning application for a proposed crematorium development at Burnside of Duntrune.

1.2 A Scoping meeting was held with Angus Council Traffic Team in November 2019.

1.3 The purpose of this Transportation Assessment is to assess the suitability of the site transport infrastructure proposals, the local road network and local transport infrastructure for the development and to respond to the Scoping Meeting items raised by the Angus Council Traffic Team.

2.0 DEVELOPMENT PROPOSALS

2.0 The site is 4.5 hectares and is proposed to be developed for a 120-seating capacity crematorium.

2.1 The site is located on the north side of the C4 and is set in a rural location around 7km to the northeast of Dundee City Centre and around 0.5km to the east of the village of Burnside of Duntrune. The Site Location Plan is contained below:

BALDOVIE ROAD

Figure 1 – Site Location Plan.

2.2 The site is surrounded by wooded areas to the north, east and west beyond which is generally agricultural land. Agricultural land also bounds the site to the to the south of the C4.

Development Layout and Access Overview

2.3 The Architects Proposed Site Layout Plan is contained below and shows that a single simple priority T-junction is proposed for the site access taken from the C4.

Figure 2 – Proposed Site Layout Plan

2.4 The site frontage is currently a national speed limit 60mph. The C4 along the site frontage is typically 4.75m to 5.2m in width. It is proposed to widen the existing road to 5.5m along the full length of the site frontage.

2.5 At the scoping meeting it was agreed that the new access priority T-junction will require 4.5m x 120m visibility splays in both directions. This was agreed as a result of the weekly average of the 85%tile speed survey results taken along the site frontage being 40mph eastbound and 42mph westbound. Using a 40mph design speed which corresponds to a 70A kph design speed in accordance with the DMRB. The speed survey results are contained within **Appendix A**.

2.6 Similarly it was agreed that the desired visibility in both directions at the Unclassified Road junction with Kellas Road is 4.5m x 160m as a result of the weekly average 85%tile surveyed speeds being 48mph eastbound and 49mph westbound. This corresponds to a 50mph or 85A kph design speed.

2.7 The desired 4.5m x160m visibility is achieved on the Unclassified Road looking southbound although this requires shrubs/grass etc to be cut down to ground level to achieve this. Looking northbound around 2.4mx160m is achieved once tress/shrubs/grass are cut back and down to ground level within the visibility splay which is within the adopted road envelope.

2.8 It should be noted that the local authority is currently not adequately maintaining the stated desired visibility splays at the Unclassified Road/ Kellas Road junction as only a narrow strip of verge is being cut. The existing visibility splays for the junctions considered within this assessment are contained within **Appendix B**.

2.9 A review of the existing road widths has been undertaken. The existing road widths, signage, passing place provision and proposed improvements are shown within the drawings provided within **Appendix B**. This shows that the existing C4 along the site frontage is typically between 4.8m and 5.18m in width. Continuing southbound to the C4/unclassified road junction the C4 is typically between 5.1 and 5.7m in width. The road then continues southbound from this junction as an unclassified road where the width remains between 4.65m and 5.5m in width.

2.10 The stretch of C4 between the unclassified Road and the B978 Kellas Road is narrower with a typical width of 3.8m to 4.2m. As a result, it is anticipated that this route will see a lesser traffic generation than the unclassified road coming off Kellas Road. It is therefore suggested that the signed route is via the unclassified Road. This also takes traffic through the junction off Kellas Road with the better visibility splay provision

2.11 Also the C4 junction with the unclassified Road and the B978 Kellas Road has substandard visibility splay provision.

<u>Parking Provision</u>

2.12 At the scoping meeting it was agreed that for a 120 seating capacity crematorium Angus Council would be looking for 40 spaces to be provided. Based on subsequent information it is proposed that a total of 90 spaces will be provided with a significant proportion of this being overflow with a soft appearance so as not to have the majority of funerals that have a lower attendance have to deal with a large empty, baron and unattractive parking areas.

2.13 The National Parking Standard indicates that there should be a minimum of 4 No disabled spaces or 4% of the total capacity. 4% of 90 spaces provided is 4 spaces.

2.14 A separate staff car parking area will be provided. There is expected to be 4 full time staff and therefore 4 staff spaces are considered to be adequate corresponding to 1 space per permanent staff member. 1 disabled user staff space will be provided. 1 of the staff spaces will also be an electrical charge point.

<u>Review of agreed Parking Provision for Existing Crematorium</u>

Brewsterswells, 100 Acre Wood, (Fife) – 120 Seats

2.15 The spaces provided are 90 total, including 50 standard, 4 disabled, 32 over flow and 4 staff.

Parkgrove, 164 Seats

2.16 In 2011 conducted 750 cremations averaging 3 per week as proposed for this smaller crematorium. Parkgrove has only 24 formal spaces for cars with large overspill on loop road, totalling 100 car capacity. Parkgrove sees an average occupancy of 3 people / car.

3.0 SUSTAINABLE TRAVEL OPPORTUNITIES

Walking

3.1 Due to the rural nature of the development there are no footpath links to the crematorium site. Adequate footpath provision to link the various car park areas to the crematorium building will be provided within the Architects development layout.

Cycle Infrastructure

3.2 It is very unlikely that anyone will travel to a funeral by cycle given the rural location of the development. As a result, no public cycling facilities is proposed to be provided. Those who wish to cycle to the crematorium by cycle to visit the memorial gardens would be able to keep their cycle with them within the memorial gardens and therefore there is no requirement for a public cycle storage facility.

3.3 There is anticipated to be 4 full time staff and therefore the provision of a single Sheffield stand would suffice to comply with the National Parking Standard which requires 1 space per 4 permanent staff members. There will be locker and shower facilities available for staff to use.

3.4 There is no designated cycle routes within the vicinity of the site and cyclists would require to the carriageway.

3.5 Given the anticipated low public demand for cycling to the development and the proposed staff cycle parking, locker and shower facilities it is considered that there is adequate provision for cyclists should they wish to travel to the crematorium.

Public Transport

Existing Provision

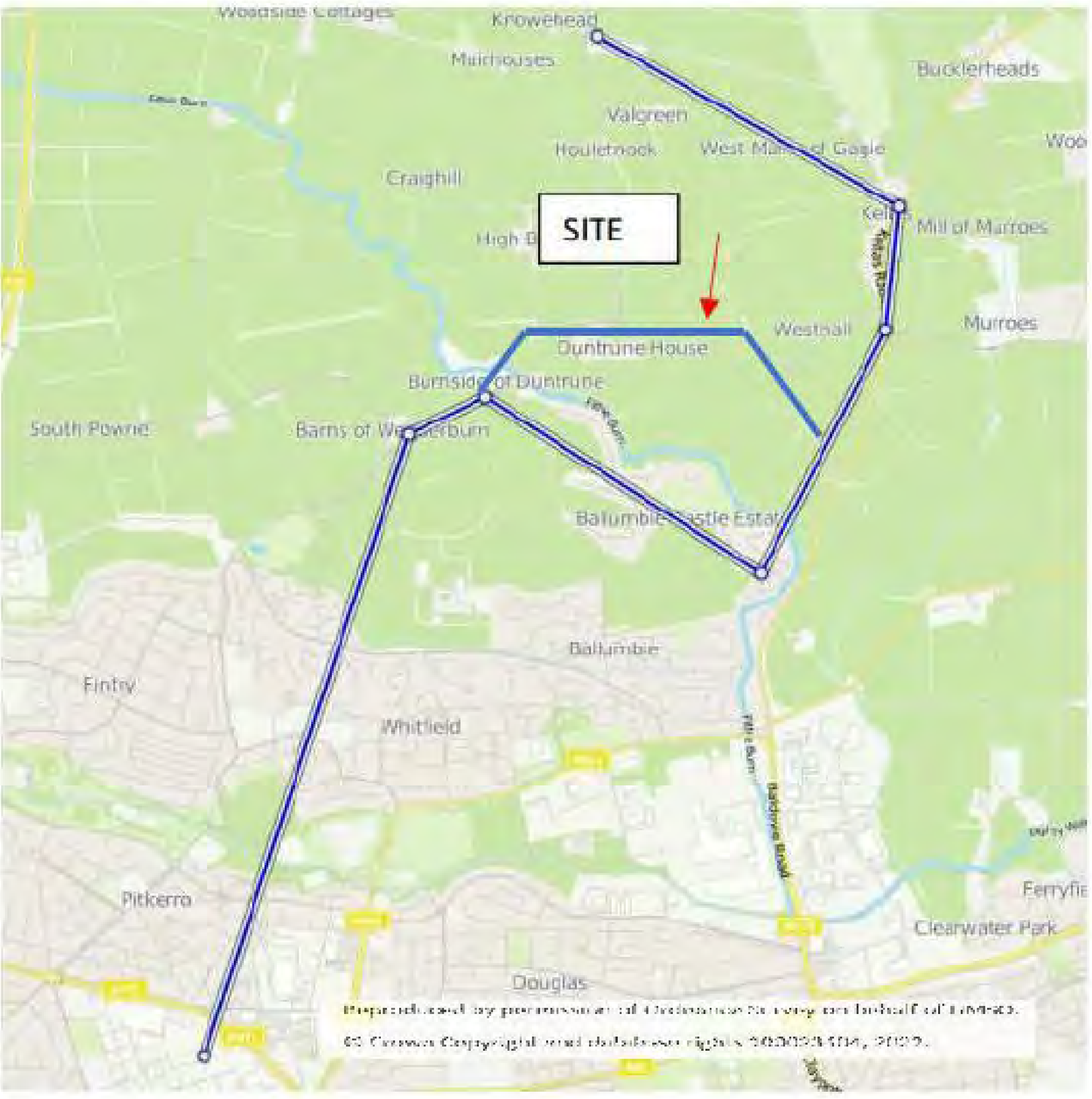
3.6 There is currently two existing bus services that run directly past the proposed crematorium site. The A17 & A38 which run one in each direction each working day. Bus services in this area run on a hail and ride basis and as such would stop outside the site, even if no fixed stop was installed should someone require. The bus routes and timetable are shown below:

A38 – Fishers Tours bus route and timetable shown below:

Pitkerro, opp Keyline	08:00
Burnside of Duntrune, at Braeside Cottages	08:16
Kellas, at Smiddy	08:22
Kellas, at Keillorcroft	08:23
Wellbank Forge (at)	08:27
Wellbank, at Forbes of Kingennie	08:29
Monifieth, at High School	08:40
	Operates on Angus schooldays only

Monifieth, at High School	16:00
Wellbank, opp Forbes of Kingennie	16:11
Wellbank Forge (opp)	16:14
Kellas, opp Keillorcroft	16:15
Kellas, opp Smiddy	16:16
Burnside of Duntrune, opp Braeside Cottages	16:21
Pitkerro, at Keyline	16:37
	Operates on Angus schooldays only

A17 – Fishers Tours – Murroes School – Ballumbie Castle



Monday to Friday, not QE0 : BUS.CIF days

Ballumbie Castle and Fishers Depot - Murroes School

Pitkerro, opp Keyline	08:28
Barns of Wedderburn, at Farmhouse Road End	08:37
Burnside of Duntrune, at Braeside Cottages	08:38
Ballumbie Castle, opp Hawthorn Grove	08:44
Kellas, opp South Kingennie Road End	08:46
Kellas, at Smiddy	08:47
Westhall Terrace, at Murroes School	08:50
	Operates on Angus schooldays only

Murroes School - Ballumbie Castle and Fishers Depot

Westhall Terrace, at Murroes School	15:30
Burnside of Duntrune, opp Braeside Cottages	15:34
Barns of Wedderburn, opp Farmhouse Road End	15:35
Burnside of Duntrune, at Braeside Cottages	15:36
Ballumbie Castle, opp Hawthorn Grove	15:40
Pitkerro, at Keyline	15:49
	Operates on Angus schooldays only

3.7 Two additional local bus services (Nos 22 & 139) run past the site some 450m west of the proposed site access. Whilst the distance to walk to a bus route to the west is slightly above the desired 400m any funeral attendee would likely be making this journey infrequently. Service 22 operates two services per day in each direction Mondays to Fridays. One service in each direction operates on a Saturday. Service 139 operates 2 services per day Monday to Friday each day. The bus routes and timetables are shown below:

139 – Explore Dundee route AND Timetables Shown Below

139 Tealing | Inveraldie | Westhall Terrace | Dundee

Monday to Friday

from 9th August 2020

	139	139
Inveraldie Hall Place	0902	-
Tealing School	0910	1300
Tealing Village	0913	1303
Westhall Terrace	0919	1309
Burnside of Duntrune	0922	1312
South Powrie	0924	1314
City Centre High Street [H1]	0937	1327

139: Service terminates at High Street [H1]. Use Union Street instead of Whitehall and wait at H1 for any layover. H4 is pick-up point only.

139 Tealing | Inveraldie | Westhall Terrace | Dundee

Saturday

from 9th August 2020

Inveraldie Hall Place	0902	-
Tealing School	0910	1300
Tealing Village	0913	1303
Westhall Terrace	0919	1309
Burnside of Duntrune	0922	1312
South Powrie	0924	1314
City Centre Whitehall Street [W1]	0937	1327

139 Dundee | Westhall Terrace | Inveraldie | Tealing

Monday to Friday

from 9th August 2020

		$
City Centre High Street [H4]	0840	1225
City Centre Commercial Street [1]	0842	1227
South Powrie	-	1238
Burnside of Duntrune	-	1240
Westhall Terrace	-	1243
Inveraldie Hall Place	0859	1250
Tealing Village	-	1257
Tealing School	-	1300

$: Inveraldie Hall Place is served on request to the driver.

139 Dundee | Westhall Terrace | Inveraldie | Tealing

Saturday

from 9th August 2020

		$
City Centre High Street [H4]	0840	1225
City Centre Commercial Street [1]	0842	1227
South Powrie	-	1238
Burnside of Duntrune	-	1240
Westhall Terrace	-	1243
Inveraldie Hall Place	0859	1250
Tealing Village	-	1257
Tealing School	-	1300

$: Timing Points, South Powrie, Burnside of Duntrune, Westhall Terrace, are served on request to the driver, otherwise proceed to Inveraldie Hall Place

3.8 Further buses can be accessed on Hawick Drive off the Drumgeith Road approximately 2.4km from the site. There is no footpath provision from the site until the Kellas Road junction with Poplar Drive approximately 1.4km from the proposed crematorium site.

3.9 The Table below gives a summary of the buses that can be accessed from the Hawick Drive bus stops.

Service Operator	Service Type	Service No.	Journey	Typical Time Interval Between Services: Peak Hours	Typical Time Interval Between Services: Outwith Normal Hours
Moffat & Williamson	Bus	78C	Dundee to Monikie via Kellas Rd		There is a total of 3 services per day
Moffat & Williamson	Bus	78A/79A	Monikie to Dundee via Kellas Rd		There is a total of 4 services per day

Service Operator	Service Type	Service No.	Journey	Typical Time Interval Between Services Peak Hours	Outwith Normal Hours
Moffat & Williamson	Bus	88 at Hawick Drive	Whitfiled – Broughty Ferry Circular via Hawick Drive	hourly	hourly

Table 1 – Summary of Existing Public Transport Provision.

3.10 Given the rural nature of the site and the fact that there are several bus routes identified that either pass the site or are within the surrounding area of the site there is the opportunity for staff or funeral attendees to travel to the site via existing public transport.

3.11 There will be potential for people to travel to the site by private bus and the site layout is designed to have adequate space for buses although no designated space will be provided. Buses would be expected to utilise the overspill parking area.

Additional Transport Enhancement Options

3.12 If considered essential an appropriate bus stop or pull in area could be incorporated as part of the access to be formed for the site. Correspondence from Xplore Dundee who run buses in the area indicates they *"would be happy with anything that would improve accessibility and make a service more useful for people" and they* have previously contacted the relevant parties at Angus Council.

3.12 Alternatively bearing in mind the anticipated infrequency it is anticipated that people will want to access facilities by public transport: it would probably be more suitable to incorporate into the transport plan for the site the provision of a call up service for those who wanted to be collected from the existing nearest bus stops. As we have already incorporated provision for electric vehicles on site this could also be by electric vehicle to keep emissions to an absolute minimum.

3.13 Paragraph 276 of Scottish Planning Policy (SPP) States:

"In rural areas the plan should be realistic about the likely viability of public transport services and innovative solutions such as demand-responsive public transport and small-scale park and ride facilities at nodes on rural bus corridors should be considered."

This flexibility in terms of access to public transport is an approach that has previously been adopted by Angus Council on many occasions.

4.0 NETWORK ANALYSIS

Road Network Extent Considered

4.1 The initial extent of the existing road network to be included in the study was agreed with Angus Council Traffic Team at the scoping meeting and includes the following junctions:

- New Site Access junction
- C4/C6 simple priority T-junction
- Unclassified Rd/ C4 simple priority T-Junction
- C4/ Kellas Road simple priority T-Junction
- Unclassified Road/ Kellas Road simple priority T-Junction

4.2 The following junction with the Dundee City Council area is also within the extent of road network considered. The B978 Baldovie Road is dual-carriageway and changes to single carriageway at Drumgeith Road. Kellas Road is also designated as the B978.

- Kellas Road/Baldovie Road/Drumgeith Road ghost island right turn junction.

Traffic Surveys

4.3 A turning count traffic survey was undertaken by Transurveys Ltd on Tuesday the 8th of October 2019 at the B961 Drumgeith Road/B978 Kellas Road and Baldovie Road ghost island junction. A week long speed survey was also undertaken at the same period on the B978 Kellas Road approximately 30m south of the unclassified road. A speed survey was also undertaken on the C4 along the site frontage. Straight ahead flows are also provided at the speed survey locations for the peak periods. The traffic flow survey data is contained within **Appendix A**.

4.4 The AM and PM peak flows were established from the traffic counts and are displayed in the road network diagrams below:

Assessment Years/Periods

4.5 We confirm a we will assess the development for a proposed opening year of 2021 and the NRTF central growth rate has been applied to the 2019 base flows. The NRTF central growth factor is = a growth rate of 1.19% over 2 years which = 1.019*1.019= 1.038. The 2021 AM and Pm Base Flows are contained in the figures below.

Cameron+Ross

AC32

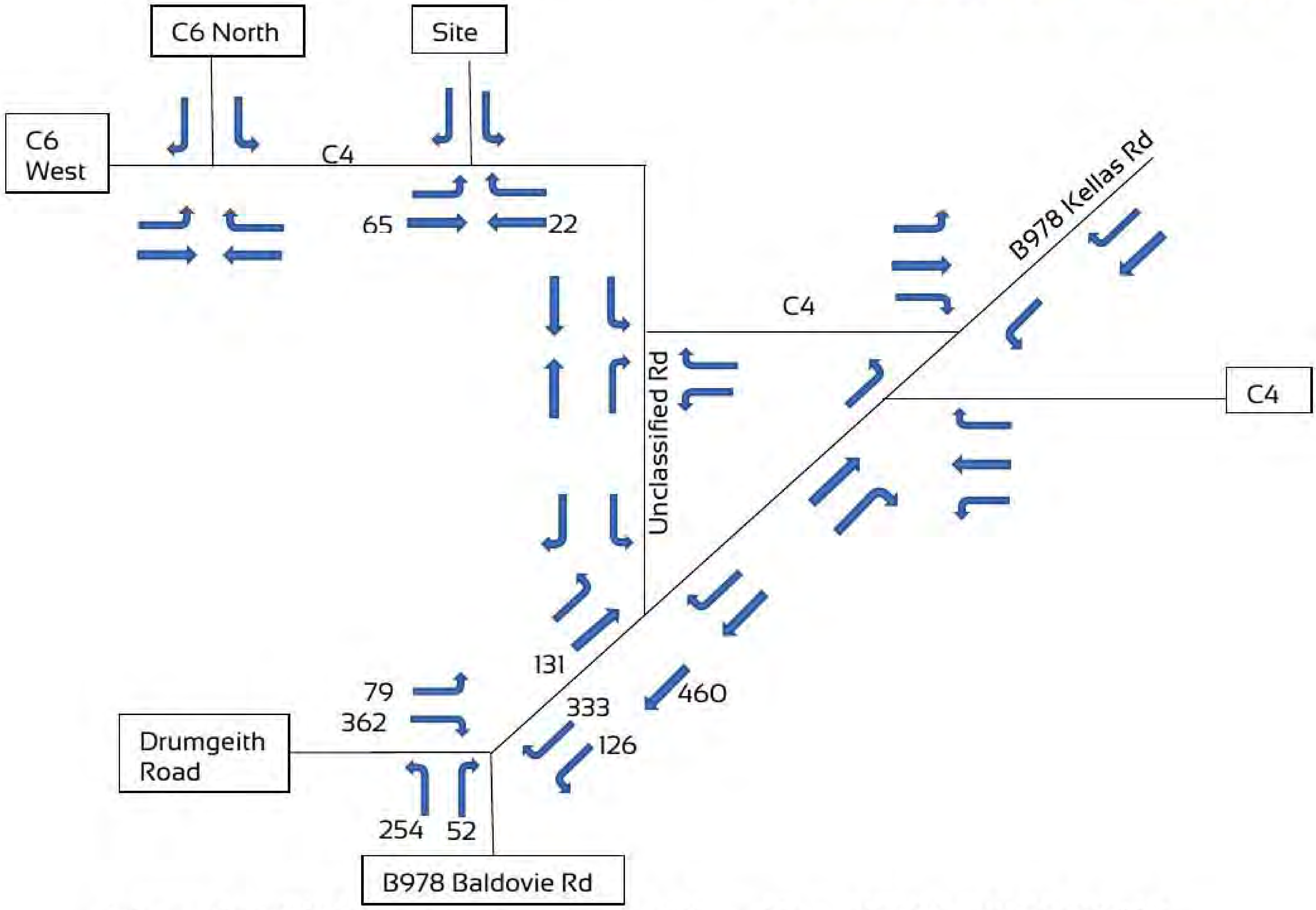


Figure 3 – 2019 Weekday AM Surveyed Base Flows 07:30 – 08:30 (PCUs)

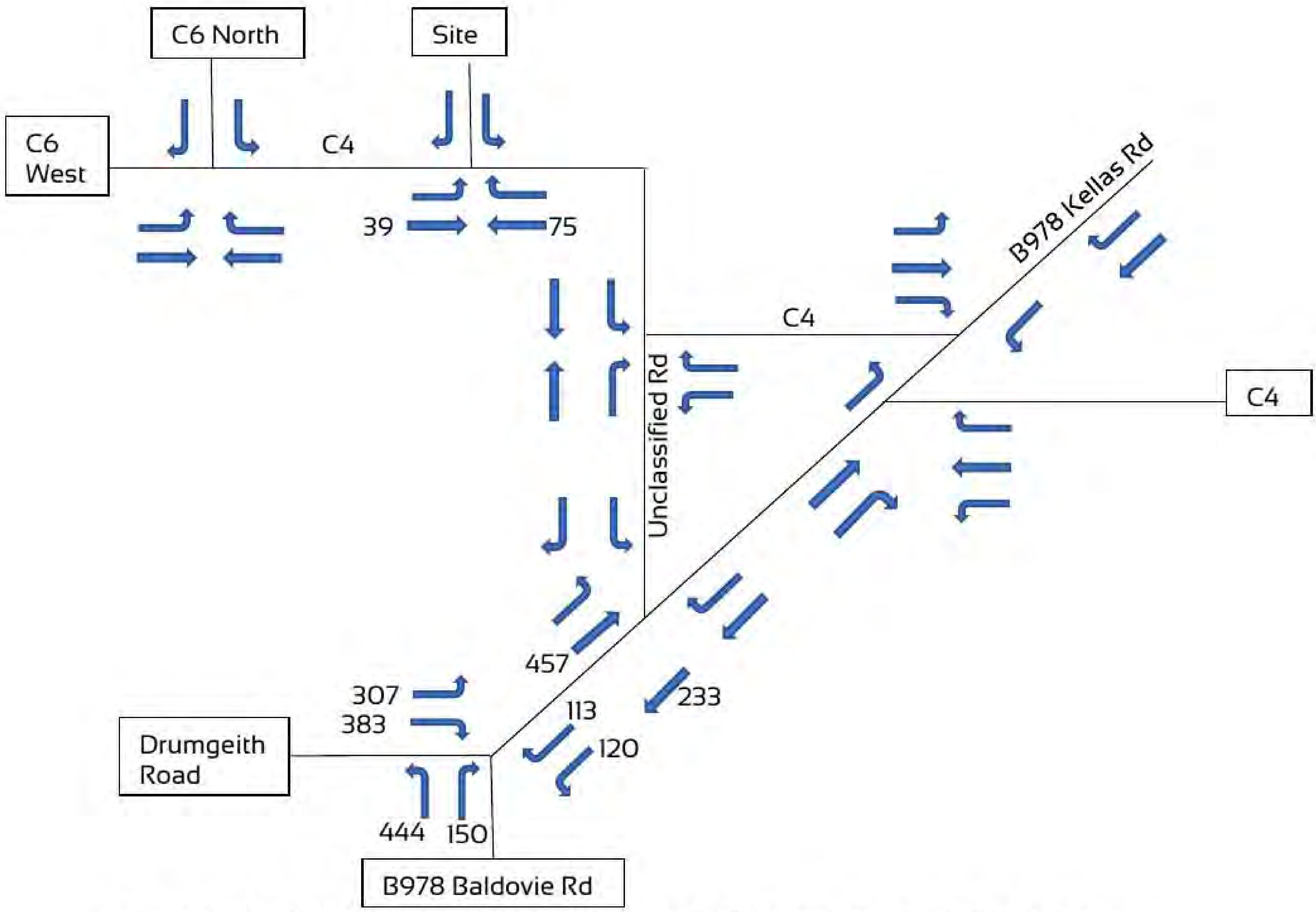


Figure 4 – 2019 Weekday PM Surveyed Base Flows 16:15 – 17:15 (PCUs)

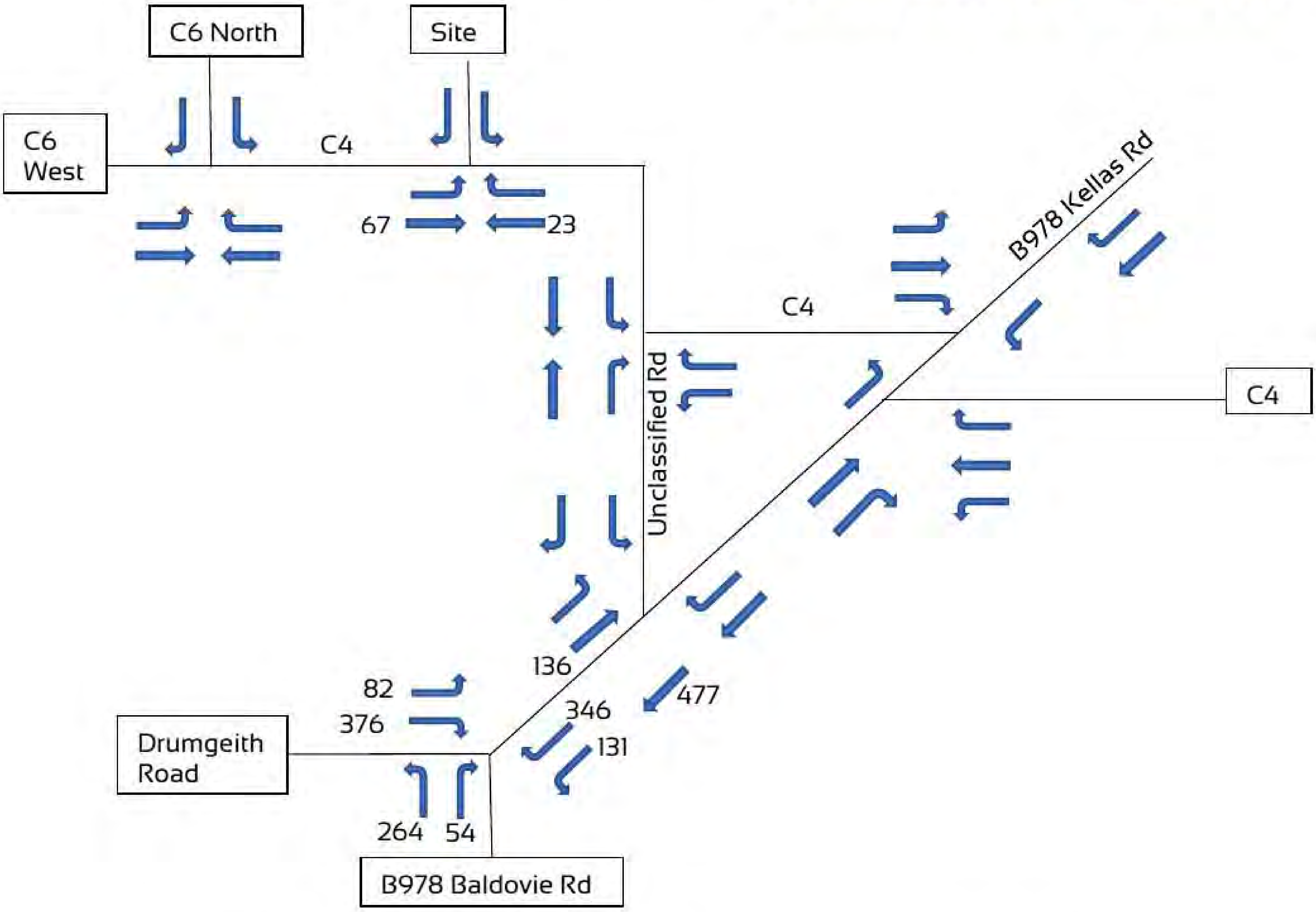


Figure 5 – 2021 Weekday AM Base Flows 07:30 – 08:30 (Vehicles)

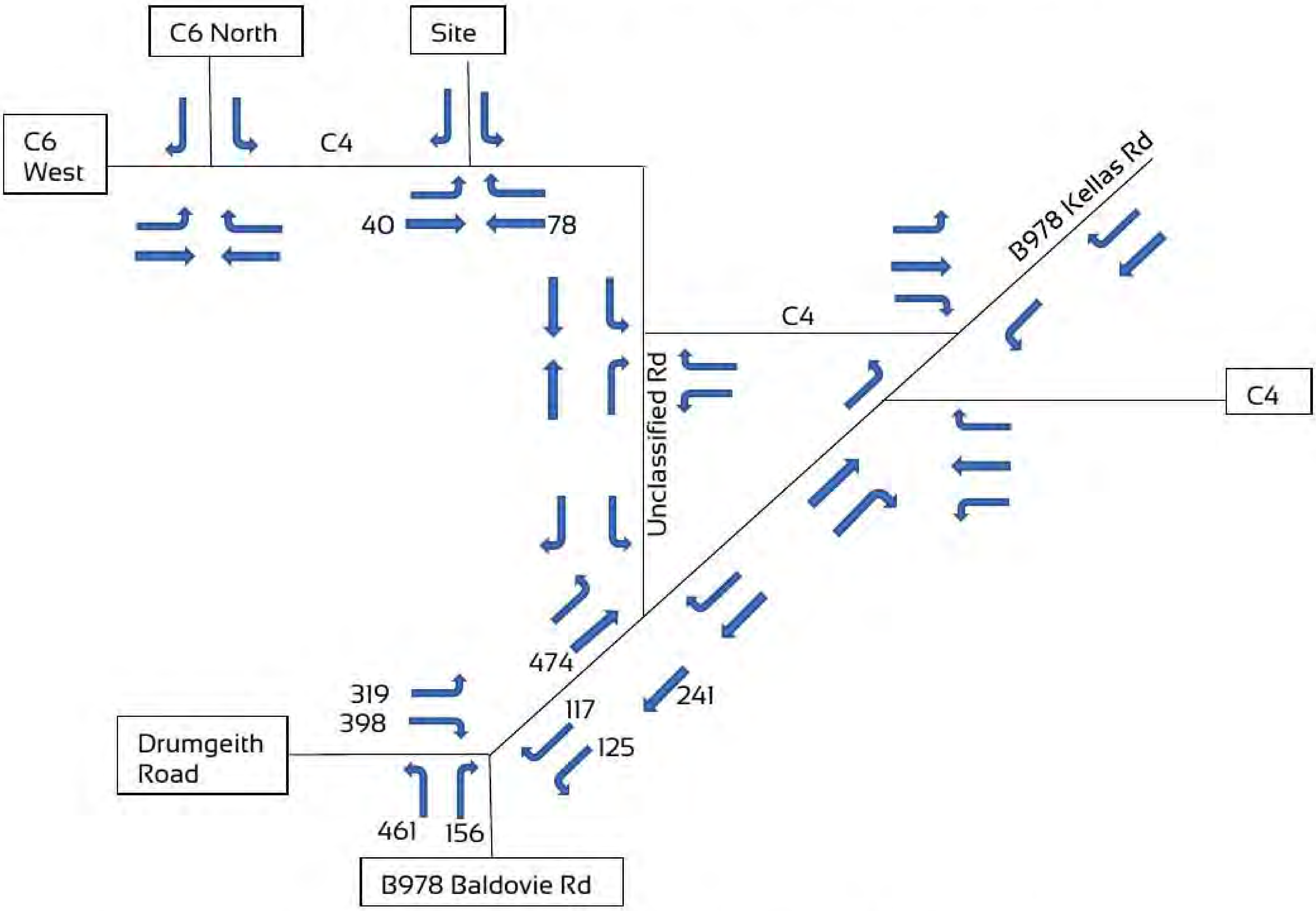


Figure 6 – 2021 Weekday PM Base Flows 16:15 – 17:15 (Vehicles)

TRIP GENERATION

4.6 As there are no sites from Crematoriums within the TRICS database the generated trips will be based on the expected usage of the Crematorium. The following information has been provided by the developer. Some of the information has been based on a previous TA undertaken for a Crematorium at 100Acre Wood in Fife which used information obtained from Parkgrove Crematorium near Friockheim.

- The Crematorium will have a seating capacity of 120.
- There is expected to be an average of 3 cremations per day.
- There will be no weekend cremations.
- A maximum of 5 cremations per day will take place.
- Cremations will be at a minimum of 1-hour intervals (i.e. There is a minimum of 1-hour gap between a service ending and the next one starting).
- Cremations start times will be between 09:00 and 16:00.
- 4 full time staff.
- Cremations will be attended by an average of 70 people arriving in 24 cars, with a very infrequent extreme maximum of 200 people arriving in 67 cars. This is based on the average occupancy of 3 people per car as experienced at Parkgrove (See section 2.16)
- There will be a memorial garden which is expected to not have a high peak demand with peak usage expected at weekends when there are no cremations planned.
- Coaches will be expected at approximately 3% of funerals.
- Visitors to the memorial gardens will generate an average of 10 vehicles per day although this will only reach this figure once the garden is fully established.

4.7 It is unlikely that two maximum capacity funerals would take place back to back and these are not expected to occur with any great frequency. Therefore, the worst case frequently experienced scenario to be considered is for an average size funeral leaving and an average size funeral arriving within the same hourly period. Therefore, it is considered that 24 cars arriving and leaving within the same hour should be assessed for impact on the local road network.

Trip Distribution

4.8 It was agreed at the scoping meeting that a population gravity/distribution model should be used to determine the percentage distribution of the generated trips. A population gravity model was considered however this would likely lead to a much disproportionately high proportion of trips from Dundee given the high population and short distance to the site. The crematorium is to primarily serve the Angus Council District.

4.9 The distribution is therefore based on a population distribution model which has been determined using the populations of electoral ward areas provided within the Scotland Census 2011 data. This has considered the catchment area of the crematorium to be the Angus Council electoral wards and the Dundee City Council wards. The extent of the electoral wards selected is shown below:

Figure 7 – Scottish Census Electoral Ward Areas – Proposed Crematorium Catchment Area

4.10 A percentage of the traffic from each electoral ward area has been apportioned to the most likely routes used from these electoral wards to access the crematorium and enter the assessed road network area.

4.11 The population distribution model is contained in **Appendix C**. The % distribution through the assessed road network is in figure 8 below:

4.12 The proposed traffic generated by the development with 24 inbound and 24 outbound trips is shown in the figure 9 below:

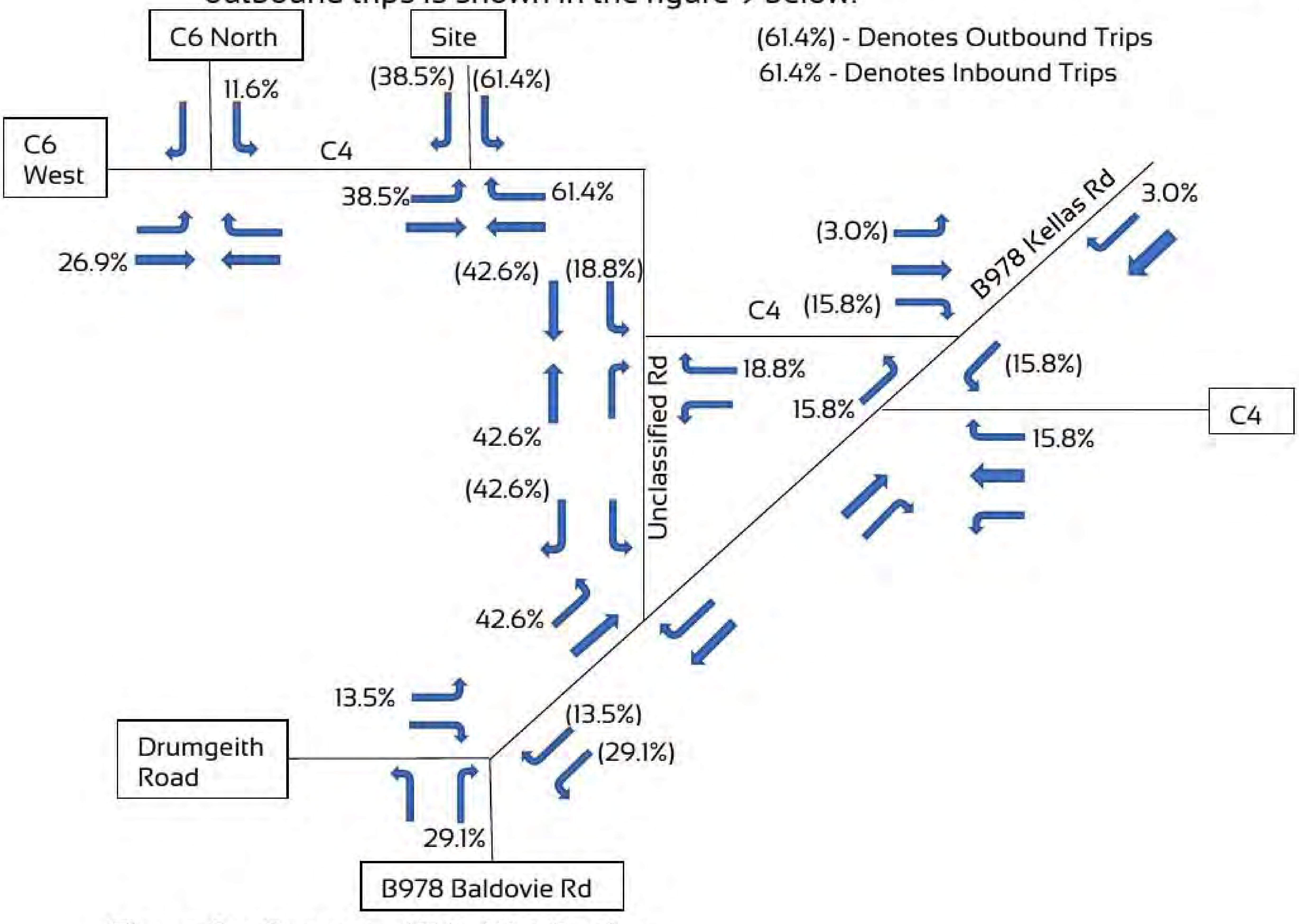


Figure 8 – Generated Trip Distribution

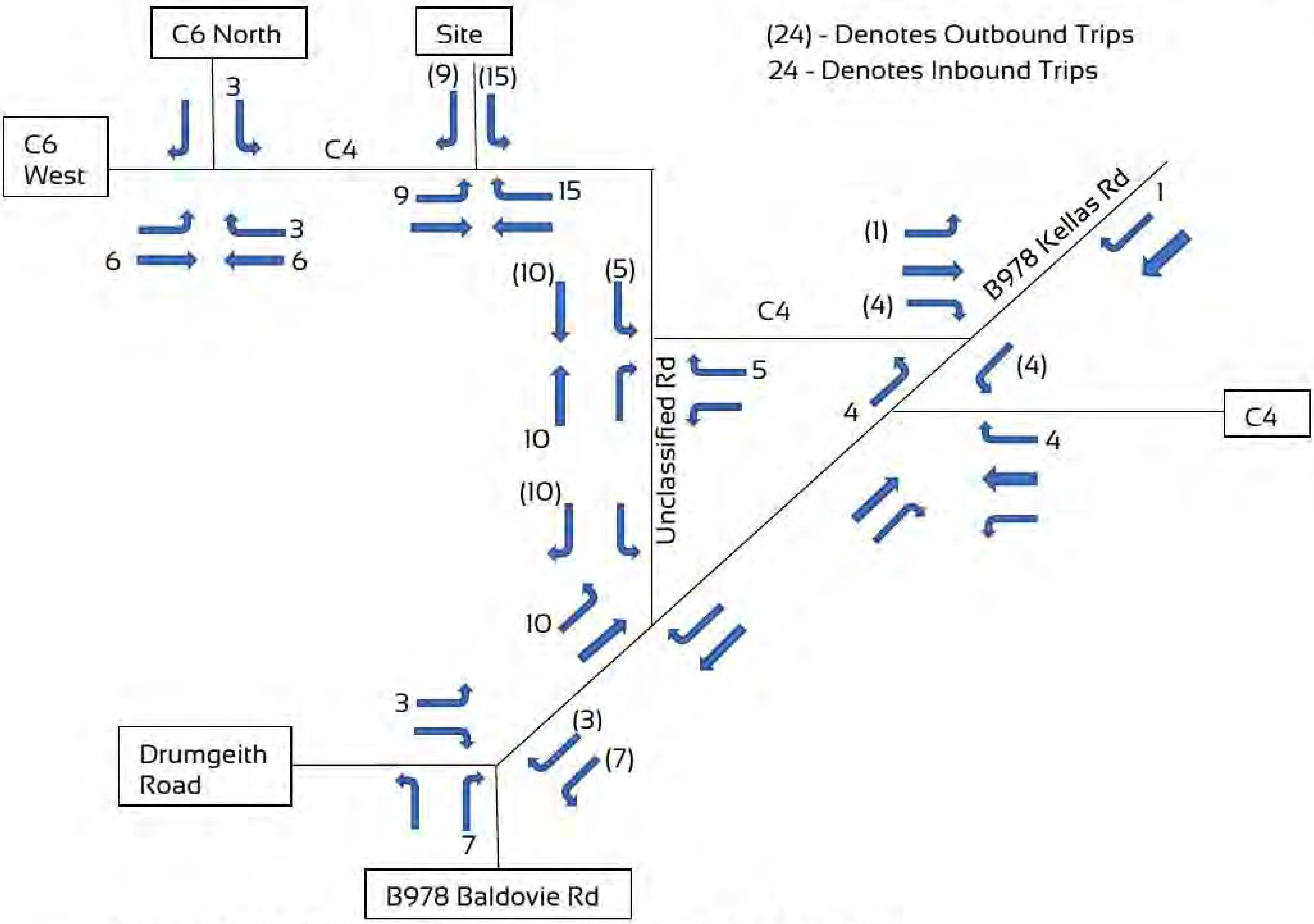


Figure 9 – Generated Trips Based on Average Funerals

Committed Developments

4.13 There are no known committed developments to consider.

Threshold Assessment

4.14 The above proposed traffic generation figures are applied to the 2021 AM and PM Base Flows to determine the 2-way flow thresholds assessment which is shown in the figures below. Where the generated traffic results in an increase of greater than 5% a junction capacity analysis is normally considered to be required to be undertaken. Although where existing plus proposed development traffic is clearly shown to be well below that expected to cause capacity and queuing issues then it is accepted that modelling is not required in these circumstances.

4.15 Based on the figures below it is shown that due to the relatively small existing traffic flows on the existing minor roads there is a large percentage increase in traffic resulting from the development with a 27% increase during the AM peak on the C4 at the site frontage. Due to the existing traffic flows and expected traffic generation it was accepted at the scoping meeting that there would be no requirement to model the proposed site access junction provided a simple priority T-junction with adequate visibility lines is provided.

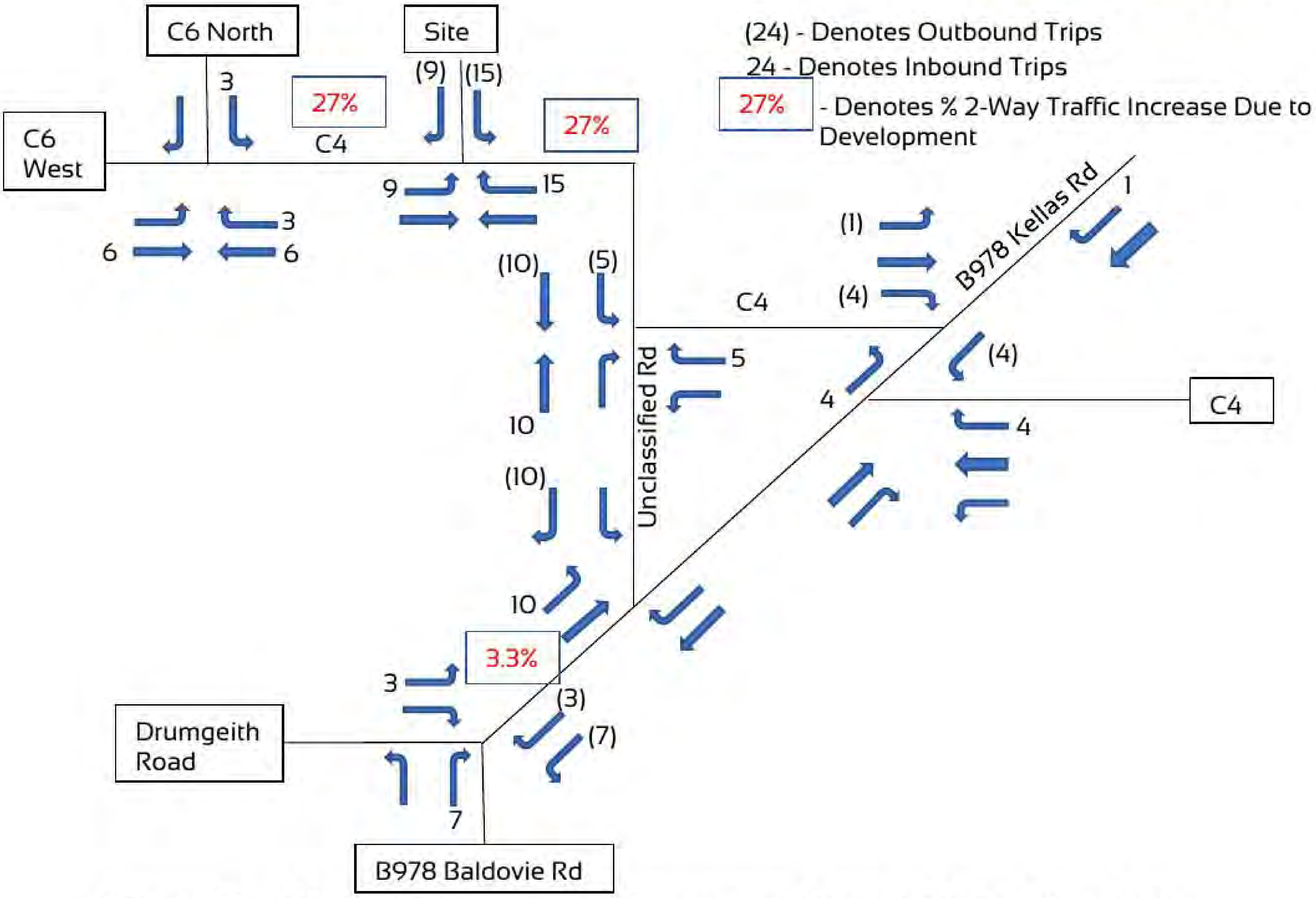


Figure 10 – 2-Way Traffic Threshold Assessment Generated Trips Based on Average Funerals Compared with 2021 AM Base Flow

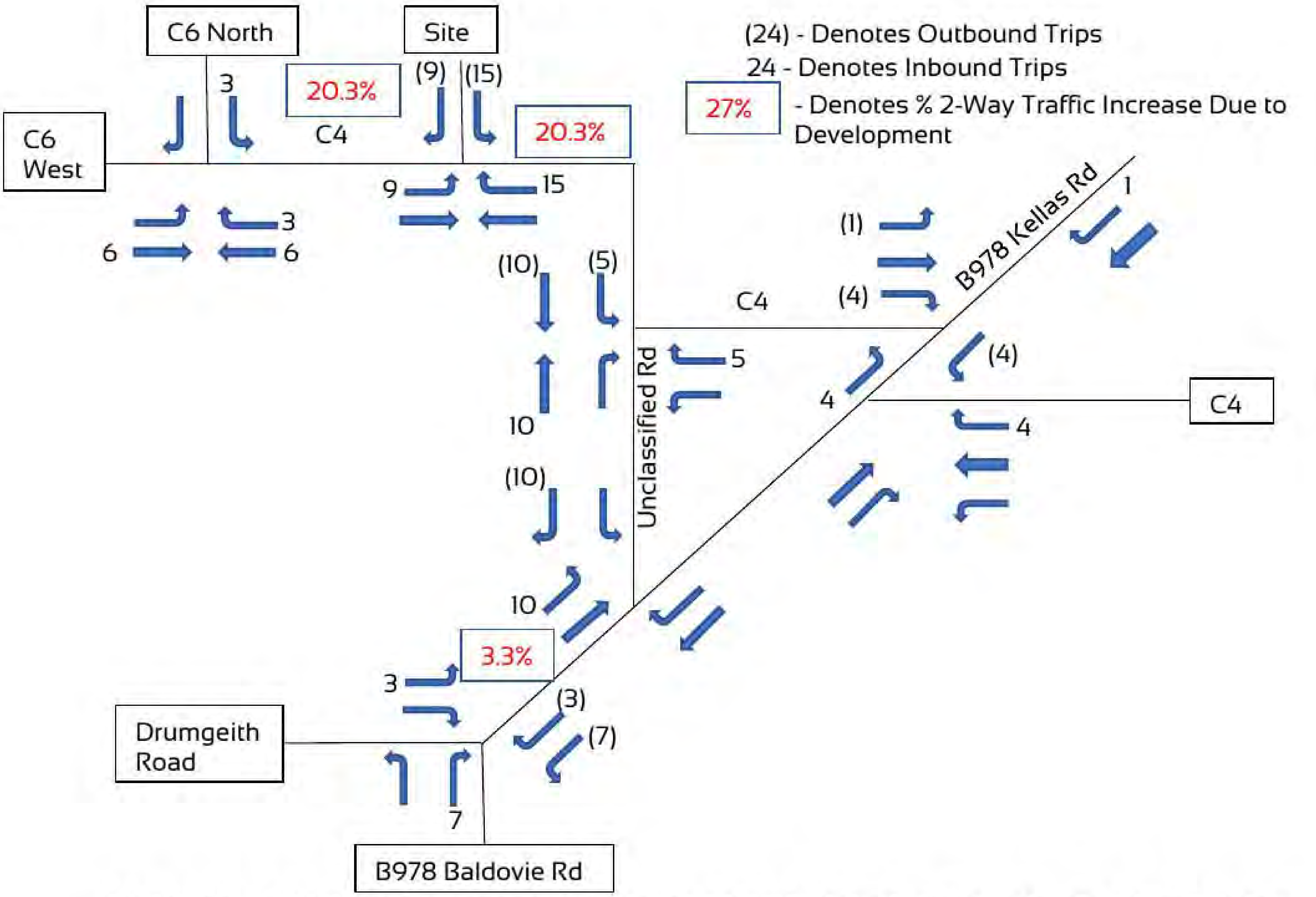


Figure 11 – 2-Way Traffic Threshold Assessment Generated Trips Based on Average Funerals Compared with 2021 PM Base Flow

5.15 The increases in traffic are only 3.3% for both AM and PM peak periods on Kellas Road itself and therefore there is no requirement for a capacity analysis of the Kellas Road junction with Baldovie Road. Even if it was considered that one maximum seating capacity funeral was followed by an average funeral the percentage increase on Kellas Road would then only increase to 4.4%.

5.0 CONCLUSIONS

5.1 The proposed 120 seating capacity crematorium is anticipated to serve primarily the Angus Council area.

5.2 Given its location close to Dundee a reasonable percentage of trips would be generated from Dundee which is the largest population within the nearby area.

5.3 The proposed site access will be in the form of a simple priority T-junction taken off the C4 with 4.5m x 120m visibility splays provided each side to suit the design speed of 40mph established through speed surveys.

5.4 Junction modelling for the proposed simple priority T-junction site access junction is not required as a result of the existing low traffic flows and the scale of the development would clearly not result in the proposed access junction having any capacity issues. It is also considered that there is no requirement to undertake junction capacity modelling on any of the existing road network junctions.

5.5 It is proposed to provide signage so that those accessing the site from the C4 West and from Baldovie Road are directed to use the unclassified Road rather than the C4 section between the unclassified Road and Kellas Road due to this section of the C4 having a lesser road width than the unclassified road. Also the C4 junction with B878 Kellas Road has substandard visibility.

5.6 A number of additional passing places will be provided along the C4 and unclassified road as identified on the drawings in **Appendix B**.

5.7 The existing road along the full length of the site frontage will be widened to 5.5m.

5.8 The unclassified junction with the B978 Kellas Road desired visibility is 4.5mx160m to suit a 50mph design speed which has been determined by speed survey data presented within this report. Bushes/shrubs within the adopted road envelope requires to be cleared in order for this to be achieved when looking to the South.

5.9 At the same junction the visibility achieved to the North is 2.2mx160m and again this will require shrubs and grass to be cut back within the road envelope in order to provide this visibility. Once this is undertaken this will improve the existing visibility at the junction and therefore it is considered that the visibility provided is acceptable.

5.10 A total of 90 spaces are proposed including 50 standard, 4 disabled, 32 overflow and 4 staff.

5.11 Bus services are available including two services which pass the site frontage and can be accessed on a hail and ride basis. Additional bus services are provided to the surrounding area which gives the opportunity for staff and funeral attendees to access the site via existing public transport.

5.11 If considered essential an appropriate bus stop or pull in area could be incorporated as part of the access to be formed for the site. Correspondence from Xplore Dundee who run buses in the area indicates they *"would be happy with anything that would improve accessibility and make a service more useful for people" and they* have previously contacted the relevant parties at Angus Council.

5.12 Alternatively bearing in mind the anticipated infrequency it is anticipated that people will want to access facilities by public transport: it would probably be more suitable to incorporate into the transport plan for the site the provision of a call up service for those who wanted to be collected from the existing nearest bus stops. As we have already incorporated provision for electric vehicles on site this could also be by electric vehicle to keep emissions to an absolute minimum.

5.13 Although it has been shown that there is reasonable public transport infrastructure already provided when considering the sites rural location, the potential to extend surrounding bus services to include the site should demand require it and the potential for a call up service to/from the site to the nearby bus stops there is ample opportunity to ensure funeral attendees and staff can access the site via public transport. It is not expected that there would be any significant demand for public transport provision given the nature of the development. The above information in our view gives adequate provision and opportunity to travel to site via public transport.

5.14 There are currently no footpath or cycle links to the site and given the nature of the development there is no proposal to provide a footpath link.

5.14 As a result, of the low traffic impact on the surrounding road network and the proposed access provision and improvements to existing visibility splays there is no foreseeable reason for refusal of the proposed planning application, in terms of traffic impact or transport provision.

BAC
28.09.2021

APPENDIX A – TRAFFIC SURVEY AND SPEED SURVEY DATA

TRANSURVEYS

TRAFFIC SURVEY REPORT

KELLAS ROAD, DUNDEE

TRANSURVEYS LIMITED

BLUE SQUARE OFFICES, 272 BATH STRET, GLASGOW, G2 4JR

TRAFFIC SURVEY REPORT

QUALITY MANAGEMENT

CLIENT	Cameron + Ross
PROJECT	Kellas Road, Dundee
REFERENCE	TS-19-058
REVISION	001

Revision	Date	Prepared by	Signed	Checked by	Signed
001	22/10/2018	Neil Dempsey	[redacted]	Neil Dempsey	[redacted]

DISCLAIMER

SURVEYED NETWORK

Junction Turning Counts & Queue Surveys:-

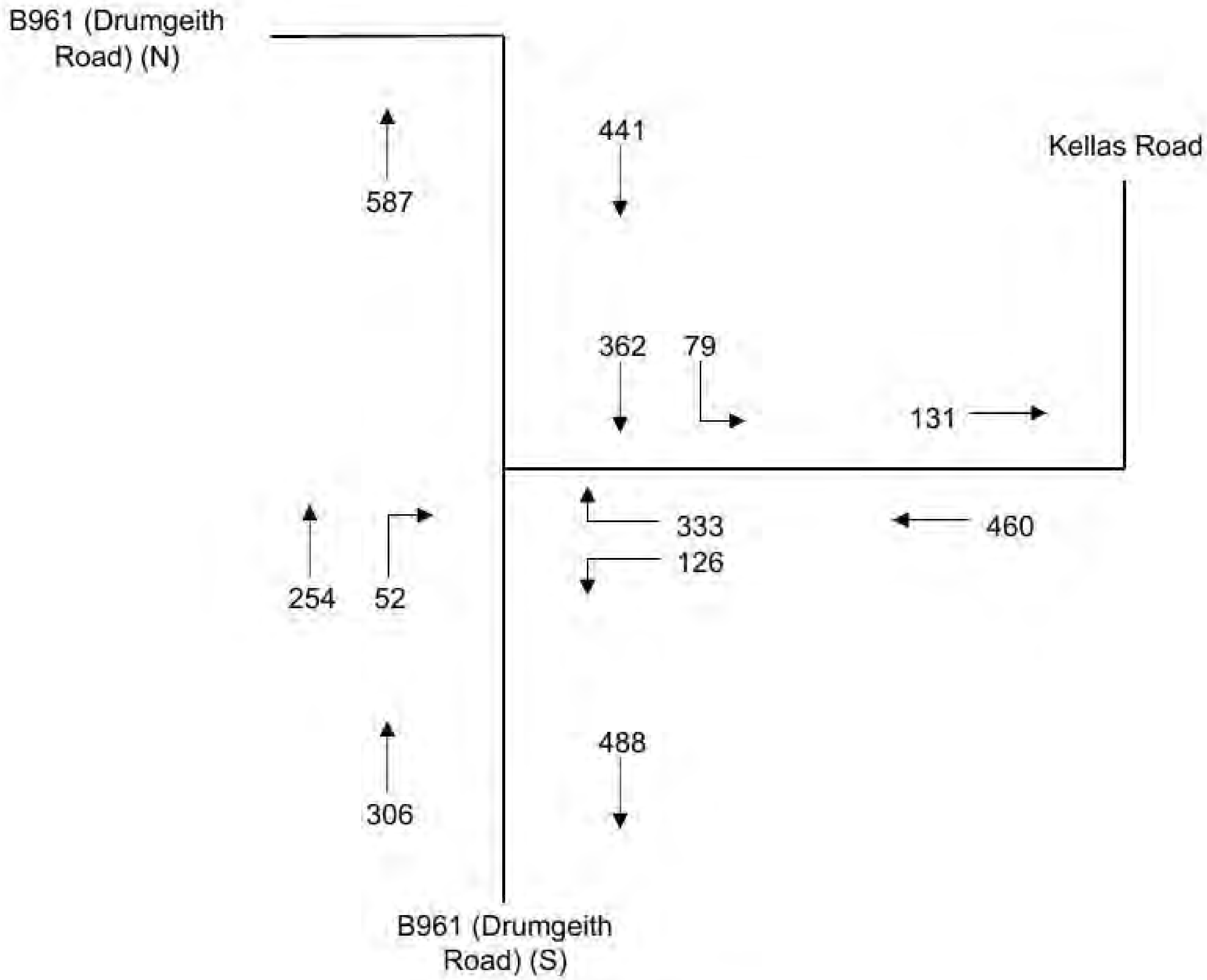
1. B961 (Drumgeith Road) / Kellas Road Priority Junction

Automatic Traffic Counts:-

2. Unnamed Road, east of Duntrune House; and
3. Kellas Road - approximately 30m south of Unnamed Road.

CLASSIFIED VEHICLE JUNCTION TURNING COUNTS

SURVEY NETWORK TRAFFIC FLOW DIAGRAMS

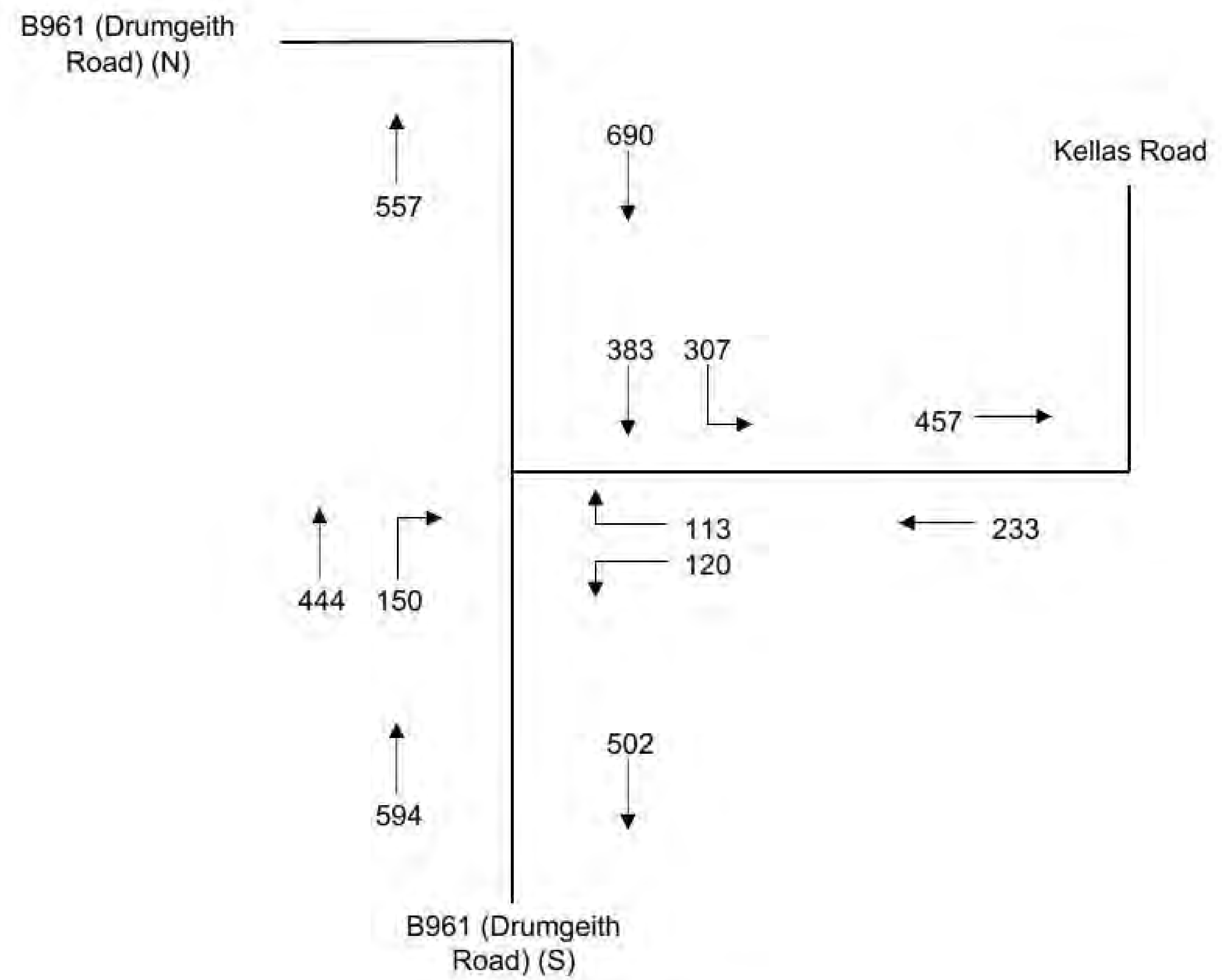


	Peak Hour
Weekday AM Hour	07:30-08:30
Veh.Classification	TOTAL PCUs

Date: 8th October 2019

For illustrative purposes only, please refer to data sheets for individual traffic movements

SURVEY NETWORK TRAFFIC FLOW DIAGRAMS



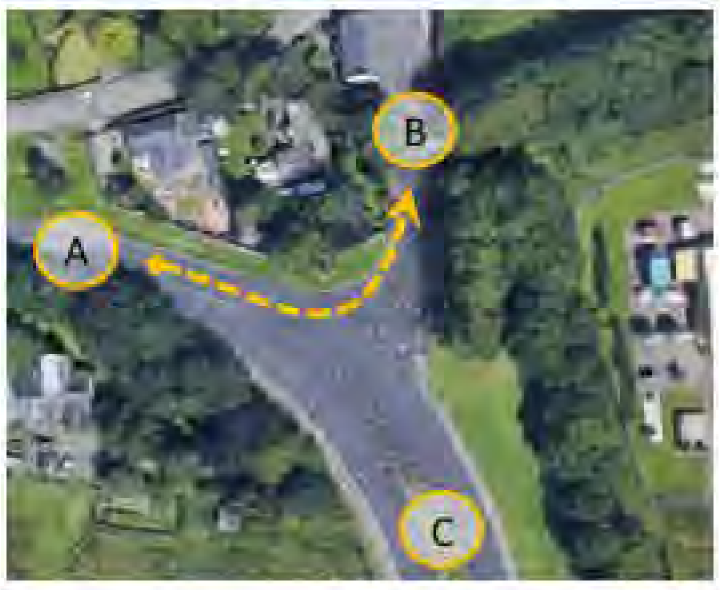
	Peak Hour
Weekday PM Hour	16:15-17:15
Veh.Classification	TOTAL PCUs

Date: 8th October 2019

For illustrative purposes only, please refer to data sheets for individual traffic movements

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.1: B961 (Drumgeith Road) (North) to Kellas Road Left Turn (A-B)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	7	0	0	0	0	7	0	7.00
07:15	07:30	0	0	9	2	1	0	0	12	1	12.50
07:30	07:45	0	0	10	3	0	0	1	14	1	15.00
07:45	08:00	0	0	12	6	2	0	0	20	2	21.00
08:00	08:15	0	0	13	3	2	0	0	18	2	19.00
08:15	08:30	0	0	18	6	0	0	0	24	0	24.00
08:30	08:45	0	0	11	3	1	1	0	16	2	17.80
08:45	09:00	0	1	18	3	0	0	0	22	0	21.40
09:00	09:15	0	0	16	7	1	2	0	26	3	29.10
09:15	09:30	0	0	12	3	2	0	0	17	2	18.00
09:30	09:45	0	0	7	6	0	0	0	13	0	13.00
09:45	10:00	0	0	21	7	2	0	0	30	2	31.00
TOTAL		0	1	154	49	11	3	1	219	15	228.80

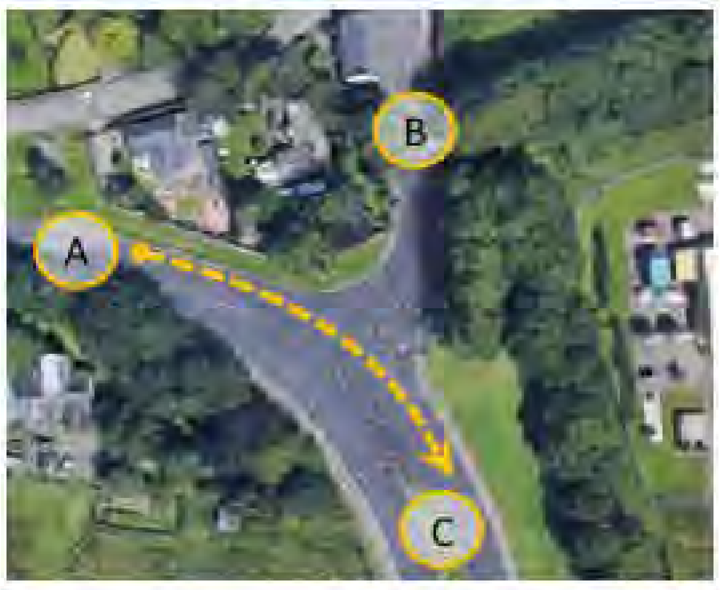
PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	53	18	4	0	1	76	5	79.00
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	53	18	4	0	1	76	5	79.00

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	0	39	6	1	1	0	47	2	48.80
15:45	16:00	0	0	55	6	4	1	0	66	5	69.30
16:00	16:15	0	1	53	5	1	0	0	60	1	59.90
16:15	16:30	1	0	53	15	4	0	0	73	4	74.20
16:30	16:45	0	0	55	10	1	0	1	67	2	68.50
16:45	17:00	1	0	61	7	1	0	0	70	1	69.70
17:00	17:15	0	0	84	9	1	0	0	94	1	94.50
17:15	17:30	0	1	68	4	1	0	0	74	1	73.90
17:30	17:45	0	0	49	6	1	0	0	56	1	56.50
17:45	18:00	0	0	56	9	0	1	0	66	1	67.30
18:00	18:15	0	0	56	3	0	1	0	60	1	61.30
18:15	18:30	0	0	43	2	0	0	0	45	0	45.00
TOTAL		2	2	672	82	15	4	1	778	20	788.90

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	2	0	253	41	7	0	1	304	8	306.90
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	2	0	253	41	7	0	1	304	8	306.90

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.2: B961 (Drumgeith Road) (North) to B961 (Drumgeith Road) (South) Ahead (A-C)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	37	2	1	1	0	41	2	42.80
07:15	07:30	1	0	61	12	4	1	0	79	5	81.50
07:30	07:45	0	1	60	13	4	0	0	78	4	79.40
07:45	08:00	1	0	82	20	5	4	0	112	9	118.90
08:00	08:15	0	0	44	15	6	3	0	68	9	74.90
08:15	08:30	2	1	62	13	4	3	0	85	7	88.70
08:30	08:45	0	0	51	11	3	2	0	67	5	71.10
08:45	09:00	0	0	58	11	0	0	0	69	0	69.00
09:00	09:15	0	0	39	10	4	0	0	53	4	55.00
09:15	09:30	0	0	32	7	2	3	0	44	5	48.90
09:30	09:45	0	0	44	8	8	3	0	63	11	70.90
09:45	10:00	0	0	48	10	3	0	0	61	3	62.50
TOTAL		4	2	618	132	44	20	0	820	64	863.60

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	3	2	248	61	19	10	0	343	29	361.90
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	3	2	248	61	19	10	0	343	29	361.90

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	1	55	8	4	1	0	69	5	71.70
15:45	16:00	0	0	60	8	3	5	0	76	8	84.00
16:00	16:15	0	0	70	6	2	0	0	78	2	79.00
16:15	16:30	0	0	69	12	5	2	0	88	7	93.10
16:30	16:45	0	0	81	16	2	2	0	101	4	104.60
16:45	17:00	0	0	69	11	1	2	0	83	3	86.10
17:00	17:15	0	0	76	11	2	3	1	93	6	98.90
17:15	17:30	0	0	83	10	3	1	0	97	4	99.80
17:30	17:45	0	0	62	7	2	1	0	72	3	74.30
17:45	18:00	0	1	68	7	1	2	0	79	3	81.50
18:00	18:15	0	0	48	8	0	0	0	56	0	56.00
18:15	18:30	0	0	68	5	0	2	0	75	2	77.60
TOTAL		0	2	809	109	25	21	1	967	47	1006.60

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	295	50	10	9	1	365	20	382.70
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	295	50	10	9	1	365	20	382.70

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

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Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.3: Kellas Road to B961 (Drumgeith Road) (South) Left Turn (B-C)

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	13	1	0	1	0	15	1	16.30
07:15	07:30	1	1	18	4	0	0	0	24	0	22.60
07:30	07:45	0	1	15	3	2	0	0	21	2	21.40
07:45	08:00	0	0	27	9	0	2	0	38	2	40.60
08:00	08:15	0	0	20	2	2	0	1	25	3	27.00
08:15	08:30	1	0	25	12	0	0	0	38	0	37.20
08:30	08:45	0	0	26	2	0	1	0	29	1	30.30
08:45	09:00	0	0	31	5	1	1	0	38	2	39.80
09:00	09:15	1	0	18	5	0	0	0	24	0	23.20
09:15	09:30	1	0	21	6	0	0	0	28	0	27.20
09:30	09:45	0	0	21	4	2	1	0	28	3	30.30
09:45	10:00	0	0	21	5	0	0	0	26	0	26.00
TOTAL		4	2	256	58	7	6	1	334	14	341.90

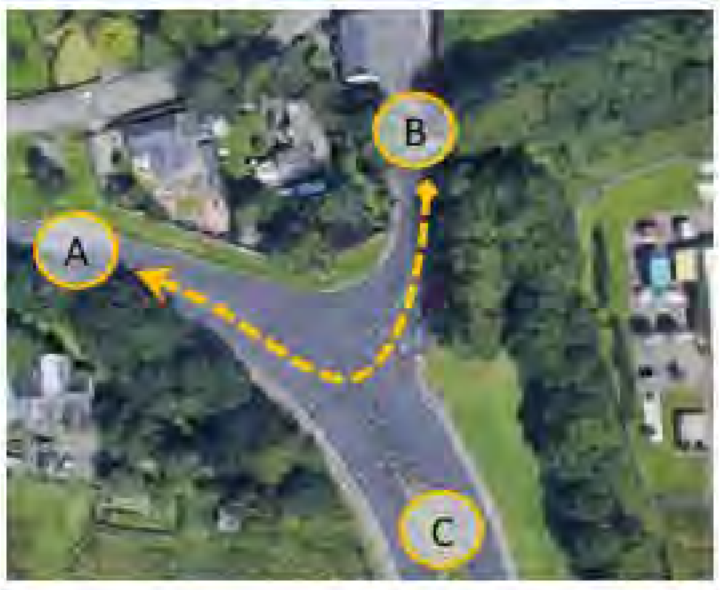
PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	1	1	87	26	4	2	1	122	7	126.20
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	1	1	87	26	4	2	1	122	7	126.20

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	1	0	17	2	0	0	0	20	0	19.20
15:45	16:00	0	0	28	2	2	0	0	32	2	33.00
16:00	16:15	0	0	21	6	0	0	0	27	0	27.00
16:15	16:30	0	0	33	7	0	0	0	40	0	40.00
16:30	16:45	0	0	18	2	0	1	0	21	1	22.30
16:45	17:00	1	0	28	2	0	0	0	31	0	30.20
17:00	17:15	0	0	23	1	2	0	0	26	2	27.00
17:15	17:30	0	0	17	5	0	0	0	22	0	22.00
17:30	17:45	0	0	32	4	1	0	0	37	1	37.50
17:45	18:00	0	0	25	1	1	1	0	28	2	29.80
18:00	18:15	0	0	31	2	1	0	0	34	1	34.50
18:15	18:30	0	0	18	2	1	0	0	21	1	21.50
TOTAL		2	0	291	36	8	2	0	339	10	344.00

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	102	12	2	1	0	118	3	119.50
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	102	12	2	1	0	118	3	119.50

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.3: Kellas Road to B961 (Drumgeith Road) (North) Right Turn (B-A)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	32	8	0	0	0	40	0	40.00
07:15	07:30	0	0	40	7	0	2	0	49	2	51.60
07:30	07:45	1	0	63	13	4	0	0	81	4	82.20
07:45	08:00	1	0	63	6	1	3	0	74	4	77.60
08:00	08:15	0	0	70	9	0	0	0	79	0	79.00
08:15	08:30	0	0	87	6	1	0	0	94	1	94.50
08:30	08:45	0	0	62	13	4	0	0	79	4	81.00
08:45	09:00	0	1	36	8	0	2	1	48	3	51.00
09:00	09:15	0	0	33	4	3	1	0	41	4	43.80
09:15	09:30	0	0	36	4	4	1	0	45	5	48.30
09:30	09:45	0	0	23	2	2	1	0	28	3	30.30
09:45	10:00	0	0	47	2	0	0	0	49	0	49.00
TOTAL		2	1	592	82	19	10	1	707	30	728.30

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	2	0	283	34	6	3	0	328	9	333.30
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	2	0	283	34	6	3	0	328	9	333.30

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	0	27	6	1	1	0	35	2	36.80
15:45	16:00	0	0	21	7	1	0	0	29	1	29.50
16:00	16:15	1	0	17	5	0	0	0	23	0	22.20
16:15	16:30	0	1	15	8	0	0	0	24	0	23.40
16:30	16:45	0	0	27	5	0	0	1	33	1	34.00
16:45	17:00	0	0	21	4	1	1	0	27	2	28.80
17:00	17:15	0	0	23	4	0	0	0	27	0	27.00
17:15	17:30	0	0	32	2	0	0	0	34	0	34.00
17:30	17:45	0	0	24	1	0	0	0	25	0	25.00
17:45	18:00	0	0	21	3	0	0	0	24	0	24.00
18:00	18:15	0	0	27	4	0	0	0	31	0	31.00
18:15	18:30	0	0	24	3	0	0	0	27	0	27.00
TOTAL		1	1	279	52	3	2	1	339	6	342.70

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	1	86	21	1	1	1	111	3	113.20
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	1	86	21	1	1	1	111	3	113.20

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee

Client: Cameron + Ross

Project Ref: TS-19-058

Date: Tuesday 8th October 2019

Weather: AM: Dry / Sunny; PM: Wet / Overcast

Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction

Movement 1.4: B961 (Drumgeith Road) (South) to B961 (Drumgeith Road) (North) Ahead (C-A)

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	39	9	1	0	0	49	1	49.50
07:15	07:30	0	0	31	7	1	0	0	39	1	39.50
07:30	07:45	0	0	49	6	1	6	1	63	8	72.30
07:45	08:00	0	0	41	13	1	3	0	58	4	62.40
08:00	08:15	0	0	48	8	2	0	0	58	2	59.00
08:15	08:30	0	0	40	8	8	0	0	56	8	60.00
08:30	08:45	0	0	31	13	4	1	0	49	5	52.30
08:45	09:00	0	0	37	9	2	1	0	49	3	51.30
09:00	09:15	0	0	40	12	4	5	0	61	9	69.50
09:15	09:30	0	0	31	16	3	0	0	50	3	51.50
09:30	09:45	0	0	37	13	4	0	0	54	4	56.00
09:45	10:00	0	0	49	12	3	0	0	64	3	65.50
TOTAL		0	0	473	126	34	16	1	650	51	688.80

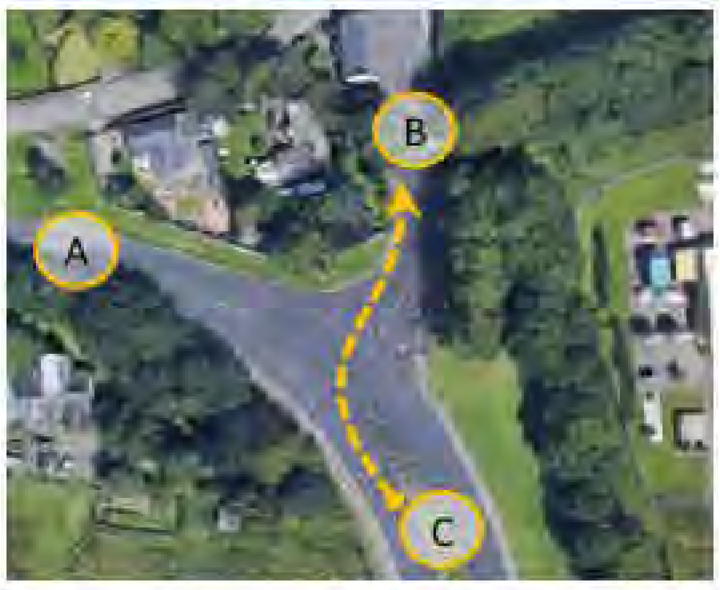
PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	178	35	12	9	1	235	22	253.70
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	178	35	12	9	1	235	22	253.70

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	1	0	123	6	0	4	0	134	4	138.40
15:45	16:00	0	0	56	10	0	2	0	68	2	70.60
16:00	16:15	1	0	63	11	4	1	0	80	5	82.50
16:15	16:30	0	0	78	19	6	2	0	105	8	110.60
16:30	16:45	0	0	97	16	2	3	0	118	5	122.90
16:45	17:00	0	0	74	9	2	2	0	87	4	90.60
17:00	17:15	1	0	105	8	3	1	0	118	4	120.00
17:15	17:30	0	0	83	10	0	0	1	94	1	95.00
17:30	17:45	0	0	77	7	0	1	0	85	1	86.30
17:45	18:00	0	0	41	3	0	0	0	44	0	44.00
18:00	18:15	0	0	47	6	0	0	0	53	0	53.00
18:15	18:30	0	0	53	6	0	0	0	59	0	59.00
TOTAL		3	0	897	111	17	16	1	1045	34	1072.90

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	354	52	13	8	0	428	21	444.10
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	1	0	354	52	13	8	0	428	21	444.10

CLASSIFIED VEHICLE JUNCTION TURNING COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058
Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast
Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction
Movement 1.5: B961 (Drumgeith Road) (South) to Kellas Road Right Turn (C-B)



TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:00	07:15	0	0	7	1	0	1	0	9	1	10.30
07:15	07:30	0	0	7	2	1	0	0	10	1	10.50
07:30	07:45	0	0	7	2	1	0	0	10	1	10.50
07:45	08:00	0	0	7	1	0	0	0	8	0	8.00
08:00	08:15	0	0	10	2	0	1	0	13	1	14.30
08:15	08:30	0	0	14	4	1	0	0	19	1	19.50
08:30	08:45	0	0	12	2	0	0	0	14	0	14.00
08:45	09:00	0	0	10	2	1	0	0	13	1	13.50
09:00	09:15	0	0	15	6	0	0	0	21	0	21.00
09:15	09:30	0	0	13	3	0	0	1	17	1	18.00
09:30	09:45	0	0	13	5	0	0	0	18	0	18.00
09:45	10:00	0	0	18	4	3	0	0	25	3	26.50
TOTAL		0	0	133	34	7	2	1	177	10	184.10

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	38	9	2	1	0	50	3	52.30
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
07:30 - 08:30	0	0	38	9	2	1	0	50	3	52.30

TIME		VEHICLE CLASSIFICATION							TOTAL		
		B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
15:30	15:45	0	1	33	5	0	1	0	40	1	40.70
15:45	16:00	1	0	32	4	1	0	0	38	1	37.70
16:00	16:15	0	0	35	2	0	1	0	38	1	39.30
16:15	16:30	0	0	36	2	0	1	1	40	2	42.30
16:30	16:45	0	0	35	4	0	0	0	39	0	39.00
16:45	17:00	0	0	23	4	0	0	0	27	0	27.00
17:00	17:15	0	0	34	5	0	1	0	40	1	41.30
17:15	17:30	1	0	31	2	0	0	0	34	0	33.20
17:30	17:45	0	0	31	1	0	2	0	34	2	36.60
17:45	18:00	0	0	24	1	0	0	0	25	0	25.00
18:00	18:15	0	0	35	2	1	0	1	39	2	40.50
18:15	18:30	0	0	19	1	1	0	0	21	1	21.50
TOTAL		2	1	368	33	3	6	2	415	11	424.10

PEAK	VEHICLE CLASSIFICATION							TOTAL		
JUNCTION	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	128	15	0	2	1	146	3	149.60
NETWORK	B/CYCLE	M/CYCLE	CAR/TAXI	LGV	OGV1	OGV2	BUS/COACH	VEHICLES	HGVs	PCUs
16:15 - 17:15	0	0	128	15	0	2	1	146	3	149.60

VEHICLE QUEUE SURVEYS

STUDY NETWORK MAXIMUM QUEUE COUNT

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project Ref: TS-19-058

Date: Tuesday 8th October 2019
Weather: AM: Dry / Sunny; PM: Wet / Overcast

Junction 1: B961 (Drumgeith Road) / Kellas Road Priority Junction

TIME		VEHICLE MOVEMENT(S) / QUEUE - PCUs / LANE			
		B961 (Drumgeith Road) (North) (A-BC)	Kellas Road		B961 (Drumgeith Road) (South) (C-B)
			Near. (B-C)	Off. (B-A)	
07:15	07:20	-	0	1	0
07:20	07:25	-	0	4	0
07:25	07:30	-	0	4	1
07:30	07:35	-	0	3	0
07:35	07:40	-	0	11	0
07:40	07:45	-	0	3	1
07:45	07:50	-	1	7	1
07:50	07:55	-	1	16	0
07:55	08:00	-	1	9	1
08:00	08:05	-	1	2	0
08:05	08:10	-	1	4	0
08:10	08:15	-	1	2	1
08:15	08:20	-	1	5	2
08:20	08:25	-	1	4	1
08:25	08:30	-	2	11	2
08:30	08:35	-	2	2	0
08:35	08:40	-	1	4	1
08:40	08:45	-	2	10	1

QUEUE	NETWORK PEAK (07:30-08:30)			
MINIMUM	-	0	2	0
MAXIMUM	-	2	16	2
AVERAGE	-	1	6	1
85th%ILE	-	1	11	1

TIME		VEHICLE MOVEMENT(S) / QUEUE - PCUs / LANE			
		B961 (Drumgeith Road) (North) (A-BC)	Kellas Road		B961 (Drumgeith Road) (South) (C-B)
			Near. (B-C)	Off. (B-A)	
16:00	16:05	-	1	2	2
16:05	16:10	-	2	2	3
16:10	16:15	-	1	2	1
16:15	16:20	-	2	6	1
16:20	16:25	-	3	2	3
16:25	16:30	-	1	1	2
16:30	16:35	-	1	4	2
16:35	16:40	-	0	4	3
16:40	16:45	-	2	2	1
16:45	16:50	-	1	3	1
16:50	16:55	-	1	3	2
16:55	17:00	-	1	2	1
17:00	17:05	-	1	2	2
17:05	17:10	-	2	2	1
17:10	17:15	-	1	5	5
17:15	17:20	-	2	5	2
17:20	17:25	-	1	4	4
17:25	17:30	-	2	2	2

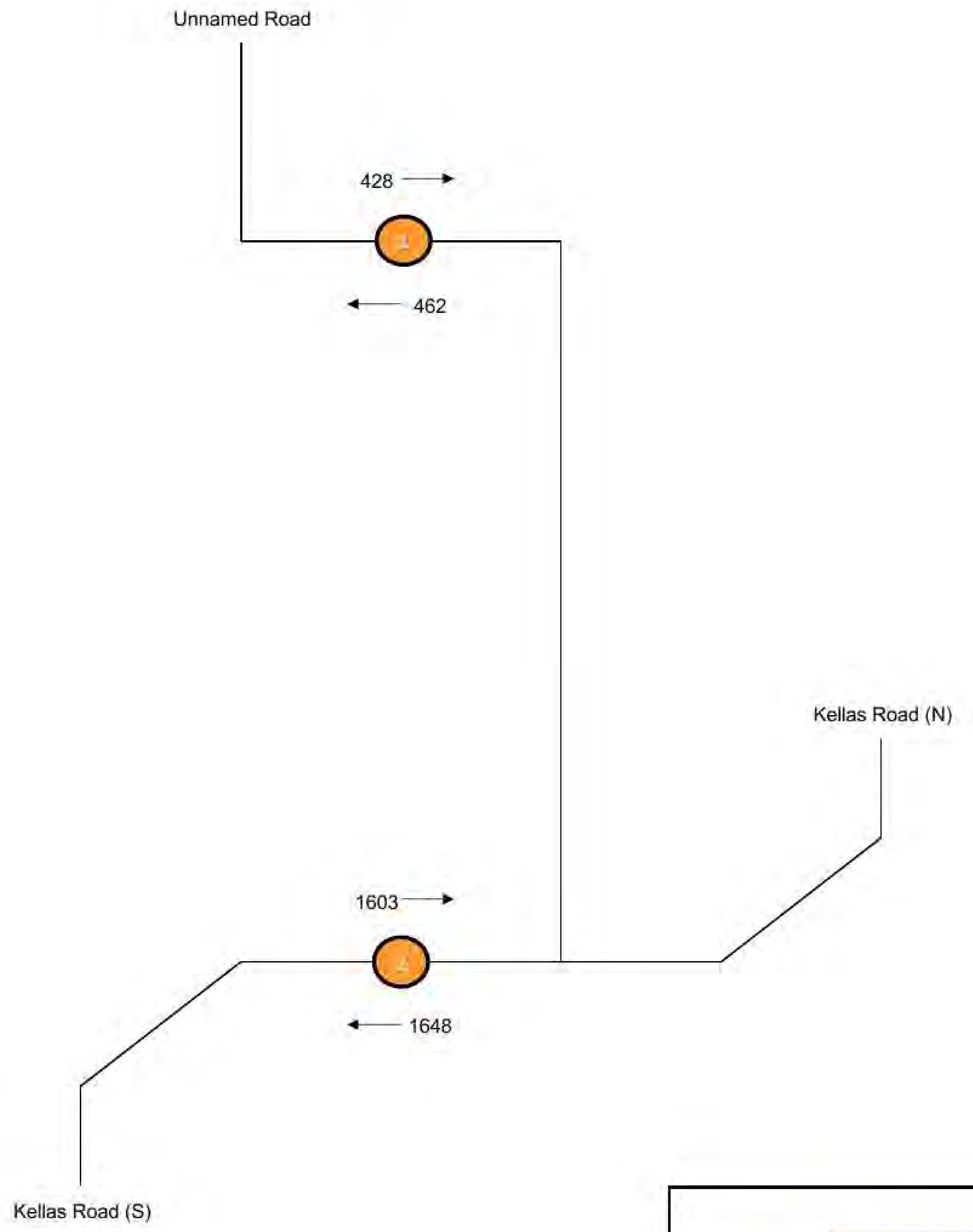
QUEUE	NETWORK PEAK (16:15-17:15)			
MINIMUM	-	0	1	1
MAXIMUM	-	3	6	5
AVERAGE	-	1	3	2
85th%ILE	-	2	4	3

CLASSIFIED AUTOMATIC TRAFFIC COUNTS (LINK FLOW & SPEED SURVEYS)

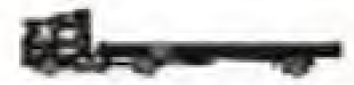
TRAFFIC SURVEY REPORT

SITE LOCATION	
Project:	Kellas Road, Dundee
Client:	Cameron + Ross
Project.Ref.	TS-19-058
Location 1:	Unamed Road, east of Duntrune House
Location 2:	Kellas Road - Approx. 30m south of Unnamed Road

SURVEY NETWORK TRAFFIC FLOW DIAGRAM



Time	24hr (00:00-00:00)
Date	7 day (Weekly) Average

CLASS	AXLES	AXLE GROUPS	DESCRIPTION	DOMINATE VEHICLE	AGGREGATE
1	2	1 or 2	Very Short - Bicycle or Motorcycle		
2	2	1 or 2	Short - Car, 4WD or Light Van		**LIGHT**
3	3 / 4 / 5	3	Short Towing - Trailer, Caravan etc.		
4	2	2	2-Axle Truck or Bus		
5	3	2	3-Axle Truck or Bus		**MEDIUM**
6	>3	2	4-Axle Truck		
7	3	3	3-Axle Articulated Vehicle or Rigid Vehicle & Trailer		
8	4	>2	4-Axle Articulated Vehicle or Rigid Vehicle & Trailer		
9	5	>2	5-Axle Articulated Vehicle or Rigid Vehicle & Trailer		**HEAVY**
10	>=6	>2	6 (or more) Axle Articulated Vehicle or Rigid Vehicle & Trailer		
11	>6	4	B-Double or Heavy Truck & Trailer		
12	>6	>=5	Double or Triple Heavy Truck & 2 (or more) Trailers		

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref: TS-19-058

Location 1: Unnamed Road, east of Duntrune House
Movement: Eastbound

TIME	TOTAL	ARX VEHICLE CLASSIFICATIONS: LIGHT 1	2	3	MEDIUM 4	5	6	HEAVY 7	8	9	10	11	12	SPEED BIN TOTALS: 0-5mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	SPEED STATISTICS: AVERAGE	MINIMUM	MAXIMUM	85th%ile
Date: 10 October 2019																																					
00:00 01:00	1	[illegible]	1	[illegible]																																	
07:00-19:00	[illegible]																																				
Date: 11 October 2019																																					
07:00-19:00	[illegible]																																				
Date: 12 October 2019																																					
07:00-19:00	[illegible]																																				
Date: 13 October 2019																																					

TIME	TOTAL	AXA VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS	SPEED STATISTICS			
		LIGHT			MEDIUM			HEAVY							AVERAGE	MINIMUM	MAXIMUM	85th%ile
		1	2	3	4	5	6	7	8	9	10	11	12					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Date: 14 October 2019																		
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Date: 15 October 2019																		
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Date: 16 October 2019																		
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5 day (Weekday) Average																		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 day (Weekly) Average																		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 1: Unnamed Road, east of Duntrune House
Movement: Westbound

TIME	TOTAL	ARX VEHICLE CLASSIFICATIONS												SPEED BIN TOTALS																					SPEED STATISTICS			
		LIGHT			MEDIUM			HEAVY																											AVERAGE	MINIMUM	MAXIMUM	85th%ile
		1	2	3	4	5	6	7	8	9	10	11	12	0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph					
Date: 10 October 2019																																						
Date: 11 October 2019																																						
Date: 12 October 2019																																						
Date: 13 October 2019																																						

TIME	TOTAL	AXA VEHICLE CLASSIFICATIONS: LIGHT 1	2	3	MEDIUM 4	5	6	HEAVY 7	8	9	10	11	12	SPEED BIN TOTALS: 0-5mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	SPEED STATISTICS: AVERAGE	MINIMUM	MAXIMUM	85%ile
[illegible]																																					
Date: 14 October 2019																																					
[illegible]																																					
Date: 15 October 2019																																					
[illegible]																																					
Date: 16 October 2019																																					
[illegible]																																					
5 day (Weekday) Average																																					
[illegible]																																					
7 day (Weekly) Average																																					
[illegible]																																					

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 2: Kellas Road - Approx. 30m south of Unnamed Road
Movement: Northbound

Date: 10 October 2019

Date: 11 October 2019

Date: 12 October 2019

Date: 13 October 2019

TIME	TOTAL	AXA VEHICLE CLASSIFICATIONS	SPEED BIN TOTALS	SPEED STATISTICS

Date: 14 October 2019

Date: 15 October 2019

Date: 16 October 2019

5 day (Weekday) Average

7 day (Weekly) Average

ATC CLASSIFIED LINK & SPEED SURVEY

Project: Kellas Road, Dundee
Client: Cameron + Ross
Project.Ref. TS-19-058

Location 2: Kellas Road - Approx. 30m south of Unnamed Road
Movement: Southbound

TIME	TOTAL	ARX VEHICLE CLASSIFICATIONS: LIGHT 1	2	3	MEDIUM 4	5	6	HEAVY 7	8	9	10	11	12	SPEED BIN TOTALS: 0-5 mph	5-10mph	10-15mph	15-20mph	20-25mph	25-30mph	30-35mph	35-40mph	40-45mph	45-50mph	50-55mph	55-60mph	60-65mph	65-70mph	70-75mph	75-80mph	80-85mph	85-90mph	90-95mph	95-100mph	SPEED STATISTICS: AVERAGE	MINIMUM	MAXIMUM	85th%ile
Date: 10 October 2019																																					
Date: 11 October 2019																																					
Date: 12 October 2019																																					
Date: 13 October 2019																																					

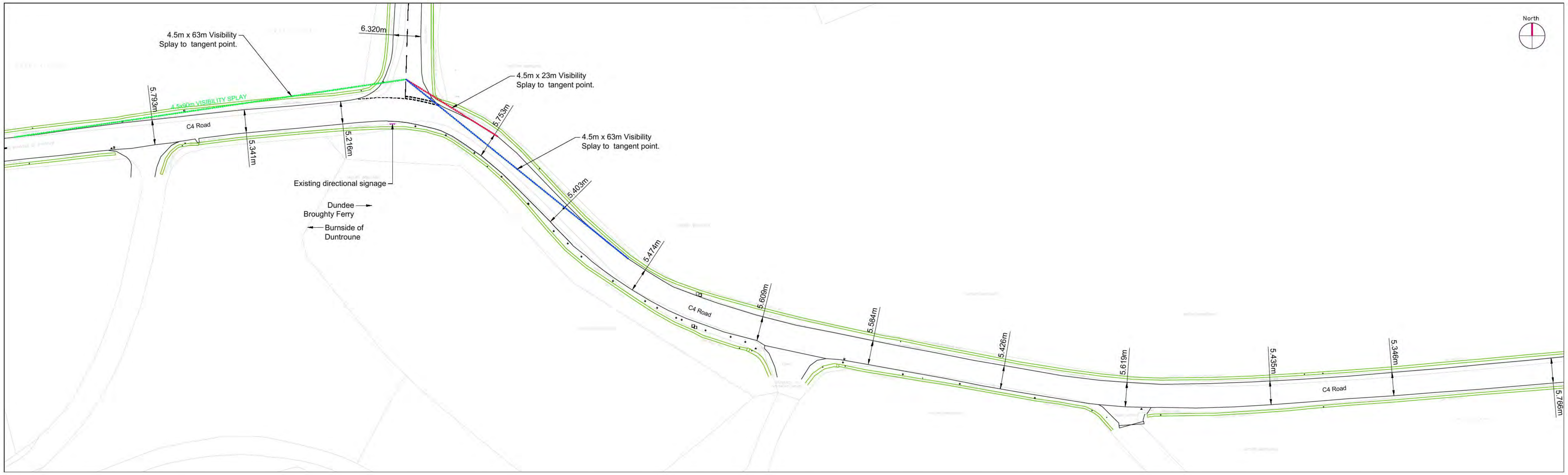
TIME	TOTAL	AXA VEHICLE CLASSIFICATIONS	SPEED BIN TOTALS	SPEED STATISTICS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Date: 14 October 2019				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Date: 15 October 2019				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Date: 16 October 2019				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5 day (Weekday) Average				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7 day (Weekly) Average				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

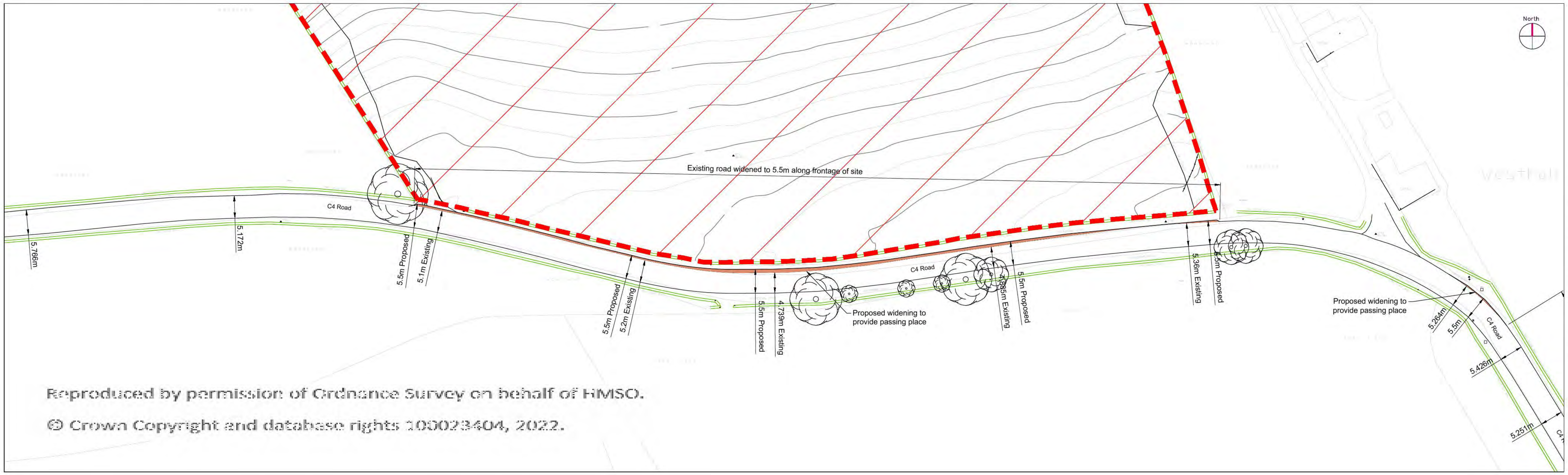
APPENDIX B – ROAD LAYOUT DRAWINGS

FIGURED DIMENSIONS ONLY TO BE USED

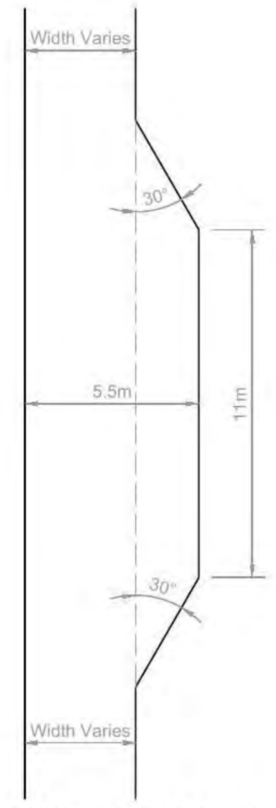
General notes:
1. Locations of viewports can be found on C+R Drg A/190889-900 - Roads Layout Plan.

VIEWPORT 1





VIEWPORT 2



Typical Passing Place Detail
Scale 1:200

Issue	Revision	Initial	Date
1	Full site frontage widened to 5.5m & Typical Passing Place detail amended to suit NRDG.	CRM	26/03/20

Cameron+Ross
CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB
Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Layout Plan
Sheet 1 of 3

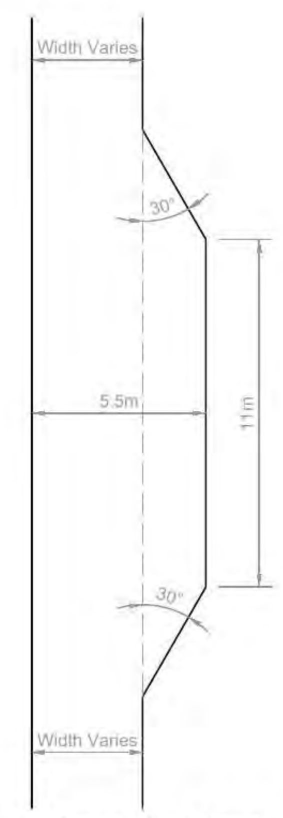
Status:
Concept

Scale:	1:500 @ A1	Date:	20/02/2020
By: CRM	Checked: BAC	Approved: RAG	

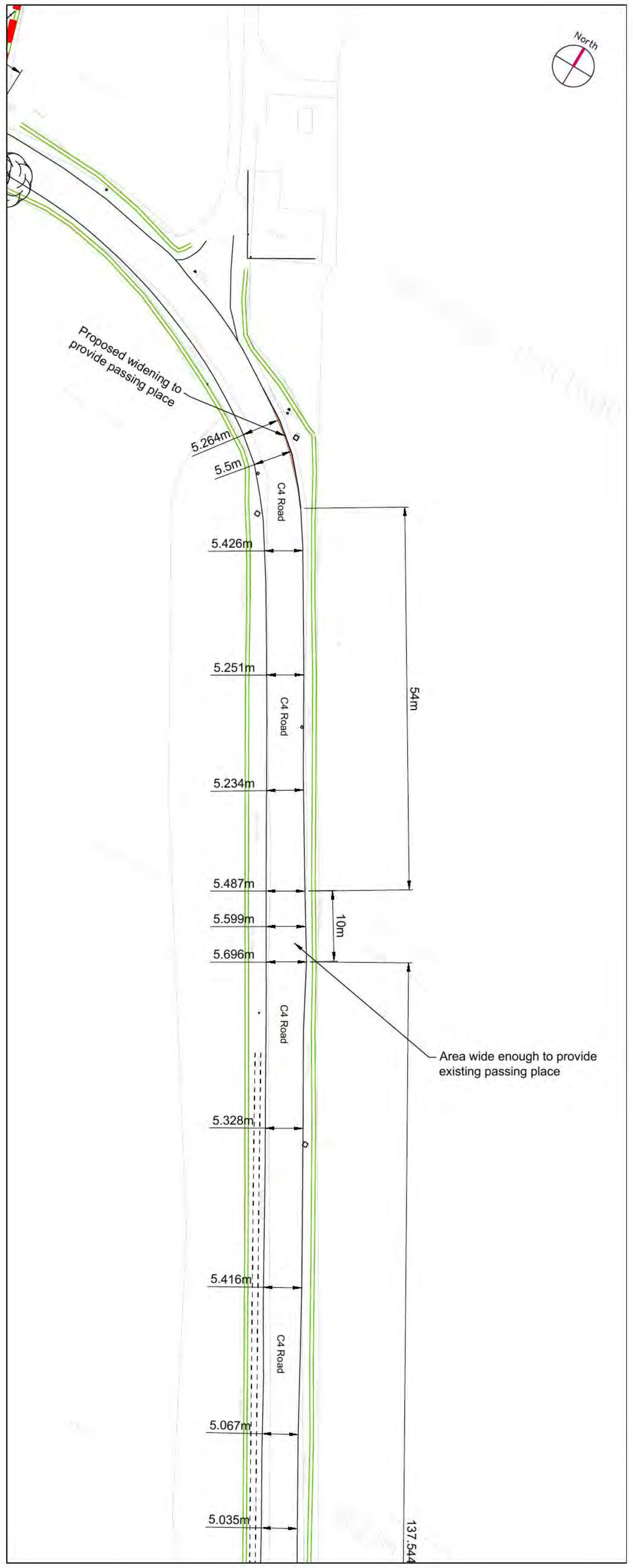
Dwg. No.: A/190889 – 901
Rev.: 1

FIGURED DIMENSIONS ONLY TO BE USED

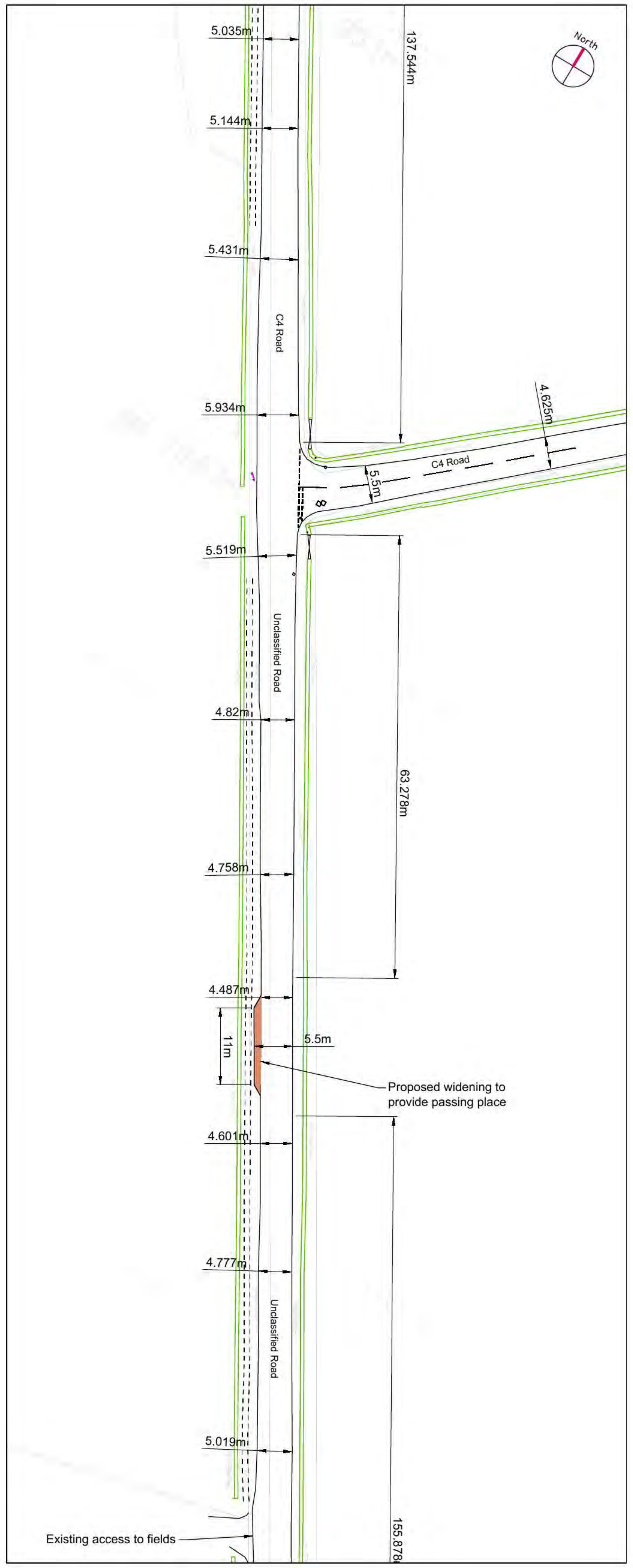
General notes:
1. Locations of viewports can be found on C+R Drg A/190889-900 - Roads Layout Plan.



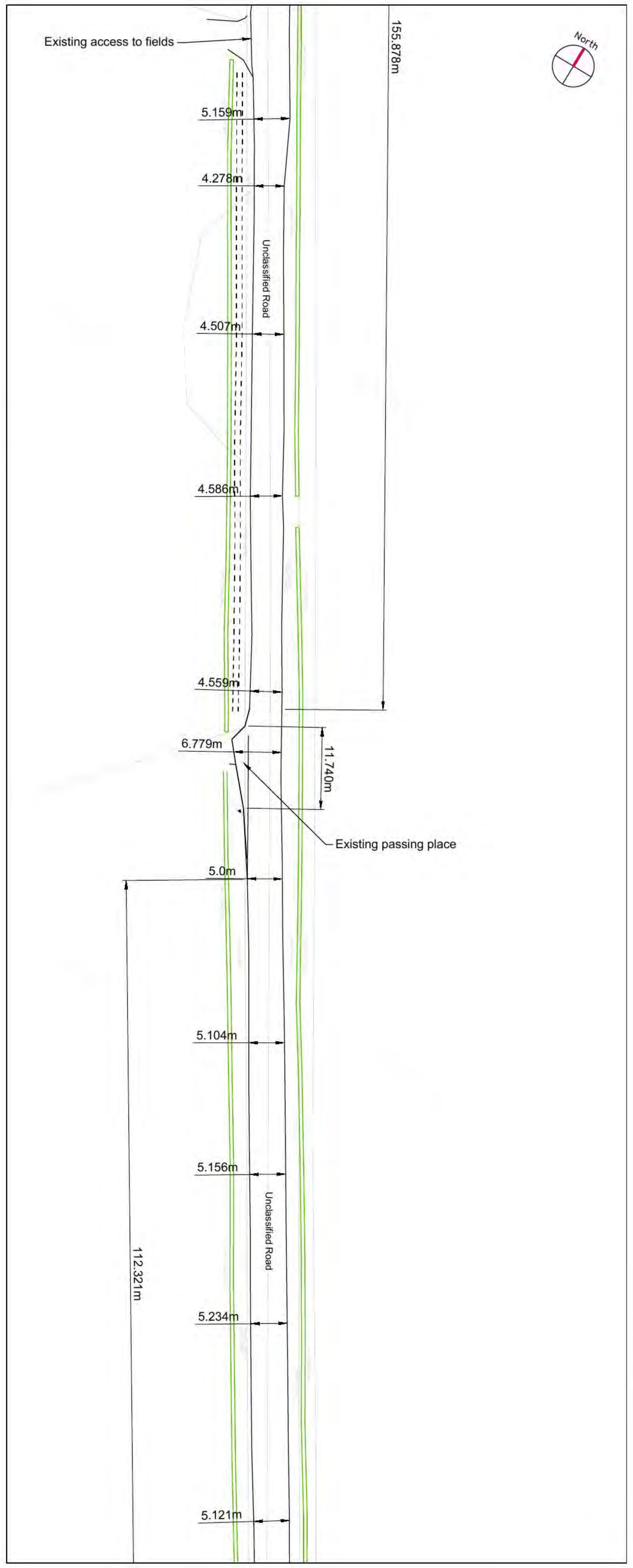
Typical Passing Place Detail



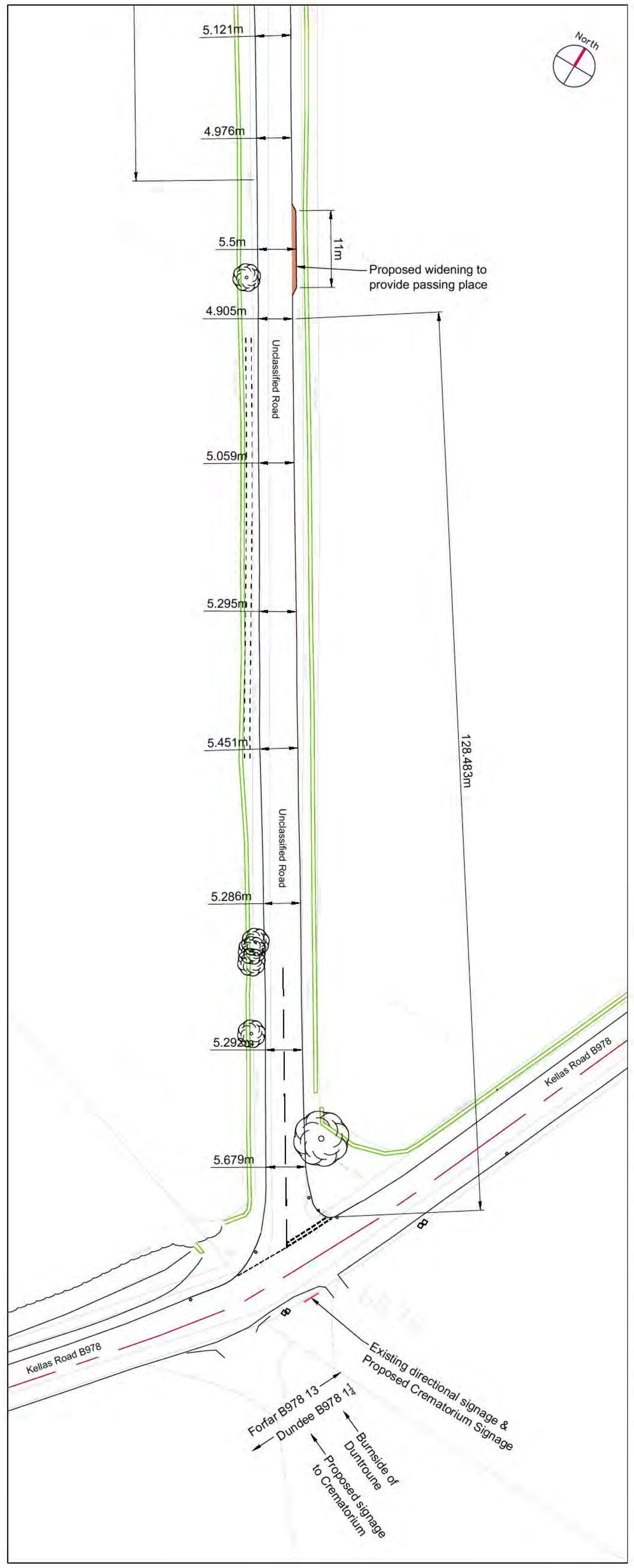
VIEWPORT 3



VIEWPORT 4



VIEWPORT 5



VIEWPORT 6

Issue	Revision	Initial	Date
1	Proposed passing places & Typical Passing Place detail amended to suit NRDG.	CRM	26/03/20

Cameron+Ross

CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB
Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Layout Plan
Sheet 2 of 3

Status:
Concept

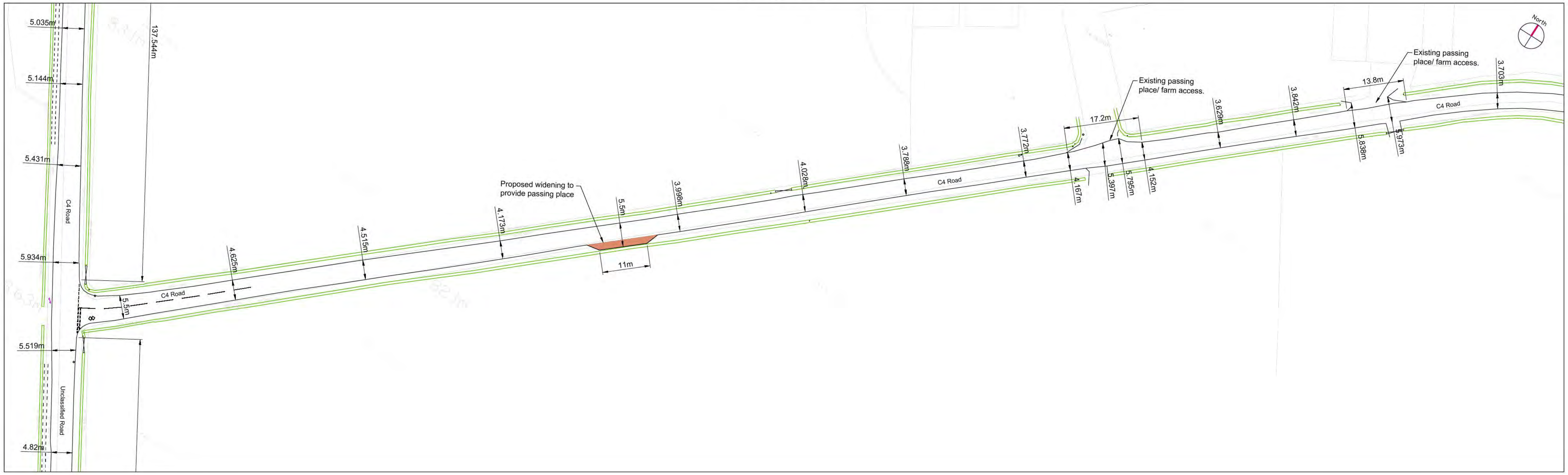
Scale: 1:500 @ A1	Date: 20/02/2020	
By: CRM	Checked: BAC	Approved: RAG

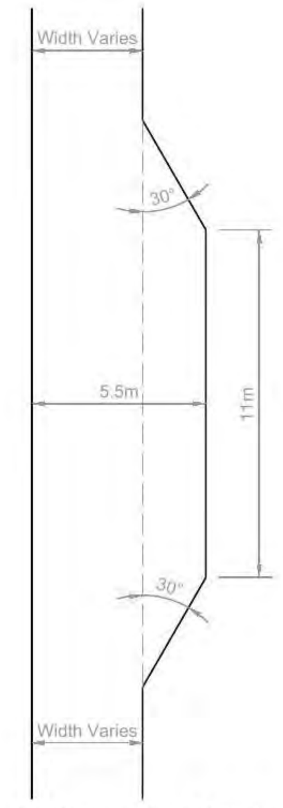
Dwg. No. A/190889 – 902   Rev. 1

FIGURED DIMENSIONS ONLY TO BE USED

General notes:
1. Locations of viewports can be found on C+R Drg A/190889-900 - Roads Layout Plan.

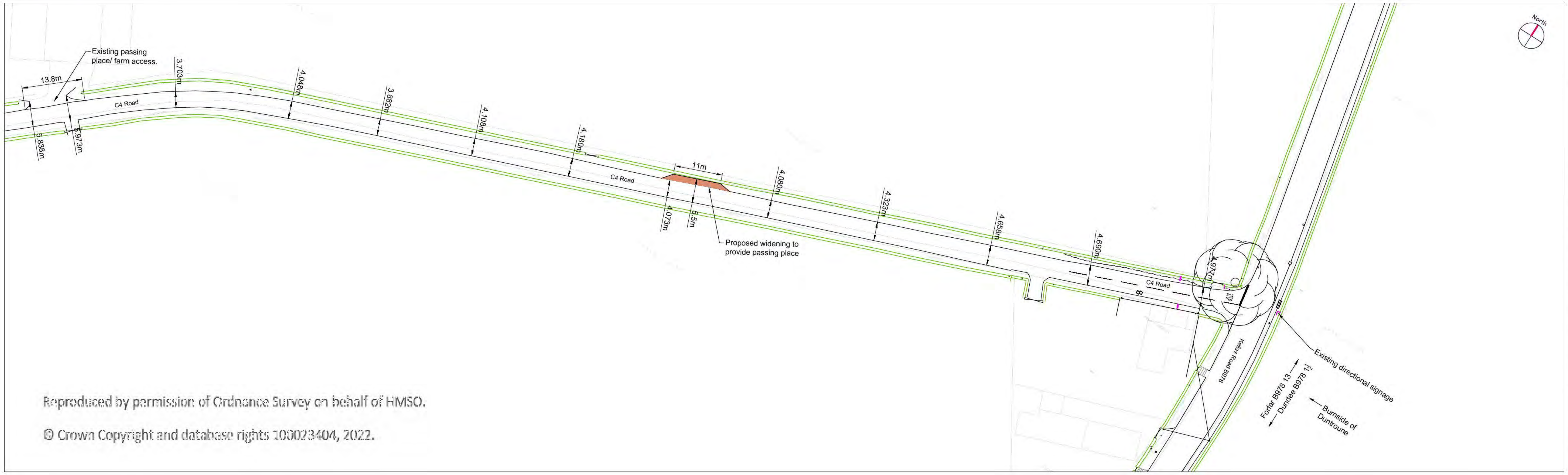
VIEWPORT 7





Typical Passing Place Detail

Scale 1:200



VIEWPORT 8

Issue	Revision	Initial	Date
1	Additional passing places added & Typical Passing Place detail amended to suit NRDG.	CRM	26/03/20

Cameron+Ross

CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB

Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Layout Plan
Sheet 3 of 3

Status:
Concept

Scale: 1:500 @ A1	Date: 20/02/2020

By: CRM	Checked: BAC	Approved: RAG

Dwg. No.	Rev.
A/190889 – 903	1

FIGURED DIMENSIONS ONLY TO BE USED

North

Issue	Revision	Initial	Date

Cameron+Ross

CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB

Mulberry House | 39-41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Visibility Splays
Sheet 1 of 3

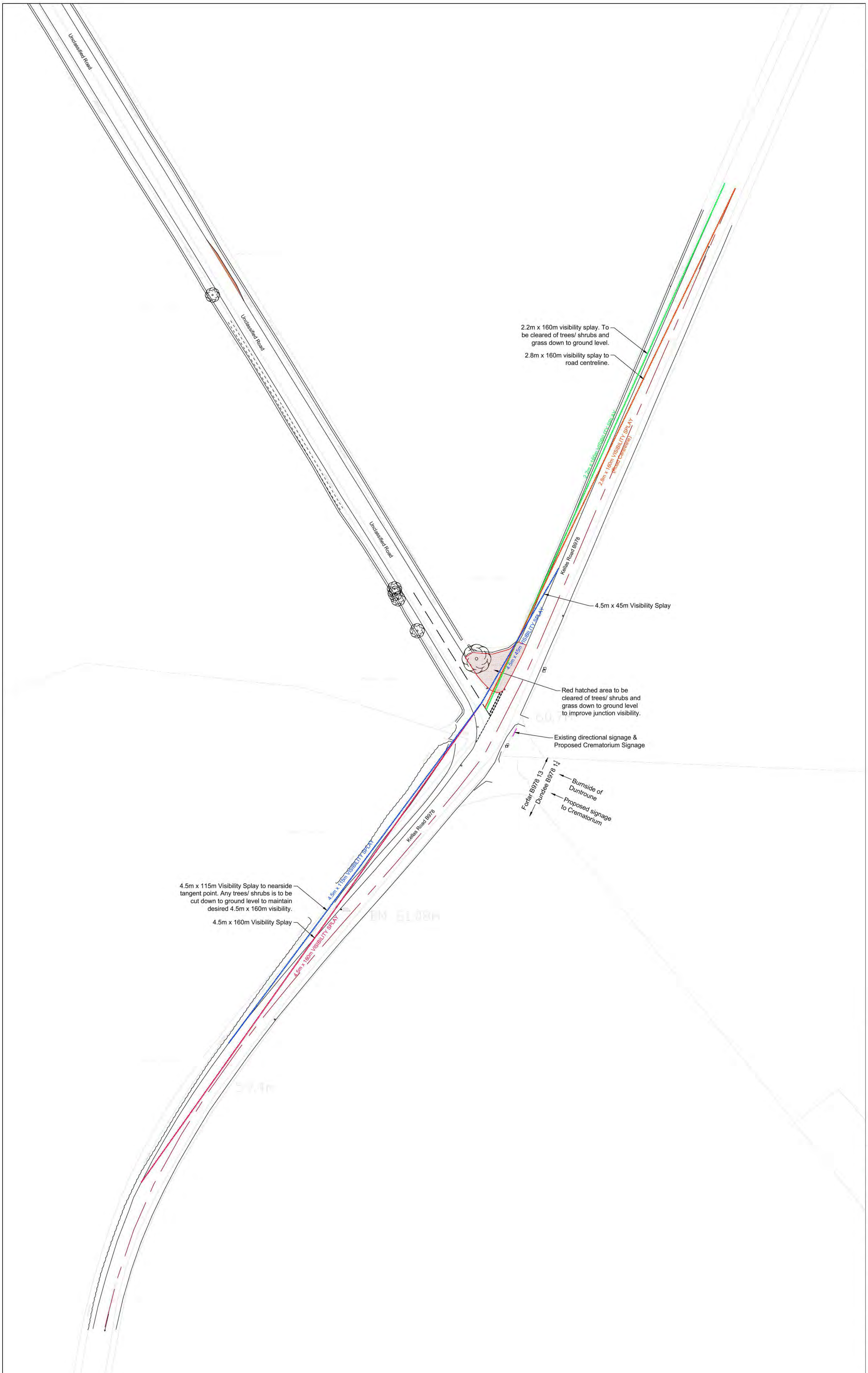
Status:
Concept

Scale:	1:500 @ A1	Date:	20/02/2020
By: CRM	Checked: BAC	Approved: RAG	

Dwg. No. A/190889 – 904

Rev. –

FIGURED DIMENSIONS ONLY TO BE USED



Issue	Revision	Initial	Date

Cameron + Ross
CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB
Mulberry House | 39–41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

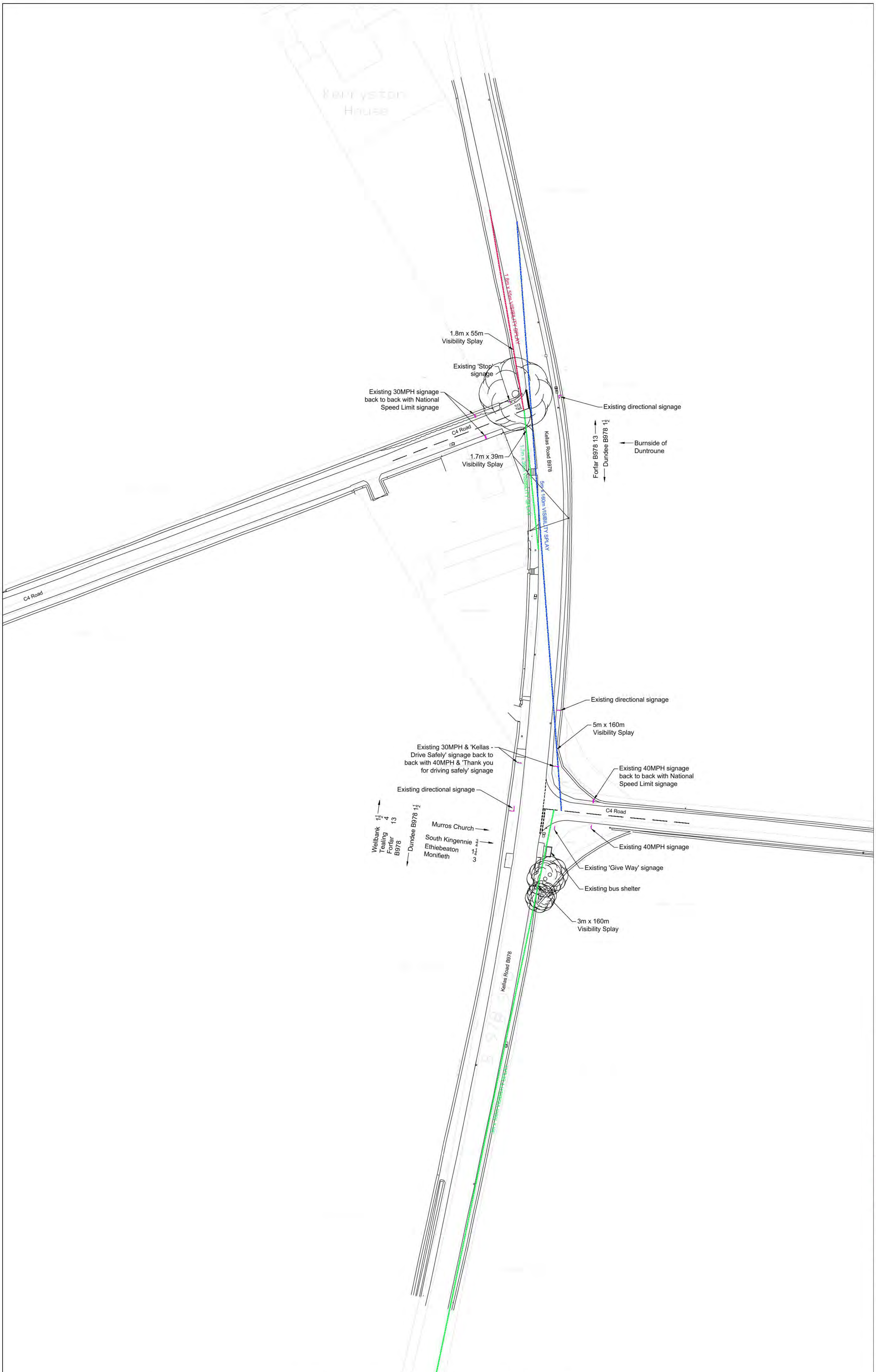
Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Visibility Splays
Sheet 2 of 3

Status:
Concept

Scale: 1:500 @ A1	Date: 20/02/2020	
By: CRM	Checked: BAC	Approved: RAG

Dwg. No. A/190889 – 905 | Rev. –



FIGURED DIMENSIONS ONLY TO BE USED

North

Issue	Revision	Initial	Date

Cameron + Ross

CIVIL + STRUCTURAL ENGINEERING

Forbes House | 15 Victoria Street | Aberdeen | AB10 1XB

Mulberry House | 39–41 Harbour Road | Inverness | IV1 1UF

Client:
FM & G Batchelor

Project:
Crematorium at Burnside of Duntrune, Duntrune, Angus

Drawing Title:
Roads Visibility Splays
Sheet 3 of 3

Status:
Concept

Scale: 1:500 @ A1	Date: 20/02/2020	
By: CRM	Checked: BAC	Approved: RAG

Dwg. No.	Rev.
A/190889 – 906	–

APPENDIX C

POPULATION DISTRIBUTION MODEL

PROPOSED CREMATORIUM DEVELOPMENT ORIGIN/DESTINATION POPULATION GRAVITY MODEL.

Origin-Destination Town-Area	Population	% of Total Population		ROUTE SPLIT C6 West	C6 North	Kellas Rd North	C4 East	Baldovie Rd	Drumgeith Rd	% TOTAL TRIPS ROUTE SPLIT C6 West	C6 North	Kellas Rd North	C4 East	Baldovie Rd	Drumgeith Rd	
Electoral Ward 2007																
Arbroath East and Lunan	16283	6.2%					50.0%	50.0%		0.0%	0.0%	0.0%	3.1%	3.1%	0.0%	
Arbroath West and Letham	15600	5.9%					50.0%	50.0%		0.0%	0.0%	0.0%	3.0%	3.0%	0.0%	
Brechin and Edzell	11668	4.4%		100.0%						4.4%	0.0%	0.0%	0.0%	0.0%	0.0%	
Carnoustie and District	13302	5.1%					50.0%	50.0%		0.0%	0.0%	0.0%	2.5%	2.5%	0.0%	
Coldside	19956	7.6%		33.3%			33.3%	33.3%		2.5%	0.0%	0.0%	2.5%	2.5%	0.0%	
East End	16550	6.3%						25.0%	75.0%	0.0%	0.0%	0.0%	0.0%	1.6%	4.7%	
Forfar and District	15931	6.1%			100.0%					0.0%	6.1%	0.0%	0.0%	0.0%	0.0%	
Kirriemuir and Dean	10749	4.1%			100.0%					0.0%	4.1%	0.0%	0.0%	0.0%	0.0%	
Lochee	19223	7.3%		50.0%				25.0%	25.0%	3.7%	0.0%	0.0%	0.0%	1.8%	1.8%	
Maryfield	16397	6.2%		33.3%				33.3%	33.3%	2.1%	0.0%	0.0%	0.0%	2.1%	2.1%	
Monifieth and Sidlaw	16518	6.3%					50.0%	50.0%		0.0%	0.0%	0.0%	3.1%	3.1%	0.0%	
Montrose and District	15927	6.1%			25.0%	50.0%	25.0%			0.0%	1.5%	3.0%	1.5%	0.0%	0.0%	
North East (Dundee City)	15667	6.0%		50.0%					50.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%	
Strathmartine	19387	7.4%		100.0%						7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	
The Ferry	19463	7.4%						100.0%		0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	
West End	20625	7.8%		50.0%				25.0%	25.0%	3.9%	0.0%	0.0%	0.0%	2.0%	2.0%	
TOTALS	**263246**	**100.0%**								**26.9%**	**11.6%**	**3.0%**	**15.8%**	**29.1%**	**13.5%**	**100.0%**

Total Pull Factor **0.0**

PROPOSED CREMATORIUM

BURNSIDE OF DUNTRUNE, BY DUNDEE, ANGUS

Rev B SEPTEMBER 2021

PLANNING DESIGN & ACCESS STATEMENT

@rchitects
Chartered Architects

LOCATION

The site is located to the south of Angus, north of Dundee and to the east of the A90. It is provided with good transport links to the surrounding area and beyond via both the A90, to the west and the B978 (Kellas Road) to the south and east. The A90 provides trunk road links to the north through Angus and beyond. To the south it connects to Dundee, Perth and the M90. The site also readily connected to the A92 providing link up the east coast of Angus and beyond. The site is discreetly located and is well suited to the nature of this type of use.

This type of development is not suitably located within existing settlements or development boundaries for two main reasons. Firstly the requirements of the Crematorium Act which I have covered. This requires a site of around 2 acres (preferably with space for possible future expansions of the landscape / memorial use). The site also needs to allow the crematorium not to be built closer than 200 yard from a dwelling house and no closer than 50 yards from a public highway (considerable distances). Both of which criteria the current proposals just meet. It also says a suitable site should preferably already benefits from existing landscaping such as mature trees, hedgerows and advantageous to benefit from pleasant views. A crematoria needs an appropriate and sensitive setting in relation to its use. Due to these requirements this use is not suited to available sites (brownfield or greenfield) within the existing development boundaries of the existing settlements, as such and in accordance with Policy DS1 there are no suitable and available brownfield sites capable of accommodating the proposed development. This type of land use was historically located on the rural edges of settlements and the only other crematoria in Angus is located in a likewise rural location. Secondly the proposed crematorium is strategically located in south Angus in relation to the surrounding settlements The surrounding area has a population of approximately 265,529 people with about 20% of these aged 65 or over. The dispersed settlement characteristics of this area of Angus and good access makes this site a logical choice.

SITE

Site History

Currently the site is covered with rough grassland but is not being farmed regularly due to its relative low quality and difficult terrain for modern farming practices. Through checking of the Macaulay Land Capability for Agriculture (LCA) classification it has been demonstrated that any development of the site would not constitute a loss of prime agricultural land.

The site measures 1.98 hectares (Red Line) and the total area of ground owned by the applicants (Blue Line) measures 4.51 hectares.

The ground slopes from north west to south east and the site is bounded to the south by the public road. The north west and east of the site is walled with a dry-stone wall with an established woodland beyond. The remaining area of ground in the client's ownership will be brought into appropriate management as part of these proposals.

Access to the site is to be gained from the adjacent road running along the south side of the site.

DESCRIPTION OF PROPOSALS

The crematorium building is designed to face directly towards the entrance with the ground rising gently towards the access. The floor area of the crematorium is 496 sq. m. and in terms of the building, its size and general arrangement are dictated by its function. The entrance and reception hall are to the front (east) with the main hall directly behind. The cremator and servicing are then to the rear (west) of the building. To the north are the offices with the public exit point to the south where there are the most views from the site.

The position of the building nestles within the general fall of the site. This combined with the surrounding landscape, trees etc. screen the proposals completely from the west round to the east. Viewing from the adjacent road is screened by a new dry-stone wall and hedge / tree planning. The site is further screened by the mature trees to the south of the road. Additional native tree planting is incorporated into the proposals particularly to the east, screening the proposals further from this angle and further enhancing the sense of enclosure.

The position of the crematorium building within the site has been carefully chosen, so that it nestles within a natural landscape. Its location within the site will mean that it is not visible from the west, north or east and is barely visible from the south. Views from the south will be from distant vantage points and will be mostly obscured by trees along public roads.

The principal view into the site will be when passing on the adjacent road along the south side of the site, which will be glimpse views through the proposed planting and screened by a new drystone wall and hedging.

There are only three dwellings within 300m of the crematorium building. With the nearest dwelling some 183 metres away and the intervening mature woodland means that the site will not be directly visible from any dwelling houses or the surrounding areas. The site entrance itself includes a feature stone entrance wall, and gates, which will be locked when the crematorium is closed.

The crematorium building is rectangular in shape with a predominantly natural slate roof and clad elevations. The size, shape and layout of the crematorium building is largely dictated by its function with the reception area to the front of the building, the main hall within the middle part of the building and cremator area to the rear of the building. The administrative areas are to the north giving control over and access to the public areas as well as the service access and cremator area. The stack is on the rear roof section and projects above the roof level minimally.

The site will incorporate an internal one-way road, parts of which can be used as overspill parking when there is a large service. There will be 127 car parking spaces, 7 of which will be for disabled drivers, and there will be space coaches to pull up and wait. A planted garden and memorial garden will be located to the front and south of the crematorium building incorporating grassed areas, memorials and flower/shrub beds. Staff car parking including electric vehicle charging will be located to the rear of the crematorium building as will the service area and accessed along with the service area to the north of the building. A simple agricultural stob and wire fence will define the northerly perimeter of the crematorium site and the applicants intend to undertake some additional native tree planting out with the site, but still within land in their ownership.

Services will take place primarily during the week (between 9am to 5pm), however there may be some services on a Saturday. From figures obtained from the intended operator It is unlikely that there will be any more than 4 services per day, however it is likely that the average will be 3 services per day. By the purpose of its use the crematorium can be considered a community facility that will satisfy an established demand in the area.

The proposed crematorium is strategically located in relation to the surrounding settlements. The surrounding area has a population of approximately 265,529 people with about 20% of these aged 65 or over. This type of land use was historically located on the rural edges of major settlements. Due to the nature of its use it is obviously not suited to residential, commercial or employment areas and this combined with the dispersed settlement characteristics of this area of Angus and good access makes this site a logical choice. These proposals are well served by the existing road infrastructure and a proposed crematorium in this location will reduce journey times compared to the existing alternatives.

The proposals make best use of the existing landforms, walls, trees and woodland. Maintaining the privacy of both the users and the nearby neighbours. The high-quality design and scale of the proposals fit well with the landscape and will not have any significant impact on surrounding properties or existing land uses. The development of the crematorium will not affect the viability or vitality of the existing villages or town centres and to the contrary has the potential to benefit some of the established businesses in the area.

DESIGN PROPOSALS

Site Context

Rural and Agricultural Context

Buildings and structures in the area of Burnside of Duntrune and the wider context of Angus have historically used a mixture of natural stone and timber materials sourced locally from quarries and locally grown timber. The roofs are generally finished using either stone and slate tiles, with some old corrugated roof materials. Modern agricultural developments however utilise a mixture of quick build products mainly of steel structures with corrugated metal and timber panels. This area, like most of rural Angus shows this palette of materials along with simple traditional building forms. The local boundaries to the fields and properties are traditionally made of local field stone and sandstones, either mortared or more commonly as dry-stone walling, more recently stob and wire fencing has been used. Trees planting to edges with pockets of woods are also common providing shelter for both crops and wildlife against the prevailing winds.

Site Strategy

- Shelter from prevailing winds by the existing wood: building siting to utilise natural defence and nestle into the landscape.
- Use existing strong boundary enclosure: use woodland and wall enclosure to reduce impact of building.
- Main views to south: building position to take advantage of these while keeping its visual impact low.
- Sloping site: use logical floor level to maintain views and minimise site impact/parking impact and allow for a natural run of drainage. Use the site to help with the processional arrival. Visually separation from the public areas of the service access.
- Desire lines and geometry: maximise approach aspect to the building by approach leading to main elevation when turning into the site. Use aspect towards views to generate circulation routes.

Concept and Precedence

The main concept is to create a modern crematorium which reflects the traditional simple agricultural forms that are typical of this area of Angus. The form will be softened in the landscape through the use of form, large overhanging roof and the use of traditionally referenced materials expressed with an appropriate high-quality to the public areas. Cladding, Slate roof and glulam timber frame.

Design

The design of the internal roads and in particular the route to the entrance canopy has been developed to satisfy the ceremonial needs of the congregation. The landscaping design is a very important part of the crematorium and it will serve three essential functions:

- it will provide a calm, contemplative, beautiful environment as a setting for the crematorium building.
- it will provide a focus on the natural environment within and beyond the site.
- it will provide a context for the crematorium building.

Public toilets are provided close to the entrance and disabled visitors have easy access. The main hall is light and airy and affords views from the site. The administration space and cremator equipment is housed to the rear of the building together with the filtration plant.

The stack is discretely located towards the rear of the crematorium building and protrudes only 1.25 metres above the ridge of the roof. Technical information on emissions and the cremator itself have been submitted as separate documents in support of the proposal.

Foul and surface water drainage will be dealt with by way of treatment plant and soakaway. A separate Drainage Proposal Report has been submitted in support of the proposal.

Heating for the crematorium building will be provided predominantly by waste heat recovery, with any shortfall made up by a boiler running on gas.

Ground Floor Plan

East Elevation

Materials

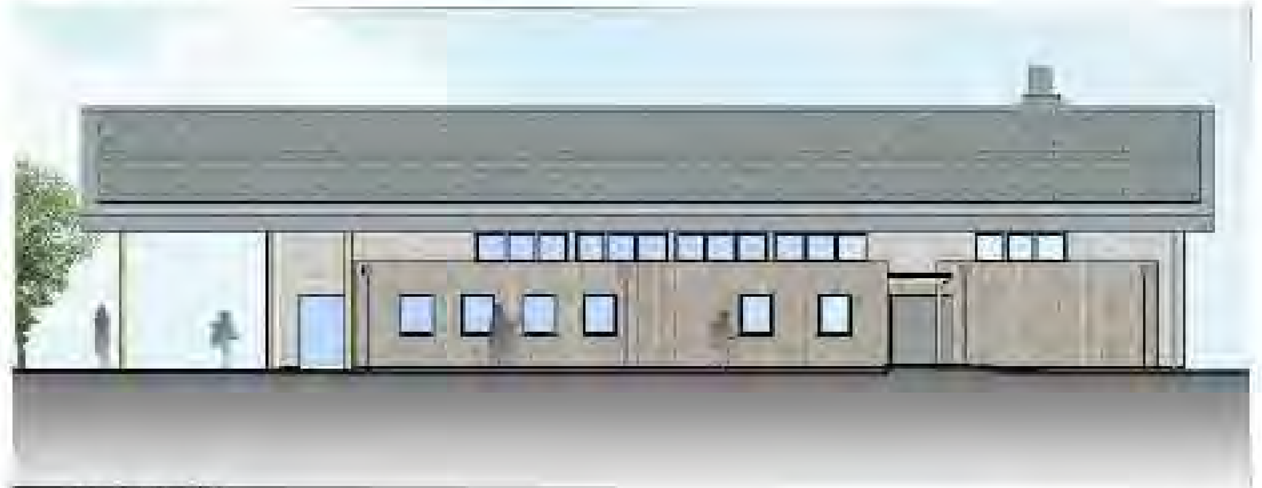
Walls - Grey Cladding

Frame - Timber Glulam

Roof - Main Roof Slate with Grey Aluminium Perimeter

Flat Roof - Grey Single Ply Membrane

Windows/Doors - Grey Alsclad Windows



North Elevation

South Elevation

West Elevation

Access and Transport:

These proposals are very well served by the existing road infrastructure and a proposed crematorium in this location will reduce journey times compared to the existing alternatives. The roads department has no objection to the proposals.

Due to the nature and type of the proposed crematorium journeys are made by private car or occasionally by private hire bus. A cremation is attended by family and friends and this combined with the emotional nature of such an activity public transport is not used. Car sharing is however very high and tends to be arranged by the family and friends directly. As such this type of proposals do not demand or justify the need for public transport links, in accordance with Policy DS2. This is also influenced by the location requirements discussed previously. The transport assessment previously agreed also reflects this and adequate parking provision has been included accordingly.

While each council obviously has differing local plans, these are generally in line with the relevant national policies and where relevant TAYplan. Within the last few years similar crematoria have been approved in both Fife and Aberdeenshire in rural locations out with the development boundaries for the exact same reasons as referred to above.

The methodology applied for the TA was agreed with Angus roads department prior to the survey work and the TA carried out. The figures in TA are based on a worst case. Local industry experience suggests an average of approx. 50 attendees per funeral (3 per car). Therefore, based on an average of 3 cremations a day, 6 days a week, this would result in just 300 car journeys per week. These figures also tally with The Federation of Burial and Cremation Authorities figures which estimates that no more than 30 mourners will attend in 50% of cremation services, and only on exceptional occasions does the number exceed eighty. The above figures also do not account for the substantial proportion of unattended cremations.

Unattended cremation figures (Pharos Statistics) 2019 -

Dundee 200 No

Crathes 288 No

Friokheim 8No (This exceptionally low figure would appear to reflect a business model rather than demand).

Using the Dundee figures of 200 No unattended funerals would further reduce anticipated car journeys per week to 236.

The TA provided gives a robust assessment of the surrounding road network and an extensive area of the local road network has been reviewed within the TA given the fact that funerals occur out with what is the peak periods for the surrounding road network. Mitigation has been put in place to counter the additional traffic movements on the surrounding road network by provision of 5No new passing places and by enhancing existing junction visibility by tree/shrub clearing at the unclassified Road/B978 Kellas Road junction. The road will be widened over the site frontage to the width agreed with the Angus Council Traffic Team, improving the road for all users over that which is currently in place.

Public Transport

People travelling to cremations, due to the upsetting nature of the event, do not generally travel by public transport. Due to this people tend to pre-arrange car sharing or private hire. Provision has however already been made on site for buses.

It is usual for those travelling to a funeral without access to a private car of their own to arrange a lift from a friend or family member or by pre-arranged taxi or a private coach. Funerals by their nature tend to lend themselves to car sharing for attendees and for the same reasons this is preferable to public transport. As discussed previously the nature of a crematorium is that it is required to be situated away from residential developments.

After checking there are currently two existing bus services that run directly past the proposed crematorium site (A17 & A38) which run once in each direction each working day. Bus services in this area run on a hail and ride basis and as such would stop outside the site, even if no fixed stop was installed should someone require.

Two additional local bus services run past both ends of the road servicing the proposals (22 & 139). Whilst the distance to walk to a bus route to the west is slightly above the desired 400m any funeral attended would likely be making this journey infrequently. The routes to the east are also still within 1km of the proposals.

With regard to the only current crematorium in Angus this is located much further from a regular bus stop and has a passing bus service no more frequently than the existing services at the location of these proposals.

Additional Transport Enhancement Options

While we have explained above why we consider that public transport relating to the nature of the proposals is not relevant; and that facilities for buses have already been included within the site which could be accessed as part of the existing bus routes. If considered essential an appropriate bus stop or bus pull in area could be incorporated as part of the access to be formed for the site. We have already received correspondence from Xplore Dundee who run buses in the area and would be happy with anything that would improve access and have previously contacted the relevant parties at Angus Council.

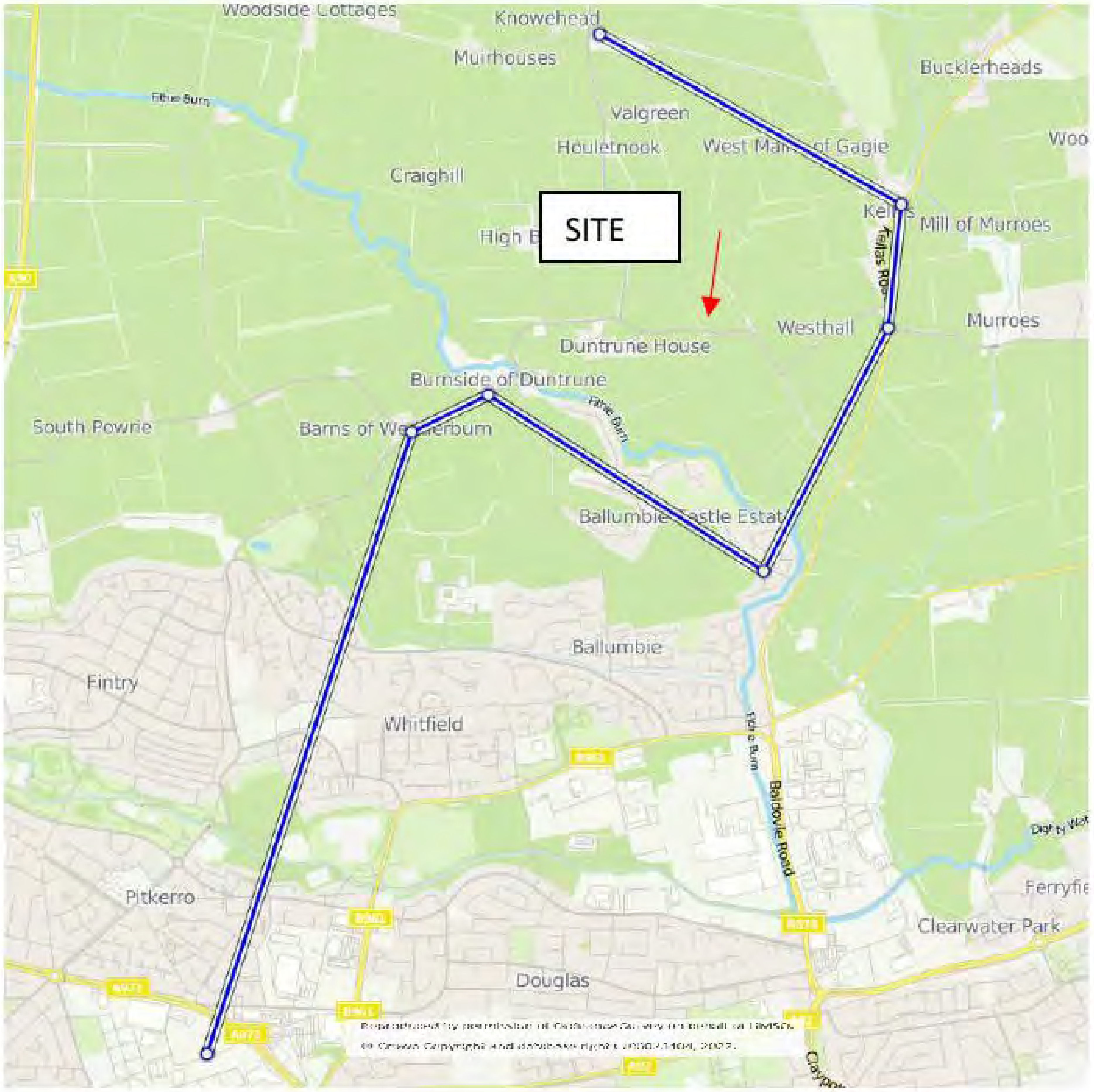
Alternatively, and bearing in mind the anticipated infrequency it is anticipated that people will want to access the facilities by public transport; it would probably be more suitable to incorporate into the transport plan for the site the provision of a call up service for those who wanted to be collected from the existing nearest bus stop. As we have already incorporated provision for electric vehicles on site this could also be by electric vehicle to keep emissions to an absolute minimum.

Paragraph 276 of Scottish Planning Policy (SPP) states:

"In rural areas the plan should be realistic about the likely viability of public transport services and innovative solutions such as demand-responsive public transport and small-scale park and ride facilities at nodes on rural bus corridors should be considered."

This flexibility in terms of access to public transport is an approach that has previously been adopted by Angus Council on many occasions.

A17 – Fishers Tours – Murroes School – Ballumbie Castle



Monday to Friday, not QE0 : BUS.CIF days

Ballumbie Castle and Fishers Depot - Murroes School

Pitkerro, opp Keyline	08:28
Barns of Wedderburn, at Farmhouse Road End	08:37
Burnside of Duntrune, at Braeside Cottages	08:38
Ballumbie Castle, opp Hawthorn Grove	08:44
Kellas, opp South Kingennie Road End	08:46
Kellas, at Smiddy	08:47
Westhall Terrace, at Murroes School	08:50
	Operates on Angus schooldays only

Murroes School - Ballumbie Castle and Fishers Depot

Westhall Terrace, at Murroes School	15:30
Burnside of Duntrune, opp Braeside Cottages	15:34
Barns of Wedderburn, opp Farmhouse Road End	15:35
Burnside of Duntrune, at Braeside Cottages	15:36
Ballumbie Castle, opp Hawthorn Grove	15:40
Pitkerro, at Keyline	15:49
	Operates on Angus schooldays only

22 – Stagecoach East Route and Timetables Shown Below

Days of Operation	Monday to Friday	
Service Number	S022_F	
Service Description	Dundee - Kirriemuir	
Service No.	**22**	**22**
Dundee bus station 3	1600	1745
Dundee Commercial Street 1	1604	1749
Westhall Terrace oppMurroesSchl	1619	1804
Tealing road end	1624	1809
Charleston opp bus shelter	1634	1819
Glamis Dundee Road	1638	1823
Southmuir Newton Hotel	1646	1831
Northmuir golf course	1653	1838
Kirriemuir Bank Street	1658	1843

Days of Operation	Saturday
Service Number	S022_F
Service Description	Dundee - Kirriemuir
Service No.	**22**
Dundee bus station 3	1745
Dundee Commercial Street 1	1749
Westhall Terrace oppMurroesSchl	1804
Tealing road end	1809
Charleston opp bus shelter	1819
Glamis Dundee Road	1823
Southmuir Newton Hotel	1831
Northmuir golf course	1838
Kirriemuir Bank Street	1843

Days of Operation	Monday to Friday	
Service Number	S022_F	
Service Description	Dundee - Kirriemuir	
Service No.	**22D**	**22**
Kirriemuir High Street	0733	0943
Northmuir opp golf course	0738	0948
Southmuir opp Newton Hotel	0745	0955
Glamis opp Primary School	0753	1003
Charleston bus shelter	0757	1007
Tealing road end	0809	1018
Westhall Terrace	-	1023
Dundee Commercial Street	0829	1038
Dundee bus station	-	1041
Dundee Whitehall St W3	0834	-

Days of Operation	Saturday
Service Number	S022_F
Service Description	Dundee - Kirriemuir
Service No.	**22**
Kirriemuir High Street	0734
Northmuir opp golf course	0739
Southmuir opp Newton Hotel	0746
Glamis opp Primary School	0754
Charleston bus shelter	0758
Tealing road end	0809
Westhall Terrace	0814
Dundee Commercial Street	0829
Dundee bus station	0832

139 – Explore Dundee route and Timetables Shown Below

139 Tealing | Inveraldie | Westhall Terrace | Dundee

Monday to Friday

from 9th August 2020

	139	139
Inveraldie Hall Place	0902	-
Tealing School	0910	1300
Tealing Village	0913	1303
Westhall Terrace	0919	1309
Burnside of Duntrune	0922	1312
South Powrie	0924	1314
City Centre High Street [H1]	0937	1327

139: Service terminates at High Street (H1). Use Union Street instead of Whitehall and wait at H1 for any layover. H4 is pick-up point only.

139 Tealing | Inveraldie | Westhall Terrace | Dundee

Saturday

from 9th August 2020

Inveraldie Hall Place	0902	-
Tealing School	0910	1300
Tealing Village	0913	1303
Westhall Terrace	0919	1309
Burnside of Duntrune	0922	1312
South Powrie	0924	1314
City Centre Whitehall Street [W1]	0937	1327

139 Dundee | Westhall Terrace | Inveraldie | Tealing

Monday to Friday

from 9th August 2020

		$
City Centre High Street [H4]	0840	1225
City Centre Commercial Street [1]	0842	1227
South Powrie	-	1238
Burnside of Duntrune	-	1240
Westhall Terrace	-	1243
Inveraldie Hall Place	0859	1250
Tealing Village	-	1257
Tealing School	-	1300

$: Inveraldie Hall Place is served on request to the driver.

139 Dundee | Westhall Terrace | Inveraldie | Tealing

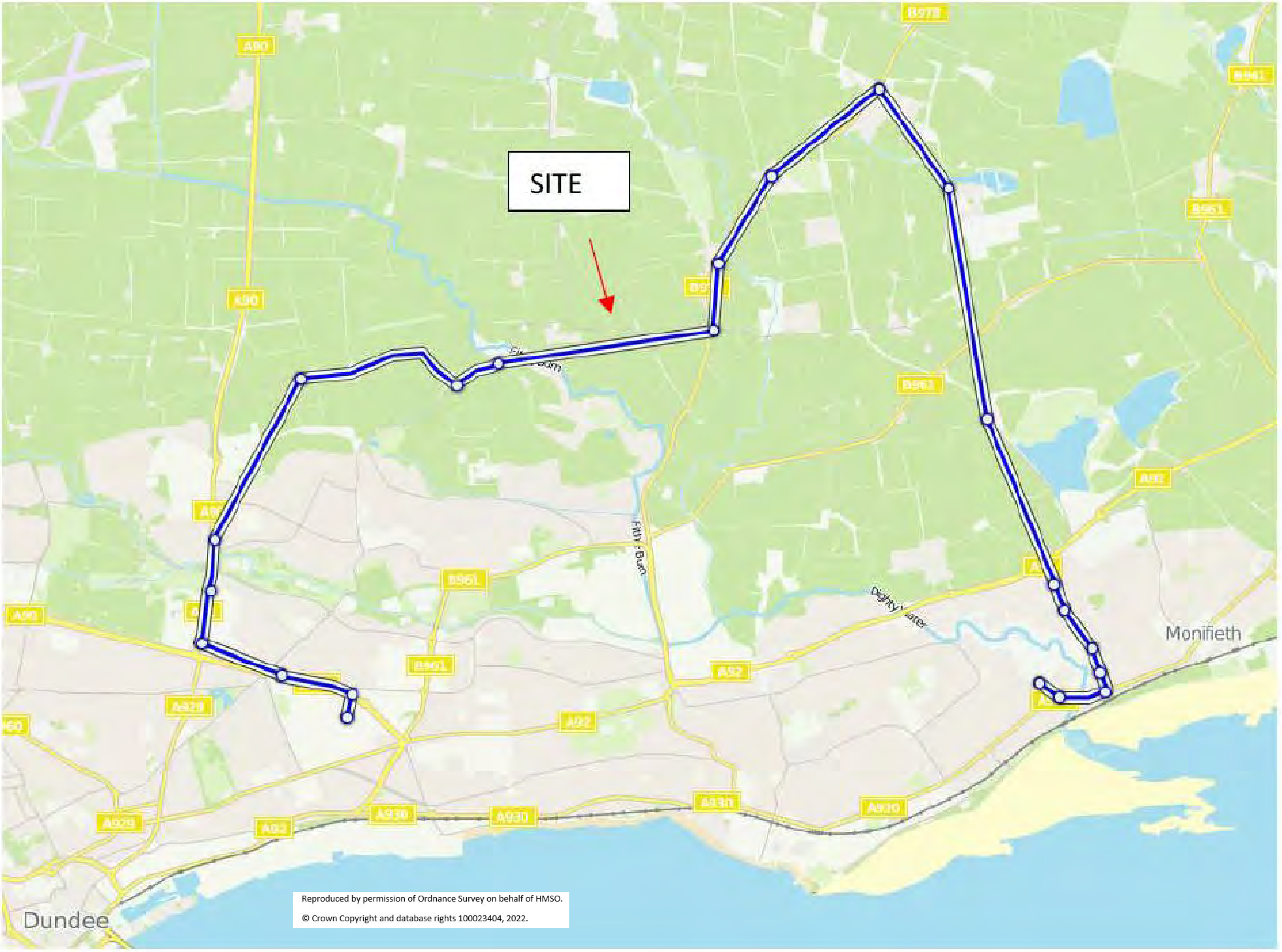
Saturday

from 9th August 2020

		$
City Centre High Street [H4]	0840	1225
City Centre Commercial Street [1]	0842	1227
South Powrie	-	1238
Burnside of Duntrune	-	1240
Westhall Terrace	-	1243
Inveraldie Hall Place	0859	1250
Tealing Village	-	1257
Tealing School	-	1300

$: Timing Points, South Powrie, Burnside of Duntrune, Westhall Terrace, are served on request to the driver, otherwise proceed to Inveraldie Hall Place

A38 – Fishers Tours bus route and timetable shown below:



Pitkerro, opp Keyline	08:00
Burnside of Duntrune, at Braeside Cottages	08:16
Kellas, at Smiddy	08:22
Kellas, at Keillorcroft	08:23
Wellbank Forge (at)	08:27
Wellbank, at Forbes of Kingennie	08:29
Monifieth, at High School	08:40
	Operates on Angus schooldays only

Monifieth, at High School	16:00
Wellbank, opp Forbes of Kingennie	16:11
Wellbank Forge (opp)	16:14
Kellas, opp Keillorcroft	16:15
Kellas, opp Smiddy	16:16
Burnside of Duntrune, opp Braeside Cottages	16:21
Pitkerro, at Keyline	16:37
	Operates on Angus schooldays only

National records of Scotland (Angus)

Current Population

On 30 June 2019, the population of Angus was 116,200. 27,790 were aged over 65. Between 1998 and 2019, the population of Angus increased by 5.8% with the 65 to 74 age group seeing the largest percentage increase (+47.5%).

Dundee has a population of nearly 30,000 larger than Angus. However, Angus has a considerably larger proportion of its population aged 65 and over giving it an older age profile.

Population Projections

The average age of the population of Angus is projected to increase as the baby boomer generation ages and the 75 and over age group is projected to see the largest percentage increase (+30.3%).

Deaths

In 2019, there were 1,410 deaths in Angus. This is a 3.1% increase from 1,367 deaths in 2018.

In Angus, the standardised death rate increased from 9.6 per 1,000 population in 2018 to 9.9 in 2019. In comparison, the rate in Scotland overall decreased from 10.8 to 10.6

Cremation Statistics

Year	2016	2017	2018	2019
Dundee	1,708	1,876	1,783	1,765
Friockheim	832	878	864	877
Total	2,540	2,754	2,647	2,642

Nationally in 2019, 26% of crematoria declined a large coffin due to inherent limitations and 60.8 % were holding over bodies for cremation.

Funeral Poverty - Local Demand

Costs and appropriate local competition – The Pharos Statistics 2020 Cremation Fee League Table As at 1st January 2020 show Dundee and Friockhiem as the most expensive crematoria in Scotland at £1050 and the joint highest in the UK out of 291 locations. Crathes, as the next nearest crematorium to the north charges only £795.00 and Perth only £788.00. We also understand that recently Parkgrove has further increased its prices. Cost offering at this new facility are anticipated to be more in line with the national average rather than the high costs offered in the area currently.

The Competition and Markets Authority (CMA) raised concerns over aspects of the industry including low numbers of crematoria providers in local areas, and difficulty for new companies to enter the market due to the planning regime and high fixed costs. This led to an investigation in 2019.

This in summary confirmed that while the prices of private sector crematoria are often significantly higher than those of crematoria operated by local authorities, the profitability analysis indicates that customers of both private and local authority facilities have been paying too much, with the former overpaying by at least £115 per cremation and potentially as much as £210 on average, while the latter are overpaying by at least £80 per cremation and potentially as much as £170 per cremation on average we consider that the upper end of these ranges is more probable than the lower end.

The issue is so pressing locally that In July 2019 the report 'Funeral Poverty in Dundee' concluded that with regard to crematorium facilities in the area:

Additional crematorium facility: To improve choice for the consumer, Dundee City Council could actively consider the addition of another cremation facility.

The CMA (2019: 89) found the average drive time to the closest crematoria was 34 minutes for the nine most expensive crematoria – almost double the time for the nine least expensive crematoria. In addition, two thirds of these more expensive crematoria had no other crematoria within a 30 minute drive time, compared to just one in nine of the least expensive. This crudely suggests prices can be kept artificially higher where competition is lower.

The CMA report suggests that there are low numbers of crematoria in any given area because only a small number may profitably operate given the fixed demand in a local market. It suggests 800 - 1,000 cremations per year are required to be viable. Given there are approximately 1,800 deaths in Dundee per annum, if the surrounding areas were included, there could be potential for an additional crematorium capacity. This would require Dundee City Council to consider more fully the 'need', liaise within Departments such as the Planning Dept. to assess potential applications, and potentially consider involving itself actively within a development.

The Cremation Act (1902) & The Cremation (Scotland) Regulations 2019

The Cremation (Scotland) Regulations 2019 only deal with how crematoria should be operated and how a cremation should be carried out. While the relevant 1902 act has recently been repealed in Scotland.

The 'Federation of Burial and Cremation Authorities', which is the principal representative of burial and cremation authorities however refers to the 1902 Act in its relevant requirements and goes on to state the following in its guidance:

A minimum of two hectares (approximately five acres) per estimated 1,000 cremations per annum is recommended to provide sufficient space for the crematorium, gardens of remembrance, traffic circulation, parking, and a modest amount of space around the building.

Ideal sites are rarely to be located in urban areas and it is emphasised that suitability of setting is of greater importance than its location in close proximity to population centres.

Site selection should be aimed at achieving quietness and seclusion. A woodland or parkland setting, or an area of undulating ground with good natural features and mature trees, would enable the establishment of a good natural setting with a minimum of horticultural treatment.

Ideal sites are rarely to be located in urban areas and it is emphasised that suitability of setting is of greater importance than its location in close proximity to population centres.

Previously developed land can often prove unsuitable, due to land contamination, which is unacceptable for the interment of ashes, or due to the presence of residential property within 200 yards. There is a growing recognition that new crematoria will be built in a countryside location close to the urban fringe.

The recommendations also separately refer to the 1902 Act directly in terms of its recommendations for proximity to dwellings and public highways.

Section 5 of the Cremation Act 1902 states that: "No crematorium shall be constructed nearer to any dwelling house than two hundred yards, except with the consent, in writing, of the owner, lessee, and occupier of such house, nor within fifty yards of any public highway, nor in the consecrated part of the burial ground of any burial authority.

The Cremation Act (1902)

The Cremation Act (1902) states that a crematorium cannot be built closer than 200 yards from a dwelling house, without the written consent of the owner and occupier. The Act also states that no new crematorium can be built closer than 50 yards from a public highway. A minimum of 2 hectares is normally required for a crematorium and the site needs to be close to a main road. A site which already benefits from existing landscaping such as mature trees, hedgerows is considered most suitable, and ideally the site should be flat or slightly sloping and pleasant views are considered advantageous.

Emissions

All UK crematoria must operate under the Secretary of State's Process Guidance for Crematoria which gives guidance on the 'Best Available Techniques' aimed at providing a strong framework for consistent regulation under the statutory Local Air Pollution Prevention and Control (LAPPC) regime in England and Wales, Scotland and Northern Ireland. In Scotland this requires an application to SEPA under Pollution Prevention and Control (Scotland) Regulations 2000; for a permit to operate, which only if satisfactory will be issued. As such it is this legislation that will ultimately asses and regulate the appropriateness of these proposals in terms of Emissions.

This process will ensure the facility operates to the highest possible standards to avoid polluting the atmosphere. SEPA carry out a twice-yearly inspection to ensure that it is operating under the terms of the permit. The crematoria will also operate under the auspices of the Federation of Burial and Cremation Authorities (FBCA) and will also be subject to six monthly inspections by Robert Swanson QPM, the Inspector of Crematoria for Scotland who operates on behalf of the Scottish Government.

With the state-of-the-art equipment used and the additional regulatory requirements placed on crematoria ensure emissions are not an issue. Cremations take place at very high temperatures, above 850 degrees centigrade and as a result there are very low levels of emissions. A tall stack is not required, and the vent is to expel primarily air only. Emissions data has been provided and emissions are regulated and controlled by SEPA under the Pollution Prevention and Control (Scotland) Regulations (2000) (As Amended).

Relevant legislation relating to emissions for this proposal - the Pollution Prevention Control Regulations 2012
The new crematorium will require authorisation from SEPA under 5.1, Part B, (c) of the Pollution Prevention Control Regulations 2012 (PPC) "cremation of human remains". The regulations require the new installation to meet 'Best Available Techniques'. Including the following:

- The aim should be to prevent any visible airborne and odorous emissions from any part of the process. Emissions from cremations should in normal operation be free from visible smoke.
- All other releases to air, other than condensed water vapour, should be free from persistent visible emissions. All emissions to air should be free from droplets
- All new crematoria to be fitted with mercury abatement.

Neither SEPA and Angus Council Environmental Health department have objected to these proposlas.

Planning Position

The site is sustainably located in relation to the relevant population centres, which in turn will significantly reduce journey times for crematorium services, compared to journey times to Friockheim, Dundee or even Perth & Kirkcaldy.

There is only one other crematoria in Angus, one in Dundee one in Perth and approval has been granted for one south of St. Andrews in Fife. It is contended that the location proposed for the crematorium will draw mainly from people located in the south of Angus and the North and East of Dundee is strategically located to serve the settlements and communities. Likewise, its location within the road network means that travelling times / distances are minimal particularly during peak traffic periods and if the weather is poor. A crematorium is not able or suited to be located within an existing settlement, because of the requirements laid down in the Crematoria Act (1902) and also the travelling distances required and difficulties with access. In any event the dispersed settlement characteristic of this part of Angus makes the site a logical choice. The crematorium is considered to be a community facility that will help satisfy the demand in the area to the benefit of the local communities.

A crematorium at Burnside of Duntrune will not on its own, or cumulatively, affect the vitality and viability of town and local centres. It is likely that the crematorium will benefit established businesses in the vicinity, such as hotels, guest houses, food establishments, taxi firms etc. The scale, design and fit of the crematorium within the landscape, will mean that it will have negligible direct or indirect impact on surrounding properties or land uses and due to the topography of the site and existing tree cover, there will either be no views of the crematorium or only very limited views. In any event, the design of the crematorium and the use of materials and landscaping, will mean that it will fit comfortably within the rural environment.

The proposed crematorium will make a positive contribution to the quality of its immediate environment. It will create a community facility with an established sense of place using high quality of built design and landscaping. It will promote, enhance and add to biodiversity, it will include water and energy conservation measures such as waste heat recovery and passive solar gain, it will incorporate appropriate waste recycling, segregation and collection facilities and the applicant will seek to minimise waste by design and during construction.

The crematorium and its setting demonstrate a high standard of architectural design which fits well with the local environment. It makes best use of the prevailing landform, trees, hedgerow s and woodland. The proposal provides both a formal and informal landscape context for the crematorium. Access and parking arrangements are safe, and the design incorporates facilities for coaches and those with disabilities and impaired mobility. The personal privacy and amenity of nearby householders will be maintained.

The accompanying Transport Assessment acknowledges that due to the nature of the crematorium, most journeys will be by private car. However, the local road network has sufficient capacity to accommodate increased car journeys, particularly as they will mostly be made out with peak periods. Sufficient car parking spaces have been made available and any rare unusually large services can be accommodated using overspill parking along the internal road.

It is contended that there is a need for a crematorium to serve this area as demonstrated by demographics and population projections The proposed countryside location is strategically situated to serve all of the surrounding communities equally, and it is considered that the location is both sustainable and of community benefit.

It is considered that local services will benefit from such a land use and the crematorium is very much seen as a community facility which will benefit the local community and provide a local service.

Pre-Application Consultation

Pre-submission enquiries were undertaken with Angus Council to determine whether the principle of a Crematorium on the subject land would be complaint with Planning Plan policy and other material considerations.

From those pre-application enquiries the following has been prior agreed with Angus Council Planning and Roads Services

- The submitted Transport Assessment is acceptable.
- The application site is not on prime quality agricultural land.

In terms of compatibility with development plan policy, pre-application liaison also recognised that there are matters relating to public transport accessibility and sequential testing of the proposals, both of which required to be addressed through an appropriate application for planning permission.

Planning Policy

Applications for planning permission require to be determined in accordance with national planning policy and the development plan unless material considerations indicate otherwise.

Scottish Planning Policy 2010

Scottish Planning Policy (February 2010) states that the planning system has a significant role in supporting sustainable economic growth in rural areas.

The aim of the planning system should be to enable development in all rural areas, which supports prosperous and sustainable communities whilst protecting and enhancing environmental quality. The strategy for rural development should respond to the specific circumstances in an area whilst reflecting the overarching aim of supporting diversification and growth of the rural economy. Development plans should therefore promote economic activity and diversification in all rural areas and developments that provide employment or community benefits should be encouraged.

All new development should respond to the specific local character of the location, fit in the landscape and seek to achieve high design and environmental standards. Planning authorities should also be realistic about the availability or likely availability of alternatives to access by car as not all locations can be served by public transport (SPP paragraphs 92 to 96 & 276).

The Development Plan

The development plan comprises of TAYplan, approved in October 2017, and the Angus Local Development Plan, adopted in September 2016.

TAYplan 2017

Policy 1 of the Approved TAYplan Strategic Development Plan advises that, in adherence with the sequential approach, development should, in the first instance, take place within settlements. However, TAYplan also states that Local Development Plans may also provide for some development in rural areas if it genuinely contributes to the objectives of TAYplan and meets specific local needs or supports regeneration of the local economy.

Angus Local Development Plan 2016

The site is not covered by any specific policies and it is not affected by any local, national or international landscape, environmental, ecological or geological designations. The proposed crematorium therefore requires to be considered against more general, but relevant, policies contained within the Local Plan.

Policy DS1 Development Boundaries and Priorities states that all proposals will be expected to support the delivery of the Development Strategy, which put very simply promotes the re-use of brownfield sites within settlement boundaries over greenfield sites out with settlement boundaries.

Whilst it has been suitably demonstrated that the site is not on prime quality agricultural land, it is also however recognised that it is a greenfield site within a rural location. However, there are various layers to Policy DS1 that have to be recognised and assessed as not all scenarios can be anticipated through the Development Plan.

Specifically out with development boundaries, proposals will be supported where they are of a scale and nature appropriate to their location and where they are in accordance with other relevant policies. Development on unallocated greenfield sites, such as the subject land, can therefore be supported where there are no suitable and available brownfield sites capable of accommodating the proposed use within a settlement boundary.

In terms of carrying out an exercise to identify any possible alternative brownfield locations within settlements that are capable of accommodating the proposed use, it is material to note that there are no new crematorium sites identified / allocated within the Angus Local Development Plan. Most notably, Policy TC9 safeguards land for cemetery use at various locations throughout Angus, but no sites are identified for additional crematorium uses.

In terms of other possible sites, i.e. that are identified within the ALDP, Policy DS1 is very clear that sites allocated for specific uses, i.e. housing, employment, open space, etc will be safeguarded for the uses as set out within the plan. The reason for this policy is to ensure the maintenance of effective housing and employment land supply and for these sites not to be taken for other uses.

To therefore satisfy the exercise of proving that there are no alternative sites for crematorium uses within settlement boundaries, a survey therefore requires to identify a possible site within a South Angus settlement boundary, i.e. Carnoustie & Barry, Monifieth and other small settlements as follows:

- Is not allocated for any other uses.
- Is technically deliverable, i.e. access, infrastructure, etc.
- Has a willing landowner.
- Has a minimum area of 2 hectares.
- Is not closer than 50 yards to a public highway yet close to a main road.
- And is not closer than 200 yards to an existing dwelling house.

Additionally, it is preferable that the site benefits from existing landscape features such as mature trees, hedgerows, and is flat or slightly sloping, i.e. not only has the site to be appropriate in all other aspects of deliverability and availability, it is also appropriate in planning terms.

In terms of accessibility, it is acknowledged that a crematorium bears similarities with non-residential institution uses, which, among other things, include community and cultural facilities that attract significant numbers of people. The development plan applies a town centre first policy for proposals for this type of use and, for a building of the proposed size, the applicant may be required to submit relevant assessments (including retail / town centre impact, transport and sequential assessments) where it is considered that the proposal may have a significant impact on the vibrancy, vitality and viability of any of the town centres in Angus.

In the case of this application, clearly retail and town centre impact assessments are not applicable / required; however Transport and Sequential Assessments are acknowledged requirements.

The Transport Assessment was prior submitted and agreed with the Councils Roads Service. It is submitted again as part of the application pack.

Regarding the requirement for a sequential test, as set out above, key information required includes details on any alternative sites considered and the reasons for discounting these sites. The reasons can include operational and amenity considerations, but the link between these reasons and the site selection must be clearly demonstrated.

The most relevant information base for such a sequential test lies within the housing and employment land audits, both prepared by Angus Council; and from any further surveys carried out by the applicant.

Sequential Test

The following therefore seeks to demonstrate that the site is the most sequentially preferable location for the proposed development; with no other brownfield opportunities within any of the South Angus settlements available, suitable and viable to accommodate the proposals.

Angus Employment Land Audit 2019

Monifieth: No suitable sites, either greenfield or brownfield are identified.

Carnoustie & Barry: The audit identifies land at 3 locations.

- **Carlogie:** 15.00 ha of identified employment land with infrastructure constraints identified. This is a greenfield site, therefore it is not a reasonable alternative location to the application site.
- **Pitskelly:** 10.00 ha of identified employment land with infrastructure constraints identified. This is a greenfield site, therefore it is not a reasonable alternative location to the application site.
- **Panmure Industrial Estate:** 3 small and physically separate brownfield sites of 0.08; 0.09; and 0.22 ha are identified and classed as brownfield. All are listed as constrained as not currently being marketed. Notably, the Panmure Industrial Estate, including the above 3 sites, is all within 200 yards of existing dwelling houses.

Angus Housing Land Audit 2020

Monifieth: The audit identifies 5 sites / locations, all of which are either too small, within proximity of residential properties or greenfield sites.

- **Milton Mill:** 1.20 ha brownfield site currently under construction.
- **Former Seaview PS:** 0.88 ha brownfield site currently under construction.
- **Victoria Street West:** 16.30 ha greenfield site currently under construction.
- **Former Panmure Hotel:** 0.38 ha brownfield site currently under construction.
- **Panmure Church:** 0.12 ha brownfield site currently under construction.

Carnoustie & Barry: The audit identifies 5 sites / locations, 4 of which are noted as constrained; all of which are either too small, within proximity of residential properties or greenfield.

- **Land at Pitskelly**: 9.76 ha greenfield site.
- **Former Social Club, Barry Road**: 1.00 ha constrained brownfield site.
- **Greenlaw Hill:** 1.70 ha constrained brownfield site.
- **Woodside / Pitskelly:** 2.50 ha constrained brownfield site within 200 yards of existing residential properties.
- **Panmure Industrial Estate:** 3.70 ha constrained brownfield site within 200 yards of existing residential properties.

South Angus HMA Landward: There are no suitable sites within the remainder of the South Angus Housing Market Area identified within the Audit due to matters of size, location, deliverability, status and proximity to existing residential properties.

Other Potential Brownfield Opportunities identified by the applicant, i.e. not identified within either the Employment or Housing Land Audits

The South Angus HMA consists of the main settlements of Carnoustie & Barry and Monifieth. Within the Landward area, Newtyle is identified as a rural service centre and there are various other small settlements that have village boundaries such as Newbigging, Monikie, Wellbank, etc.

The ALDP recognises, in relation to brownfield opportunities in Carnoustie, that whilst the plan supports the development of vacant, underused and brownfield sites within the defined settlement boundary, the availability of brownfield land and property is extremely limited and sizeable opportunities are more or less restricted to those identified in the above audits. This is primarily due to past developments at the former driving range, the former Maltings and the site of the former Kinloch Primary School. Our own survey of potential brownfield sites has therefore failed to identify any brownfield opportunity sites of at least 2 ha and at least 200 yards from existing residential properties.

At **Monifieth**, the ALDP also supports the development of vacant, underused and brownfield sites within the defined settlement boundary, however the supply has again been extremely limited to the sites identified in the above audits. Recent re-development opportunities including Ashludie Hospital and Milton Mill have taken up any potentially significant supply and again our own survey of potential brownfield sites has therefore failed to identify any brownfield opportunity sites of at least 2 ha and at least 200 yards from existing residential properties.

Similar to the conclusions from the above audits, from our survey, there are also no suitable sites within any of the small settlements boundaries identified within the **Landward** South Angus Housing Market Area which could deliver a brownfield opportunity site of at least 2 ha and is at least 200 yards from existing residential properties.

In accordance with the requirements of ALDP Policy DS1, it has therefore been suitably demonstrated that potential brownfield sites within South Angus settlement boundaries have been researched and there are no sites available or suitable within a development boundary that would re-use or make better use of vacant, derelict or under-used brownfield land or buildings.

In summary, there are therefore no sites of sufficient size within any of the South Angus Housing market Area settlement boundaries of sufficient size to meet the requirements of the proposal, or have the necessary profile required in terms of relationship to existing residential properties, residential amenity, etc.

Notwithstanding the clearly demonstrated lack of brownfield opportunity sites within identified settlement boundaries, it remains the applicants view that a land use such as a crematorium is not well suited to an urban area and the dispersed settlement / rural characteristics of this part of South Angus makes the site a logical choice.

Accessibility

The site is centrally located within the South Angus Area, directly accessible to its target catchment area and therefore sustainably located. When compared to current Crematorium locations, the location of the site will therefore provide important savings on journey times and journey miles.

Policy DS2 Accessible Development of the ALDP requires development proposals to demonstrate, according to scale, type and location, that they are or can be made accessible to existing or proposed public transport networks.

As also noted above, SPP states that planning authorities should be realistic about the availability or likely availability of alternatives to access by car as not all locations can be served by public transport. While it is respectfully suggested that this is the case with this proposal due to a lack of demand by the nature of the use. We have drawn the similarities in this area to the only other crematorium facility located in Angus and have outlined above two possible options which adequately provide access to the development without the need to travel by car.

Finally, it is contended that the South Angus location proposed for the crematorium is strategically located to serve the principal settlements and communities. Likewise, its location within the strategic and local road network means that travelling distances are minimal. A crematorium on the subject land is therefore preferable to a site within an existing South Angus settlement location.

Conclusion

The provision of a crematorium at Burnside of Duntrune will provide a significant benefit to the local community and it has been demonstrated that, there is a need for a countryside location and there is no loss of prime agricultural ground. The site is accessible and sustainably located and has been carefully chosen in relation to the surrounding local population centres. The location of the site does not offend the development plan policy or Scottish Government policy. In fact, it provides an appropriate land use which will be of direct and indirect benefit to the local community. There are no technical impediments to the proposal, and it will have no detrimental impact on the closest residential properties, of which there are few. The crematorium building and associated landscaping will enhance the landscape character and biodiversity of the area. The crematorium building includes sustainable construction methods, use of materials and high standards of energy conservation and efficiency.