Lidl Great Britain Ltd

DRAINAGE STRATEGY REPORT

Blackpill, Swansea

0327-WSP-XX-XX-C-RP-0510
SEPTEMBER 2021

PUBLIC

Lidl Great Britain Ltd

DRAINAGE STRATEGY REPORT

Blackpill, Swansea

REPORT (REV P01) PUBLIC

PROJECT NO. 70050327

OUR REF. NO. 0327-WSP-XX-XX-C-RP-0510

DATE: SEPTEMBER 2021

WSP

1 Capital Quarter
Tyndall Street
Cardiff
CF10 4BZ

Phone: +44 2920 769 200

WSP.com

QUALITY CONTROL

Issue/revision	P01	P02	P03	P04
Remarks	First Issue			
Date	Sept 2021			
Prepared by	Ollie Gentilcore			
Signature				
Checked by	Andrew Wilkinson			
Signature				
Authorised by	Andrew Wilkinson			
Signature				
Project number	70050327			
Report number	RP-0510			
File reference	0327-WSP-XX-XX-C-RP-0510			

CONTENTS

TABLES

FIGURES

APPENDICES

1. INTRODUCTION

1.1. BACKGROUND

WSP has been appointed by Lidl Great Britain Ltd to undertake a drainage strategy for a proposed retail store in Blackpill, Swansea.

The objectives of the report are to:

- Review the existing drainage arrangements on site for foul and surface water;
- Assess the feasibility of Sustainable Drainage Systems (SuDS) features within the development to control and discharge surface water runoff to comply with the requirements of the "Statutory National Standards for Sustainable Drainage Systems (Wales)" (SNSSUDS);
- Provide a preliminary design for SuDS including indicative sizing of storage/attenuation features and a conceptual plan, suitable for inclusion in a pre-application submission to the local authority's SuDS Approval Body (SAB).
- Identify a potential discharge point foul flows generated by the proposed development.

The following tasks have been undertaken to complete this report:

- Undertake a desktop investigation of the site's existing drainage arrangements;
- Outline anticipated solutions for foul and surface water disposal. This will include preliminary calculations, in order that the conceptual designs may be agreed with the relevant authorities;
- Determine the area of impermeable surfaces that will be generated by the proposed development and estimate the likely historical brownfield run-off rates for this site;
- Assess the feasibility of using infiltration as a disposal method, based on initial soakaway testing results or other available information on ground conditions;
- Estimate the size of surface water storage needed to manage run-off from the site post-development, using drainage design software (Microdrainage);
- Provide general information on the maintenance and adoption of SuDS via the SAB's approval process; and
- Give consideration to drainage exceedance. In particular, use topographic information to identify overland flow paths and areas susceptible to surface water ponding.

1.2. LIMITATIONS

WSP has prepared this report in accordance with the instructions of their client, Lidl Great Britain Ltd, for their sole and specific use. Any person who uses any information contained herein do so at their own risk.

The conclusions and recommendations contained herein are limited by the availability of background information and the planned use for the site.

Third-party information has been used in the preparation of this report, which WSP UK Ltd, by necessity assumes is correct at the time of writing. Whilst all reasonable checks have been made on data sources and the accuracy of the data, WSP UK Ltd accepts no liability.

1.3. CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2015

The revised Construction (Design and Management) Regulations 2015 (CDM Regulations) came into force in April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the designer's responsibilities under clause 9 (1) is to ensure that the client organisation, in this instance Lidl Great Britain Ltd, is made aware of their duties under the CDM Regulations.

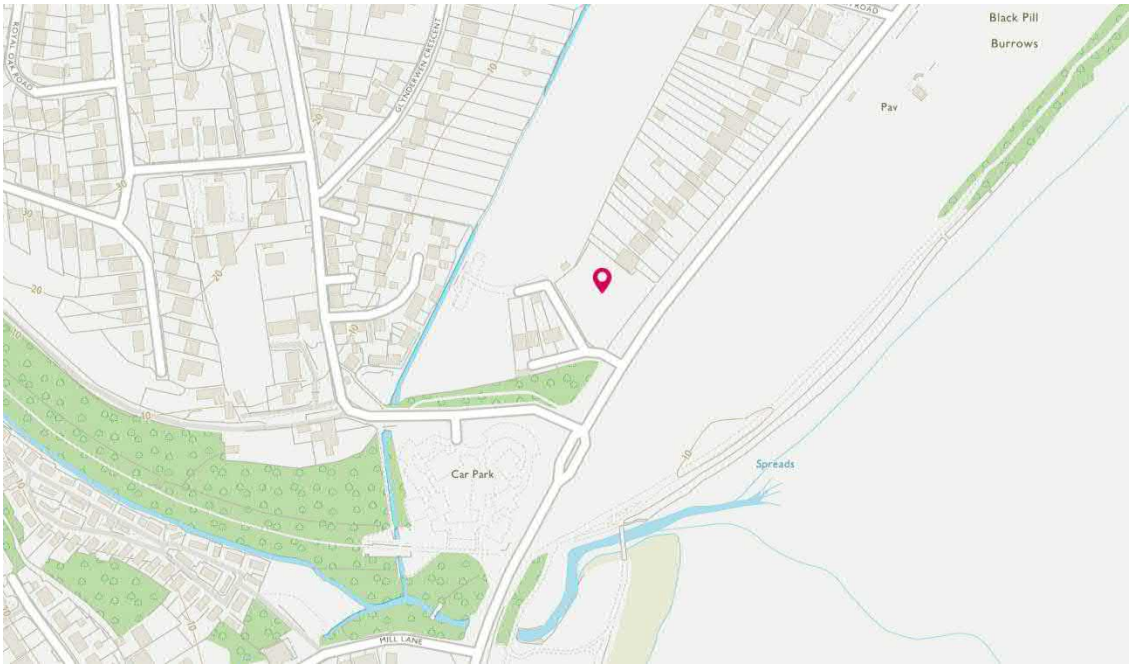
2. SITE SETTING

2.1. LOCATION

The site is located in Blackpill, Swansea SA3 5AT (Grid Ref: 62060 90963). The site previously consisted of a Petrol Filling Station (PFS) and 2no. houses, comprising of a small portion of green space. The PFS has now been demolished and remediated but the 2no. houses that form part of the site remain. The site is bounded by Mumbles Road to the east, existing houses to the north and south, and an open field to the west, which is bordered to the northwest by the Cwm Stream.

The site area is approximately 0.413ha and is shown in Figure 1 below.

Figure 1 – Site Location



2.2. DEVELOPMENT PROPOSALS

The proposed development consists of a new Lidl retail food store (Use Class A1), together with associated parking of up to 50 spaces, landscaping, related infrastructure, and engineering works.

2.3. EXISTING DRAINAGE NETWORK

The existing site consisted of a PFS and 2no. residential properties (semi-detached) with associated front and rear yards/gardens.

The Dwr Cymru Welsh Water (DCWW) public sewer record plan shows that an existing 225mm diameter foul sewer runs northeast out of the site from the location of the on-site residential units. This sewer serves multiple residential units on Mumbles Road before increasing to a 300mm diameter foul sewer and subsequently connecting to the public, brickwork combined sewer (90x60inch) located east of Mumbles Road. A copy of the DCWW public sewer record plan is appended to this report in Appendix E.

It is likely that foul flows from the 2no. residential properties that lie within the site boundary, and those from the demolished PFS, drain into the aforementioned DCWW foul sewer.

The residential properties have pitched roofs that drain via rainwater downpipes, making it possible to drain into the foul sewer at the rear of the properties. Based on topographical survey evidence, it is assumed that a significant amount of runoff was conveyed towards the open fields and a nearby stream behind the plots.

A 300mm diameter DCWW surface water sewer has also been identified running in a southwest direction alongside Mumbles Road before it crosses the southern corner of the site, before continuing towards and finally discharging into the Cwm Stream. It is assumed that surface water runoff from the PFS site discharged into this surface water sewer, as well as from the on-site residential properties which have pitched roofs and rainwater downpipes. It is also likely to receive surface water flows from some of the adjacent residential properties and the adjacent highway.

3. SURFACE WATER

The following surface water drainage strategy has been designed to fully conform with the six standards set out under the document *'Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems' (Welsh Government, 2018)*. These standards are:

- S1 – Runoff destination
- S2 – Hydraulic control
- S3 – Water quality
- S4 – Amenity
- S5 – Biodiversity
- S6 – Construction, operation and maintenance

This section is to be read in conjunction with drawing 0327-WSP-XX-XX-C-DR-0500 located under Appendix A of this report.

3.1. STANDARD S1 - RUNOFF DESTINATION

In order to determine the most appropriate runoff destination from the proposed development, the hierarchy as set out under standard S1 is to be followed:

Table 1 - SuDS Drainage Hierarchy

		Priority Level	Discharge Location	Availability	Comments
Hierarchy	↓	1	Collect for use	×	System would be implemented for roof terrace irrigation only. As this would be seasonal only there would be no stormwater management benefit and would increase the risk from legionella disease.
		2	Infiltrated to ground	×	The ground on site generally comprises of sandy gravel which facilitates rapid infiltration. gravel soil identified in the GI report. However, due to the presence of Made Ground and hydrocarbons, infiltration has been disregarded.
		3	Discharge to a surface water body	×	As noted under paragraph 2.3, there is an option to discharge surface water flows to the nearby stream, although this is restricted by third-party land and not considered further.
		4	Discharge to a surface water sewer, highway drain, or another drainage system	✓	As noted under paragraph 2.3, there is an option to connect surface water flows to the surface water sewer located on Mumbles Road. Therefore, this option has governed the overall drainage strategy.
		5	Discharge to a combined Sewer	✓	Despite the possibility to connect surface water flows to the public combined brickwork sewer, this can be discounted due to more favourable alternatives.

Collect for use

The water demand within the proposed retail unit does not warrant the cost of a rainwater harvesting system and therefore the scheme does not include collection for reuse (on the basis of viability).

Infiltration

The Phase 2 Ground Investigation report undertaken by Remada Ltd (730.03.01 Remada Phase 2), confirmed that 3no. test pits 1.5 metres below ground level were excavated to undertake a soakaway test to BRE Digest 365. The results indicated that there was rapid infiltration into the shallow soils, however, the site has historically been used as a PFS, and hydrocarbons were recorded within the underlying soils circa 2m depth. Furthermore, the natural strata underlying the made ground (and quite possibly at shallower depths on either side of the made ground) typically comprises Alluvium (soft clays with layers of peat) to depths between 6.0 and 6.3mbgl. As a result, infiltration methods and soakaways have been discounted.

Discharge to a surface water body

There is however an option to discharge into the nearby watercourse, i.e. the Cwm Stream. The stream lies some 70m southwest of the site and the site already benefits from a surface water sewer that discharges into it.

As shown on the DCWW public sewer record plan (Appendix E), the aforementioned existing sewer, into which it is thought that the site discharged into historically (i.e. from the PFS), is a public surface water sewer that also appears to serve some of the housing on Mumbles Road (to the east of the site). The existing surface water sewer discharges into the Cwm stream approximately 70m southwest of the site boundary. This can be seen as the most sustainable/viable option for surface water discharge, subject to DCWW approval.

3.2. STANDARD S2 – HYDRAULIC CONTROL

Discharge Rate

The total area of the site is 0.413 hectares and was mostly hard paved when the PFS was in situ (pre-demolition/remediation).

The proposed is considered as 100% impermeable for the purposes of this assessment. Rainfall runoff rates have been calculated for several return periods using FEH rainfall data, the results are shown in Table 2 below.

Table 2 - Surface Water Runoff Rates from Proposed Development

Return Period (Years)	Runoff Rate (l/s)
2	22.9
30	49.8
100	61.7

As per G2.24 of the *'Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems' (Welsh Government, 2018)*, previously

developed sites are to provide a betterment of at least 30%. For the purposes of this design, however, and in light of the lack of evidence around previous surface water discharge, we propose to restrict to a greenfield discharge rate of 5.1 litres per second, providing a betterment of 78% against the 2-year return period provided in Table 2.

Surface water runoff is to be restricted using a flow control device located within the car park before discharging into the existing DCWW surface water sewer.

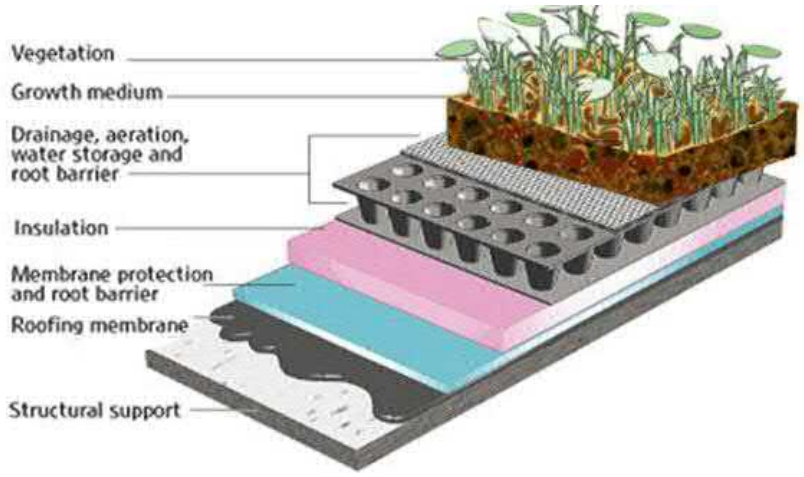
SuDS Proposals

The proposed development comprises of 1672m^2 retail floor space, a 1700m^2 car park area in addition to other essential infrastructure such as footways for pedestrian access, therefore only 9% of the total site area is available for ground level SuDS features such as swales, ponds, and bioretention.

The proposed development has a flat roof area that can adopt a 'green roof' system to enhance biodiversity. The green roof will provide limited amenity due to the lack of access, however, rainfall landing on these areas will be treated by filtration through the planting media and underlying bedding material, enhancing water quality significantly.

The proposed green roof will cover a maximum area of 1543m^2.

Figure 2 – Typical Green Roof Construction



Due to the negligible attenuation provided through the green roof system, flows will be conveyed down to the proposed permeable paving and voided subbase located within the car park. Preliminary calculations [Ref: 0327-WSP-MRS-CA-004] indicate dimensions of 58m x 24.6m x 0.50m for a Type 3 subbase with 30% voids.

Bioretention features have been proposed to provide additional benefits to water quality, amenity, and biodiversity.

Attenuation Storage

All attenuation storage has been sized to accommodate the critical 100-year storm event plus an allowance of 40% for climate change, in accordance with Table 3 of document *'Adapting to Climate*

Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales' (Welsh Government, 2017).

Development Creep

Development creep has not been included within the surface water drainage strategy as there is no space for extension.

3.3. STANDARD S3 – WATER QUALITY

Pollution index ratings for commercial/industrial roofing using inert materials is classed as very low.

Source control treatment is provided by the green roof systems located on the Lidl food store. Rainfall landing on these areas will be treated by filtration through the planting media and underlying bedding material.

Bioretention features have been provided to maximise water treatment at ground level before discharge to the proposed sub-base.

3.4. STANDARD S4 – AMENITY

Due to the proposed use of the site, amenity benefits enjoyable by the general public may not be immediately obvious, however, the bioretention features and the green roof will provide many aesthetic benefits, with a variety of colours and foliage that will evolve throughout the seasons. These features can also assist in defining clear boundaries throughout the development, contributing to a safer and calmer environment for pedestrians alongside trafficked areas. Introducing bioretention and other landscaped areas into the development, accounting for up to 275m^2 (6.7% of the total area), will only serve to improve on the existing scenario.

3.5. STANDARD S5 – BIODIVERSITY

Raingardens/bioretention areas are valuable in terms of water absorption and its filtering abilities, which in turn facilitate quality habitat conditions for wildlife in urban areas. These systems can be designed to support local biodiversity requirements. Planting is to be confirmed at detailed design by landscaping designers and agreed with the key stakeholders at a later stage.

A green roof will provide multiple environmental benefits, creating habitats for living organisms, thus significantly improving on the historical situation that was mostly hard paved.

3.6. STANDARD S6 – CONSTRUCTION, OPERATION AND MAINTENANCE

The Construction Phase Plan and Construction Environmental Management Plan documents are to be produced by the Contractor. These documents will be produced in the later design stages of the project and will be submitted as part of the Full SAB Application.

The proposed development is to be maintained by a facilities management company employed by the developer.

The proposed SuDS assets will require regular inspection and maintenance as part of the maintenance schedule for the development. Recommended maintenance schedules for the Green Roof system is noted within Table 3. Further operational and maintenance advice is provided in Appendix D but should also be confirmed with the manufacturer prior to construction.

Table 3 - Surface Water Maintenance Schedule for Green Roof Systems

Maintenance Schedule	Action	Frequency
Regular inspections	Inspect all components including soil substrate, vegetation, membranes, and roof structure for proper operation, the integrity of waterproofing and structural stability.	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms/rainfall events
	Inspect drain inlets and outlets to ensure that there are no blockages and are free draining.	Every 3 months and after severe storms/rainfall events
	Inspect underside of roof for evidence of leakage	Annually and after severe storms/rainfall events
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	Remove any debris and build up from outlets. Debris must be removed from site and not flushed down drainage system.	Every 3 months.
	During establishment (i.e. year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage, if applicable.	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs, and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material,	As required

Remedial actions	and sources of erosion damage should be identified and controlled	
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

4. FOUL DRAINAGE

4.1. PROPOSED FOUL FLOWS

Peak design discharges have been calculated based on the current development criteria as described in Section 2.2 of this report and for the following:

- Commercial: 0.6 litres/ second/ hectare (DWF, multiply by 6 for peak, i.e. 3.6 litres/ second/ hectare)

A summary of the proposed peak foul flow calculation is shown in Table 4 below.

Table 4 - Proposed Peak Foul Flow Rates

Type of Development	Floor Area	Peak Flow	Peak Foul Flow (l/s)
Commercial	0.167 ha	3.6 l/ s/ ha	0.60
Total	**-**	**-**	**0.60**

5. CONCLUSION

The proposed drainage strategy has been set out in this report to satisfy Standards S1 to S6 as set out under the *'Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems' (Welsh Government, 2018)*.

Surface water flows from the site are to be restricted to a maximum allowable rate of 5.1 litres per second, which reflects greenfield conditions and when compared with the historical brownfield runoff provides a 78% betterment against the 1 in 2yr return period event. The surface water connection and discharge rate are to be agreed upon with the LLFA and DCWW.

Surface water flows are proposed to discharge to the public surface water 300mm vitrified clay surface water sewer located within site.

As the proposed development is restricted in terms of size, it is not possible to include multiple green surface SuDS assets such as swales, ponds, or detention basins. Multiple benefits can still however be recognised through the proposed bioretention features and green roof shown within the strategy.

Flows from the green roof are to drain into the permeable paving and voided subbase lined with an impermeable membrane. A flow control device is to be fitted to outlet of the voided subbase, restricting flows to the maximum allowable discharge rate of 5.1 litres per second.

Pollution index ratings for commercial roofing using suitable materials is classed as very low and source control treatment is provided by the green roof system through filtration at source.

Amenity is provided through the raingardens that define clear boundaries throughout the development, contributing to a safer and calmer environment for pedestrians in/around trafficked areas. Introducing raingardens/bioretention into the development, accounting for up to 275m^2 (6.7% of the total area), will only improve on the existing scenario.

The green roof is to occupy 96% of the total roof area of the Lidl store. Whilst access to the roof is restricted, amenity benefits cannot be fully recognised, however, there may be an opportunity here to alter the planting specification in collaboration with the County Ecologist to provide enhanced biodiversity. This would provide a more biodiverse situation to that of the historical site that was mostly hard paved. The proposed development is to be maintained by a facilities management company employed by the developer. Funding for the maintenance of the building and external areas will be made by commercial occupants, as standard practice for this type of development. The proposed SuDS assets will require regular inspection and maintenance as part of the maintenance schedule for the development.

In summary, the scheme addresses the requirements of the Statutory Standards as follows:

Standard	Designer's Response
S1 – Runoff destination	▪ Rainwater harvesting is not viable due to low water demand and associated increased risk of legionella disease. ▪ The GI report (ref. 730.03.01 Remada Phase 2) states that infiltration is not feasible for the proposed development due to the presence of made ground (which contains hydrocarbons) with Alluvium (soft clays with layers of peat) beneath.

	▪ The nearest possible water body for discharge is the stream located to the west behind the site, which then discharges into the River Clyne and then the sea. ▪ The nearest public surface water sewer is located east of the site and passes through the southern part of the boundary before discharging into the Cwm Stream. ▪ In this case, the nearest and most viable destination for surface water runoff is to discharge into the surface water sewer at the front of the site.
S2 – Hydraulic control	▪ Surface water flows are to be restricted to a discharge rate of 5.1l/s (which is equivalent to the greenfield rate). This provides a betterment of 78% against the 2-year return period historical brownfield runoff from the PFS and houses. ▪ Attenuated surface water flows are to be stored within the voided subbase below the proposed car park. ▪ All storage has been sized to accommodate the critical storm from a 100-year return period event plus an additional allowance of 40% for climate change.
S3 – Water quality	▪ Pollution index ratings for commercial roofing using inert materials is classed as very low. ▪ Source control treatment is provided by the green roof system through filtration at source.
S4 – Amenity	▪ Amenity is provided through the multiple raingardens distributed across the site.
S5 – Biodiversity	▪ A green roof area is proposed and there may be an opportunity here to alter the planting specification in collaboration with the County Ecologist to provide enhanced biodiversity. This would provide a net gain in biodiversity to that of the historical/pre-remediated site that was mostly hard paved.
S6 – Construction, operation, and maintenance	▪ The Construction Phase Plan and Construction Environmental Management Plan documents are to be produced by the Contractor. These documents will be produced in the later design stages of the project and will be submitted as part of the Full SAB Application. ▪ The proposed development is to be maintained by a facilities management company employed by the developer/occupier. ▪ The proposed SuDS assets will require regular inspection and maintenance as part of the maintenance schedule for the development. Recommended maintenance schedules for the proposed SuDS assets are noted under Table 3 and Appendix D of the report. Further operational and maintenance advice is to be obtained from the manufacturer prior to construction.

Foul flows from the proposed unit will discharge into the dedicated public foul sewer at the eastern edge of the site.

Appendix A

SCHEME DRAWINGS

APPROXIMATE DIRECTION OF STREAM LOCATED MIN. 71m FROM BOUNDARY

ASSUMED BOUNDARY LINE, LEGALS TO BE CONFIRMED

Sub Sta

GREEN ROOF WITH PLANTS NECESSARY TO PROVIDE BIODIVERSITY (SAB STANDARD S5) MAX AREA: 1543m²

EXISTING PUBLIC FOUL SEWER TO BE ABANDONED TO POINT OF PROPOSED NEW CONNECTION

ADDITIONAL LANDSCAPED AREA: MAX 150m²

RAINGARDEN TO RECEIVE FLOWS FROM ROOF OF DELIVERY AREA MAX AREA: 20m²

NATIVE VEGETATION PREFERRED FOR MAXIMIZING BIODIVERSITY VALUE (S5). LAYOUT TO SUPPORT ECOLOGICAL CORRIDOR TOWARDS STREAM AT REAR

MIN. 2m OFFSET FROM BUILDING WALL INDICATING IMPERMEABLE GEOMEMBRANE BELOW SUB-BASE TO PREVENT WATER INFILTRATION CLOSE TO FOUNDATIONS

ADDITIONAL LANDSCAPED AREA: MAX 27m²

EXPLORE THE POSSIBILITY OF CONVERTING PARKING BAYS TO BIORETENTION AREAS SHOULD STORAGE CAPACITY AND BIODIVERSITY BE INSUFFICIENT TOTAL AREA: 35m²

DISTRIBUTION BOX USING PERMAVOID CRATE WITHIN SUB-BASE

SIGNAGE POSITIONED OVER EXISTING DRAINAGE. MAY NEED TO RELOCATE OR DIVERT DRAINAGE

PUBLIC FOUL SEWER

NEW MANHOLE CHAMBER ON LINE OF EXISTING FOUL SEWER TO FORM THE NEW HEAD OF THE RUN, AND TO RECEIVE FLOWS FROM THE PROPOSED RETAIL UNIT

TOTAL NO. PARKING SPACES: 50

ADDITIONAL LANDSCAPED AREA: MAX 38m²

CAR PARK TO BE UNDERLAIN WITH LOW FINES TYPE 3 OPEN GRADED GRANULAR MATERIAL SUB-BASE (30% VOIDS MINIMUM)

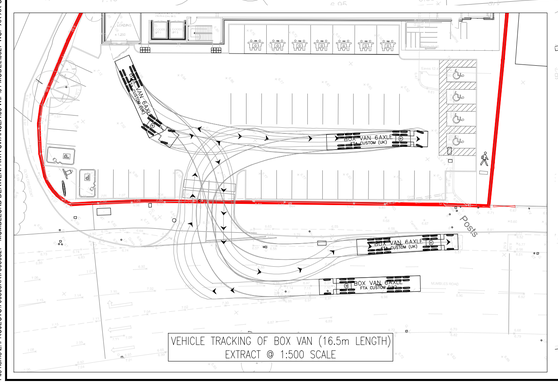
EXISTING SW SEWER (EXACT LOCATION TBC) WITH OUTFALL INTO NEARBY STREAM. PROPOSED DISCHARGE POINT FOR DEVELOPMENT

DISCHARGE RATE RESTRICTED TO GREENFIELD QBAR = 5.1l/s, PROVIDING A 78% BETTERMENT ON THE PRE-DEMOLITION/REMEDIATION SCENARIO

PERMEABLE PAVING FOR CAR SPACES MAX AREA: 568m²

STANDARD DBM SURFACE AND BASE COURSE WITH VOIDED SUB-BASE BENEATH. SUB-BASE TO PROVIDE ATTENUATION STORAGE FOR THE 1:100YR+40%CC EVENT. ESTIMATED DIMENSIONS TO BE (LxWxD) = 58mx24.6mx0.75m FROM CL

GENERALLY FLAT WITH SLIGHT FALL FROM SOUTH TO NORTH



VEHICLE TRACKING OF BOX VAN (16.5m LENGTH) EXTRACT @ 1:500 SCALE

DO NOT SCALE

KEY

- EXISTING PUBLIC FOUL
- EXISTING COMBINED ADOPTED
- EXISTING SURFACE WATER
- PUBLIC SEWER TO BE ABANDONED
- EXISTING MANHOLE
- CHANNEL DRAIN
- PERFORATED PIPE
- PROPOSED SURFACE WATER
- PROPOSED SURFACE WATER MANHOLE
- FLOW CONTROL DEVICE
- PERMAVOID RAINWATER DIFFUSER UNIT
- RAINGARDEN
- LANDSCAPED AREA
- GREEN ROOF
- PERMEABLE PAVING
- VOIDED SUB-BASE
- VOIDED SUB-BASE (W/ IMPERMEABLE GEOMEMBRANE OFFSET
- IMPERMEABLE GEOMEMBRANE OFFSET
- PUBLIC SEWER SAFETY ZONE/EASEMENT

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES OR STATUTORY BODIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR AND / OR EMPLOYER COMMENCE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT THEIR OWN RISK.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	15/09/2021	OG	FIRST ISSUE	AW	AW

DRAWING STATUS: S2 - FOR INFORMATION

wsp
1 Capital Quarter, Tyndall St, Cardiff, CF10 4BZ, UK
T+ 44 (0) 292 076 9200
wsp.com

CLIENT: LIDL GREAT BRITAIN LTD

ARCHITECT: ONE DESIGN ARCHITECTURAL SERVICES

SITE/PROJECT: BLACKPILL, SWANSEA

TITLE: ILLUSTRATIVE DRAINAGE STRATEGY

SCALE @ A1:	CHECKED:	APPROVED:
1:200	AW	AW

PROJECT NO:	DESIGNED:	DRAWN:	DATE:
70050327	OG	OG	September 2021

DRAWING No: 0327-WSP-XX-XX-C-DR-0500 REV: P01

DO NOT SCALE

KEY

- CATCHMENT A (544m^2)
- CATCHMENT B (144m^2)
- CATCHMENT C (420m^2)
- CATCHMENT D (543m^2)
- CATCHMENT E (436m^2)
- CATCHMENT F (294m^2)
- CATCHMENT G (185m^2)
- CATCHMENT H (1561m^2)

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES OR STATUTORY BODIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR AND / OR EMPLOYER COMMENCE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT THEIR OWN RISK.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	14/09/2021	OG	FIRST ISSUE	AW	AW

DRAWING STATUS: S2 - FOR INFORMATION

wsp
1 Capital Quarter, Tyndall St, Cardiff, CF10 4BZ, UK
T+ 44 (0) 292 076 9200
wsp.com

CLIENT: LIDL GREAT BRITAIN LTD

ARCHITECT: ONE DESIGN ARCHITECTURAL SERVICES

SITE/PROJECT: BLACKPILL, SWANSEA

TITLE: DRAINAGE CONCEPT STRATEGY

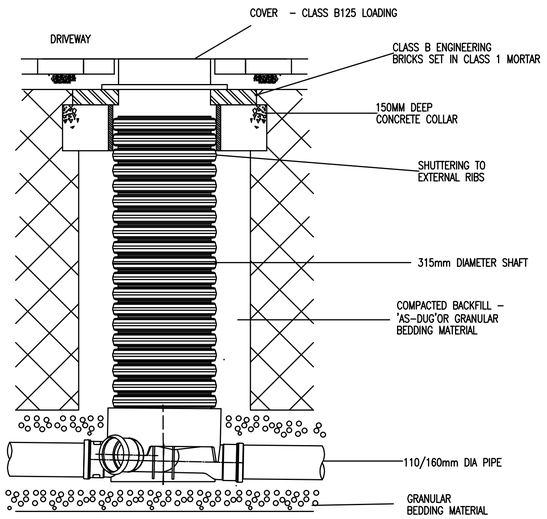
SCALE @ A1: 1:200	CHECKED: AW		APPROVED: AW
PROJECT NO: 70050327	DESIGNED: OG	DRAWN: OG	DATE: September 21

DRAWING No: 0327-WSP-XX-XX-C-SK-0501 — REV: P01

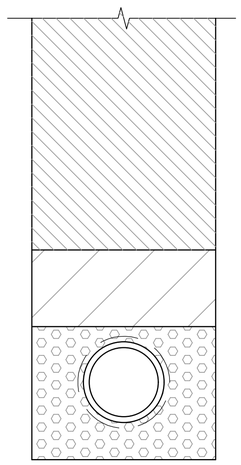
DO NOT SCALE

WAVIN – RANGE 315 (OR SIMILAR APPROVED)

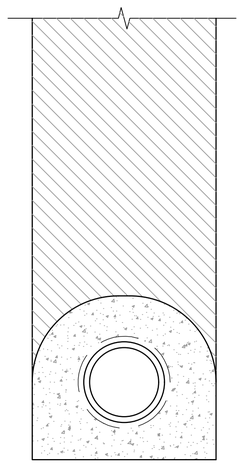
B125 LOADING (PAVED AREAS WITH LIMITED TRAFFIC LOAD)



TO BE READ IN CONJUNCTION WITH PIPE BEDDING NOTES AND HATCHINGS DETAIL



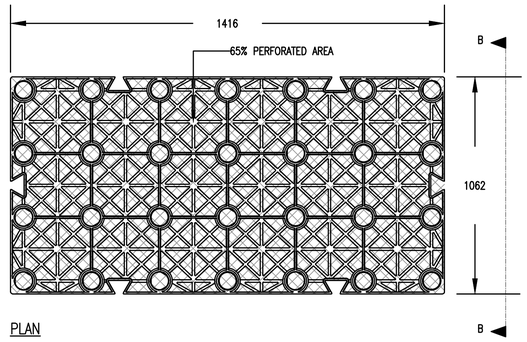
TYPE S PIPE BEDDING
(FULL GRANULAR BED & SURROUND)



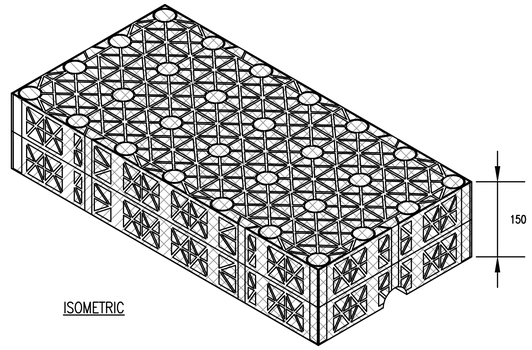
TYPE Z PIPE BEDDING
(FULL CONCRETE BED & SURROUND)

PERMAVOID DIFFUSER UNIT (OR SIMILAR APPROVED)

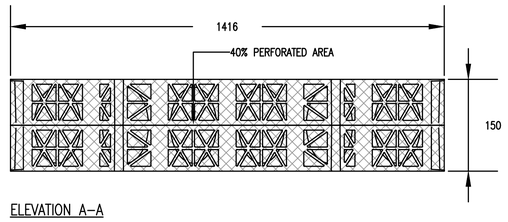
PRODUCT CODE: (ON APPLICATION)



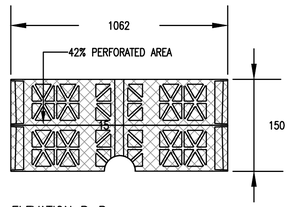
PLAN



ISOMETRIC



ELEVATION A–A



ELEVATION B–B

PERMAVOID DIFFUSER CONFIGURATION OPTIONS (OR SIMILAR APPROVED)

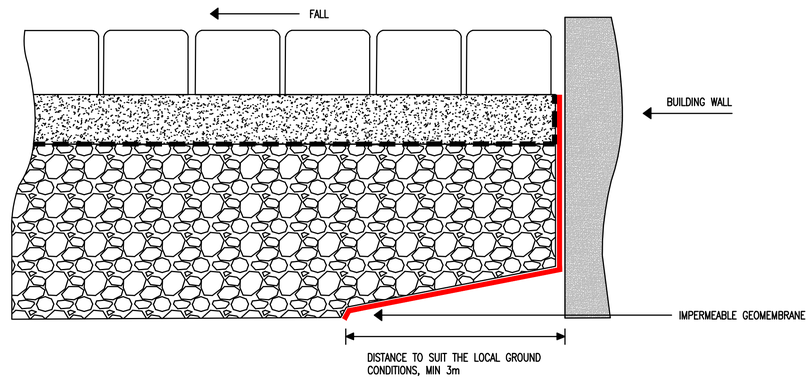
(THE BELOW SIZES ARE AVAILABLE)

WIDTH (mm) / LENGTH (mm)	354	708	1062	1416	2124
708	✓	✓	✓	✓	✓
1062	✓	✓	✗	✓	✓
1416	✓	✓	✓	✓	✓
2124	✓	✓	✓	✓	✓

NOTE:

DEPTHS AVAILABLE ARE EITHER 150mm OR 300mm.

CONNECTIONS AVAILABLE ARE EITHER Ø110MM OR Ø160mm.



TYPICAL ABUTMENT TO BUILDING WHERE RAINWATER IS DISCHARGED

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES OR STATUTORY BODIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR AND / OR EMPLOYER COMMENCE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT THEIR OWN RISK.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	14/09/2021	OG	FIRST ISSUE	AW	AW

DRAWING STATUS: S2 - FOR INFORMATION

1 Capital Quarter, Tyndall St, Cardiff, CF10 4BZ, UK
T+ 44 (0) 292 076 9200
wsp.com

CLIENT: LIDL GREAT BRITAIN LTD

ARCHITECT: ONE DESIGN ARCHITECTURAL SERVICES

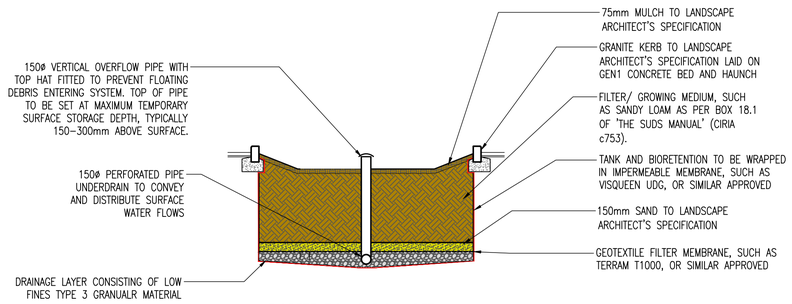
SITE/PROJECT: BLACKPILL, SWANSEA

TITLE: DRAINAGE STANDARD DETAILS (SHEET 1 OF 2)

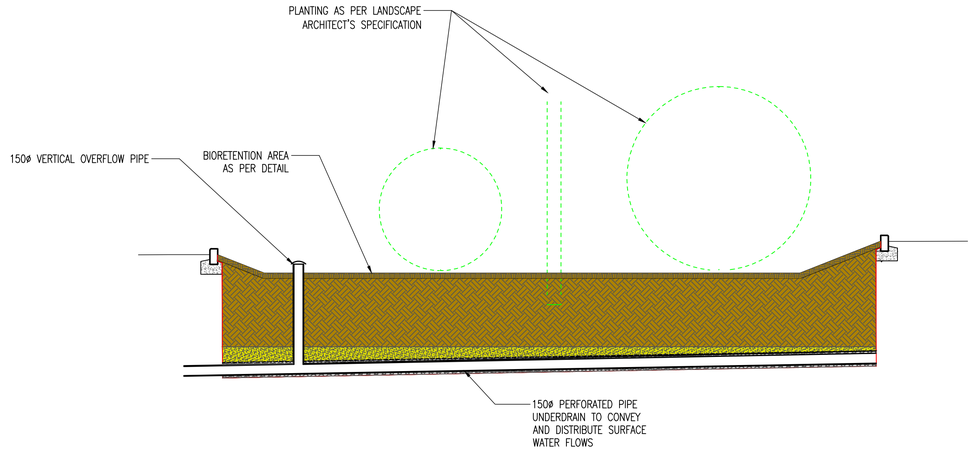
SCALE @ A1:	CHECKED:		APPROVED:
NTS	AW		AW
PROJECT NO:	DESIGNED:	DRAWN:	DATE:
70050327	OG	OG	September 2021

DRAWING No: 0327-WSP-XX-XX-C-DR-0550 REV: P01

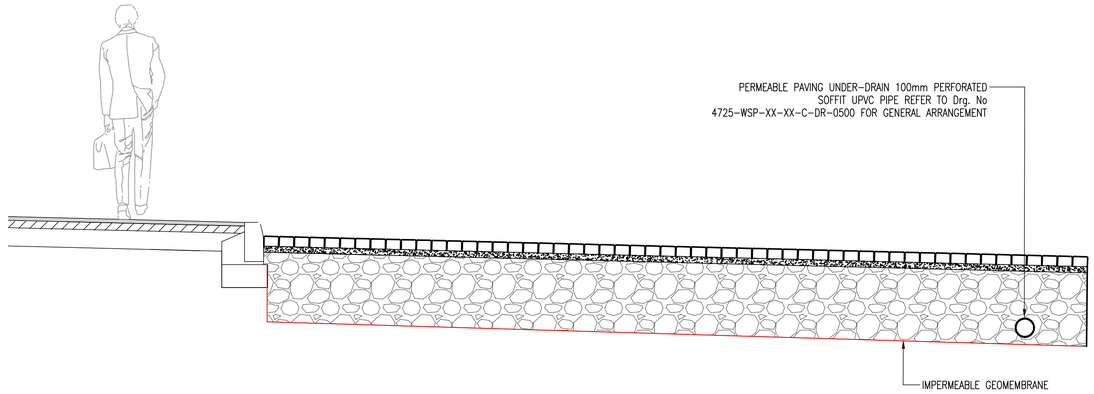
DO NOT SCALE



BIORETENTION TYPICAL DETAIL 1
SCALE 1:50



BIORETENTION TYPICAL DETAIL 2
SCALE 1:50



PERMEABLE PAVING TYPICAL DETAIL

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES OR STATUTORY BODIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR AND / OR EMPLOYER COMMENCE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT THEIR OWN RISK.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	14/09/2021	OG	FIRST ISSUE	AW	AW

DRAWING STATUS: S2 - FOR INFORMATION

1 Capital Quarter, Tyndall St, Cardiff, CF10 4BZ, UK
T+ 44 (0) 292 076 9200
wsp.com

CLIENT: LIDL GREAT BRITAIN LTD

ARCHITECT: ONE DESIGN ARCHITECTURAL SERVICES

SITE/PROJECT: BLACKPILL, SWANSEA

TITLE: DRAINAGE STANDARD DETAILS (SHEET 2 OF 2)

SCALE @ A1:	CHECKED:		APPROVED:
1:50	AW		AW
PROJECT NO:	DESIGNED:	DRAWN:	DATE:
70050327	OG	OG	September 21

DRAWING No: 0327-WSP-XX-XX-C-DR-0551 REV: P01

Appendix B

RUNOFF CALCULATIONS

Appendix B.1

BROWNFIELD RUN-OFF

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Ollie Gentilcore
Site name:	Mumbles Rd
Site location:	Swansea

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.60037° N
Longitude:	3.99361° W
Reference:	1554481394
Date:	May 10 2021 10:25

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha): 1

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.366
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.08

Hydrological characteristics

	Default	Edited
SAAR (mm):	1128	1128
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 30 years:	1.78	1.78
Growth curve factor 100 years:	2.18	2.18
Growth curve factor 200 years:	2.46	2.46

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		12.45
1 in 1 year (l/s):		10.96
1 in 30 years (l/s):		22.17
1 in 100 year (l/s):		27.15
1 in 200 years (l/s):		30.63

Lidl Blackpill, Mumbles Road - Greenfield Runoff Rates

0327-WSP-MRS-CA-001
Date Completed: 05/07/2021
Name: Ollie Gentilcore

Site Area Total	4134.4 m2
	0.413 ha

Greenfield Runoff Rates

	Unfactored Q (l/s/ha)	Factored Q (l/s)
Q1	10.96	4.5
Qbar	12.45	5.1
Q30	22.17	9.2
Q100	27.15	11.2
Q200	30.63	12.7

Appendix B.2

GREENFIELD RUNOFF

PROJECT: Lidl Blackpill, Mumbles Rd (0327-WSP-MRS-CA-002 Brownfield Rates)
From FEH Rainfall Data:

EQ. 24.7 Variable UK runoff model

$$PR = IF \times PIMP + (100 - IF \times PIMP) \times \frac{NAPI}{PF}$$

where:

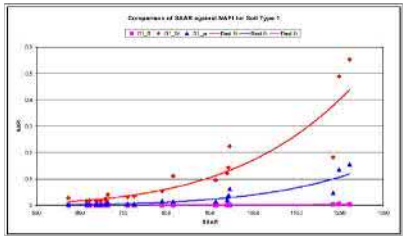
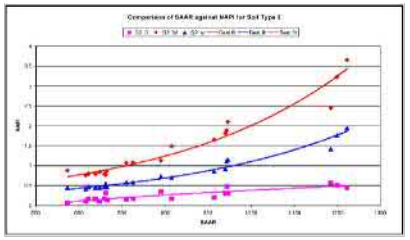
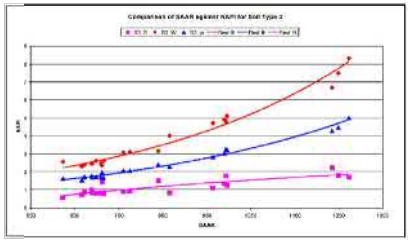
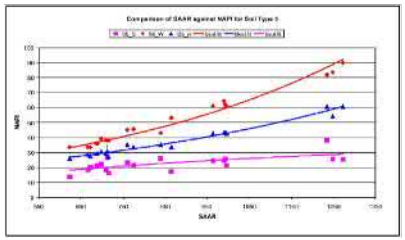
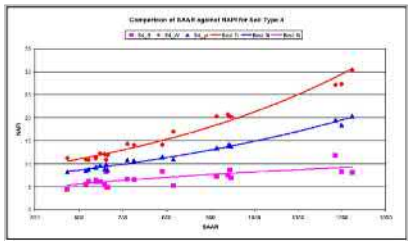
- *PR* = percentage runoff
- *IF* = effective paved area factor (Table 24.3)
- *PIMP* = percentage impermeability (0–100)
- *PF* = soil moisture depth (mm)
- *NAPI* = 30-day antecedent precipitation index (API) (depends upon the soil type)

Surface Condition	IF
Good	0.75

TABLE 24.3 Recommended values of IF

Surface condition	Effective impervious area factor, IF
Poor	0.45
Fair	0.60
Good	0.75

Impervious Area	0.413	ha	
Total Area	0.413	ha	
PIMP	100	%	Note: Percentage Impermeabililty (0-100) obtained by dividing the total directly connected impervious area (both roofs and roads) by the total contributing area. Note: Only PIMP values greater than 50% are generally accepted
PF	200	mm	Note: Recommended value of 200mm. Caution is advised if any changes are made.
SAAR	1128		Note: Use .xml FEH data for SAAR/Linked to prev. page
SOIL TYPE	3		Note: See UKSUDS to obtain SOIL type
NAPI	5	mm	Note: Use Red curve (winter) from graphs below to obtain NAPI
(See graphs below)			Source: paper.PDF (ciwem.org)
PR	75.63		

PROJECT: Lidl Blackpill, Mumbles Rd (0327-WSP-MRS-CA-002 Brownfield Rates)

From FEH Rainfall Data:

	Duration* minutes	2 year rainfall mm	10 year rainfall mm	20 year rainfall mm	30 year rainfall mm	50 year rainfall mm	100 year rainfall mm	100+cc year rainfall mm	
*base on max time of concentration	30	10.2	17.41	20.38	22.16	24.33	27.43	38.402	
		20.4	34.82	40.76	44.32	48.66	54.86	76.804	rainfall in mm/hr
Calculate Discharge Rate, Q (l/s)									
Wallingford - Variable Q (l/s)		22.94	39.15	45.83	49.83	54.71	61.68	86.36	
Proposed Rate (l/s)		5.1	5.10	5.10	5.10	5.10	5.10	5.10	
Betterment		78%	87%	89%	90%	91%	92%	94%	

Climate Change = 40.00%

Calculation & Parameters Used

	Q		l/s	
Q = 3.6CvIA	I		mm/hr	average rainfall intensity during the time of concentration
	A	0.413	ha	contributing area -unattenuated + greenfield
Cv = PR/100	Cv (VARIABLE)	0.76		Volumetric co-efficient

when whole catchment is being considered

Cv = PR/PIMP
when impermeable area alone being considered

Appendix C

SURFACE WATER SYSTEM CALCULATIONS

Mumbles Road, Swansea - 0327-WSP-MRS-CA-003 Catchment & SuDS Area Assessment
Date Completed: 17/05/2021
Name: Ollie Gentilcore

Site Area Total 4119 m2

Bioretention Area Checks

Catchment	Catchment Area (m2)	*SuDS Design Area (m2)	SuDS Actual Area (m2)	
A	554	22.2	27.3	
B	144	5.8	20.8	
C	420	16.8	23.5	
D	543	--	137 (PP)	
E	436	17.4	189.1	(sufficent capacity for roof (Catchment H) run-off)
F	294	--	130.2 (PP)	
G	185	7.4	15.2	
H	1543	--	1561 (GR)	

*Design area assumes 4% for bioretention/landscaped catchments

Notes
Greenfield - UKSuDS Data
Brownfield - FEH Rainfall data based on 30min storm

PP = Permeable Paving
GR = Green Roof

Mumbles Road, Swansea - 0327-WSP-MRS-CA-004 Green Roof Design Calculation
Ollie Gentilcore
Date: 25/08/2021

Global Variables

Storage Structure	Pipe
Outflow Control	Pipe
Climate Change	40%

Rainfall & Network Details

Return Period	100	yrs
Cv Summer	0.75	
Cv Winter	0.84	

Time Area Diagram & Green Roof

Green Roof Area	0.15432	ha	
Depression Storage	5	mm	
Evapotranpiration	0	mm/day	(worst case)

Area (per timestep)

Timestep	Area (ha)
0-4	0.028039
4-8	0.022957
8-12	0.018795
12-16	0.015388
16-20	0.012599
20-24	0.010315
24-28	0.008445
28-32	0.006914
32-36	0.005661
36-40	0.004635
40-44	0.003795
44-48	0.003107
48-52	0.002544
52-56	0.002083
56-60	0.001705
60-64	0.001396
64-68	0.001143
68-72	0.000936
72-76	0.000766
76-80	0.000627
80-84	0.000514

Pipe Structure

Cover Level	102	m
Invert Level	100	m
Diameter	0.225	m
Slope (1:X)	500	
Length	30	m

Pipe Outflow Control

Diameter	0.225	m
Slope (1:X)	500	
Length	30	m
Roughness, k	0.6	mm
Entry Loss	0.5	
Contraction	0.6	
Upstream IL	100	m

Mumbles Road, Swansea - 0327-WSP-MRS-CA-004 Subbase Design Calculation
Designed By: Ollie Gentilcore
Date: 25/08/2021

Global Variables

Storage Structure	Porous Car Park
Outflow Control	Pipe
Climate Change	40%

Rainfall & Network Details

Return Period	100	yrs
Cv Summer	0.75	
Cv Winter	0.84	

Time Area Diagram & Permeable Pavement + Green Roof

Paved Area	0.185	ha
Depression Storage	5	mm
Evapotranpiration	0	mm/day (worst case)

Area (per timestep)

Timestep	GR Area (ha)	PP Area (ha)	PP Area +GR (ha)
0-4	0.028039	0.093	0.121
4-8	0.022957	0.093	0.116
8-12	0.018795	0	0.019
12-16	0.015388	0	0.015
16-20	0.012599	0	0.013
20-24	0.010315	0	0.010
24-28	0.008445	0	0.008
28-32	0.006914	0	0.007
32-36	0.005661	0	0.006
36-40	0.004635	0	0.005
40-44	0.003795	0	0.004
44-48	0.003107	0	0.003
48-52	0.002544	0	0.003
52-56	0.002083	0	0.002
56-60	0.001705	0	0.002
60-64	0.001396	0	0.001
64-68	0.001143	0	0.001
68-72	0.000936	0	0.001
72-76	0.000766	0	0.001
76-80	0.000627	0	0.001
80-84	0.000514	0	0.001
	Total		0.339

Porous Car Park Structure

Cover Level	10	m
Invert Level	9.25	m
m. Percolation	1000	mm/hr
Infiltration	0	m/hr
Safety Factor	10	
Porosity	0.3	
Spaces	45	
Length	58	m
Av Width	24.6	m
Area	1427	m2
Slope (1:X)	100	
Depression	5	mm
Evaporation	0	mm/day
Paving/Laying Depth	130	mm
Base HBCGA	125	mm
Subbase Type 3	495	mm

Pipe Outflow

Diameter	0.1	m
Design Flow	5.1	l/s
Upstream IL	9.3	m

Results

Critical Storm	240min Winter	
Max Water Level	9.918	m
Flooded Volume	0	m3
Sum Max Outflow	5.1	l/s
Max Volume	150.9	m3

Reference

(Interpave Design & Construction of Concrete Block Permeable Pavements)

Traffic Category: 6

Traffic category	Concrete paving units – minimum thickness	Laying course – nominal thickness	Base – HBCGA or AC	Sub-base – CGA or Type 3	Design basis
11		Areas with axle loads greater than permitted by the Road Vehicles (Construction and Use) Regulations (1988) as amended are not included in this document			
10		Site specific using Interpave guide for heavy duty pavements (Knapton, 2008)			Knapton (2008)
9		Site specific using Interpave guide for heavy duty pavements (Knapton, 2008)			Knapton (2008)
8	80 mm	50 mm	300 mm HBCGA or 220 mm AC32	150 mm	ICPI Permeable Design Pro
7	80 mm	50 mm	200 mm HBCGA or 130 mm AC32	150 mm	
6	80 mm	50 mm	125 mm HBCGA or 90 mm AC32	150 mm	
5	80 mm	50 mm	100 mm HBCGA or 70 mm AC32	150 mm	

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 249 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.609	0.359	0.0	5.1	5.1	47.6	O K
30 min Summer	9.692	0.442	0.0	5.1	5.1	72.1	O K
60 min Summer	9.772	0.522	0.0	5.1	5.1	100.4	Flood Risk
120 min Summer	9.823	0.573	0.0	5.1	5.1	118.9	Flood Risk
180 min Summer	9.844	0.594	0.0	5.1	5.1	126.5	Flood Risk
240 min Summer	9.850	0.600	0.0	5.1	5.1	128.6	Flood Risk
360 min Summer	9.847	0.597	0.0	5.1	5.1	127.6	Flood Risk
480 min Summer	9.836	0.586	0.0	5.1	5.1	123.8	Flood Risk
600 min Summer	9.824	0.574	0.0	5.1	5.1	119.5	Flood Risk
720 min Summer	9.812	0.562	0.0	5.1	5.1	115.1	Flood Risk
960 min Summer	9.790	0.540	0.0	5.1	5.1	106.7	Flood Risk
1440 min Summer	9.744	0.494	0.0	5.1	5.1	89.9	Flood Risk
2160 min Summer	9.683	0.433	0.0	5.1	5.1	69.0	O K
2880 min Summer	9.628	0.378	0.0	5.1	5.1	52.8	O K
4320 min Summer	9.542	0.292	0.0	4.9	4.9	31.4	O K
5760 min Summer	9.483	0.233	0.0	4.7	4.7	20.1	O K
7200 min Summer	9.446	0.196	0.0	4.5	4.5	14.2	O K
8640 min Summer	9.425	0.175	0.0	4.3	4.3	11.3	O K
10080 min Summer	9.416	0.166	0.0	4.0	4.0	10.2	O K
15 min Winter	9.637	0.387	0.0	5.1	5.1	55.2	O K
30 min Winter	9.724	0.474	0.0	5.1	5.1	82.8	Flood Risk
60 min Winter	9.812	0.562	0.0	5.1	5.1	114.8	Flood Risk
120 min Winter	9.873	0.623	0.0	5.1	5.1	136.6	Flood Risk
180 min Winter	9.905	0.655	0.0	5.1	5.1	146.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	110.470	0.0	62.2	41
30 min Summer	76.795	0.0	89.6	56
60 min Summer	51.259	0.0	122.4	80
120 min Summer	31.024	0.0	149.8	126
180 min Summer	23.199	0.0	169.0	182
240 min Summer	18.867	0.0	184.0	234
360 min Summer	14.044	0.0	206.4	296
480 min Summer	11.322	0.0	222.4	360
600 min Summer	9.572	0.0	235.5	426
720 min Summer	8.345	0.0	246.8	492
960 min Summer	6.744	0.0	266.5	626
1440 min Summer	4.989	0.0	296.6	892
2160 min Summer	3.734	0.0	334.0	1272
2880 min Summer	3.064	0.0	366.3	1628
4320 min Summer	2.340	0.0	420.6	2332
5760 min Summer	1.954	0.0	469.4	3008
7200 min Summer	1.716	0.0	516.0	3680
8640 min Summer	1.555	0.0	561.9	4408
10080 min Summer	1.441	0.0	607.8	5136
15 min Winter	110.470	0.0	70.6	43
30 min Winter	76.795	0.0	101.3	58
60 min Winter	51.259	0.0	138.0	82
120 min Winter	31.024	0.0	168.8	126
180 min Winter	23.199	0.0	190.3	182

.
.
.

Date 25/08/2021 09:07 | Designed by UKOJG011
File Voided Subbase Design 24.08.2... | Checked by
XP Solutions | Source Control 2019.1

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ Outflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	9.918	0.668	0.0	5.1	5.1	150.9	Flood Risk
360 min Winter	9.914	0.664	0.0	5.1	5.1	149.8	Flood Risk
480 min Winter	9.897	0.647	0.0	5.1	5.1	144.3	Flood Risk
600 min Winter	9.877	0.627	0.0	5.1	5.1	138.1	Flood Risk
720 min Winter	9.857	0.607	0.0	5.1	5.1	131.2	Flood Risk
960 min Winter	9.819	0.569	0.0	5.1	5.1	117.7	Flood Risk
1440 min Winter	9.745	0.495	0.0	5.1	5.1	90.4	Flood Risk
2160 min Winter	9.646	0.396	0.0	5.1	5.1	58.0	O K
2880 min Winter	9.562	0.312	0.0	5.0	5.0	35.9	O K
4320 min Winter	9.450	0.200	0.0	4.5	4.5	14.7	O K
5760 min Winter	9.413	0.163	0.0	3.9	3.9	9.9	O K
7200 min Winter	9.400	0.150	0.0	3.4	3.4	8.3	O K
8640 min Winter	9.391	0.141	0.0	3.1	3.1	7.4	O K
10080 min Winter	9.386	0.136	0.0	2.9	2.9	6.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	18.867	0.0	207.0	236
360 min Winter	14.044	0.0	232.1	336
480 min Winter	11.322	0.0	250.1	388
600 min Winter	9.572	0.0	264.7	462
720 min Winter	8.345	0.0	277.3	536
960 min Winter	6.744	0.0	299.5	682
1440 min Winter	4.989	0.0	333.2	956
2160 min Winter	3.734	0.0	375.1	1328
2880 min Winter	3.064	0.0	411.2	1672
4320 min Winter	2.340	0.0	472.1	2296
5760 min Winter	1.954	0.0	526.7	2944
7200 min Winter	1.716	0.0	578.9	3672
8640 min Winter	1.555	0.0	630.3	4400
10080 min Winter	1.441	0.0	681.7	5072

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 262004 190933 SS 62004 90933	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.339

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.121	24	28	0.008	48	52	0.003	72	76	0.001	96	100	0.000
4	8	0.115	28	32	0.007	52	56	0.002	76	80	0.001	100	104	0.000
8	12	0.019	32	36	0.006	56	60	0.002	80	84	0.001	104	108	0.000
12	16	0.015	36	40	0.005	60	64	0.001	84	88	0.000	108	112	0.000
16	20	0.013	40	44	0.004	64	68	0.001	88	92	0.000	112	116	0.000
20	24	0.010	44	48	0.003	68	72	0.001	92	96	0.000	116	120	0.000

Model Details

Storage is Online Cover Level (m) 10.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	24.6
Membrane Percolation (mm/hr)	1000	Length (m)	58.0
Max Percolation (l/s)	396.3	Slope (1:X)	100.0
Safety Factor	10.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	0
Invert Level (m)	9.250	Membrane Depth (m)	255

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0103-5100-1250-5100
Design Head (m)	1.250
Design Flow (l/s)	5.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	103
Invert Level (m)	9.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.250	5.1	Kick-Flo®	0.772	4.1
Flush-Flo™	0.368	5.1	Mean Flow over Head Range	-	4.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	0.800	4.1	2.000	6.3	4.000	8.8	7.000	11.5
0.200	4.8	1.000	4.6	2.200	6.6	4.500	9.3	7.500	11.9
0.300	5.1	1.200	5.0	2.400	6.9	5.000	9.8	8.000	12.2
0.400	5.1	1.400	5.4	2.600	7.2	5.500	10.2	8.500	12.6
0.500	5.0	1.600	5.7	3.000	7.7	6.000	10.7	9.000	12.9
0.600	4.8	1.800	6.0	3.500	8.3	6.500	11.1	9.500	13.3

Appendix D

MAINTENANCE PLAN

LIDL UK

BLACKPILL, SWANSEA

Preliminary Maintenance Plan

PROJECT NO. 70050327

DATE: AUGUST 2021

WSP

1 Capital Quarter
Tyndall Street
Cardiff
CF10 4BZ

Phone: +44 2920 769 200

WSP.com

PROJECT:			PROJECT No:	
WSP STANDARD DETAILS			-	
DATE: March 18 CHECKED: AK APPROVED: JDP		DRAWING NO: SC02		REV: P01
REVISIONS: P01	24/07/18	PERMEABLE PAVEMENTS: OPERATION AND MAINTENANCE		DRAWING STATUS: P01

TITLE:

PERMEABLE PAVEMENTS: OPERATION AND MAINTENANCE

OPERATION AND MAINTENANCE SCHEDULE

ELEMENT	OWNERSHIP	MAINTENANCE SCHEDULE	REQUIRED ACTION	TYPICAL FREQUENCY
PERVIOUS PAVEMENTS		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 GLYPHOSATE APPLIED DIRECTLY INTO THE WEEDS BY AN APPLICATION 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 50MM OF THE LEVEL OF THE PAVING	AS REQUIRED
			REMEDIATE 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
			REMOVAL OF WEEDS OR MANAGEMENT USING GLYPHOSATE APPLIED DIRECTLY INTO THE WEEDS BY AN APPLICATION RATHER THAN SPRAYING	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, 48H AFTER LARGE STORMS IN FIRST SIX MONTHS
			INSPECT SILT ACCUMULATION RATES AND ESTABLISH APPROPRIATE BRUSHING FREQUENCIES	ANNUALLY
			MONITOR INSPECTION CHAMBERS	ANNUALLY

PROJECT: WSP STANDARD DETAILS			PROJECT No: -
DATE: March 18 CHECKED: AK APPROVED: JDP		DRAWING NO: SC03	REV: P01
REVISIONS: P01	24/07/18	VEGETATED AREAS: OPERATION AND MAINTENANCE	DRAWING STATUS: P01

TITLE:

VEGETATED AREAS: OPERATION AND MAINTENANCE

OPERATION AND MAINTENANCE SCHEDULE

ELEMENT	OWNERSHIP	MAINTENANCE SCHEDULE	REQUIRED ACTION	TYPICAL FREQUENCY
TREES		REGULAR MAINTENANCE	REMOVAL OF LITTER AND DEBRIS	MONTHLY (OR AS REQUIRED)
			MANAGEMENT OF OTHER VEGETATION AND REMOVAL OF NUISANCE PLANTS	MONTHLY (AT START, THEN AS REQUIRED)
			INSPECTION OF INLETS AND OUTLETS	INSPECT MONTHLY
		OCCASIONAL MAINTENANCE	CHECK TREE HEALTH AND APPROPRIATE MANAGEMENT OF TREE	ANNUALLY
			REMOVAL OF SILT BUILD-UP FROM INLETS AND SURFACE AND REPLACEMENT OF MULCH IF REQUIRED	ANNUALLY, OR AS REQUIRED
			WATER	AS REQUIRED (I.E. IN PERIODS OF DROUGHT) IN CONSULTATION WITH ARBORICULTURALIST /LANDSCAPE ARCHITECT
		MONITORING	INSPECT SILT ACCUMULATION RATES AND ESTABLISH APPROPRIATE REMOVAL FREQUENCIES	EVERY 6 MONTHS

PROJECT: WSP STANDARD DETAILS			PROJECT No: -	
DATE: March 18 CHECKED: AK APPROVED: JDP		DRAWING NO: SC04		REV: P01
REVISIONS: P01	24/07/18	BIORETENTION SYSTEMS: OPERATION AND MAINTENANCE		DRAWING STATUS: P01

TITLE: **BIORETENTION SYSTEMS: OPERATION AND MAINTENANCE**

OPERATION AND MAINTENANCE SCHEDULE

ELEMENT	OWNERSHIP	MAINTENANCE SCHEDULE	REQUIRED ACTION	TYPICAL FREQUENCY
BIORETENTION SYSTEMS		REGULAR INSPECTIONS	INSPECT INFILTRATION SURFACE FOR SILTING AND PONDING, RECORD DE-WATERING TIME OF THE FACILITY AND ASSESS STANDING WATER LEVELS IN UNDERDRAIN (IF APPROPRIATE) TO DETERMINE IF MAINTENANCE IS REQUIRED	QUARTERLY
			CHECK OPERATION OF UNDERDRAINS BY INSPECTION OF FLOWS AFTER RAIN	ANNUALLY
			ASSESS PLANTS FOR DISEASE INFECTION, POOR GROWTH , INVASIVE SPECIES ETC. AND REPLACE AS NECESSARY	QUARTERLY
			INSPECT INLETS AND OUTLETS FOR BLOCKAGE	QUARTERLY
		REGULAR MAINTENANCE	REMOVAL OF LITTER AND SURFACE DEBRIS AND WEEDS	QUARTERLY (OR MORE FREQUENTLY FOR TIDINESS OR AESTHETIC REASONS)
			REPLACEMENT OF ANY PLANTS TO MAINTAIN PLANTING DENSITY	AS REQUIRED
			REMOVAL OF SEDIMENT, LITTER AND DEBRIS BUILD-UP FROM AROUND INLETS OR FROM FOREBAYS	QUARTERLY TO BIANNUALLY
		OCCASIONAL MAINTENANCE	INFILL ANY HOLES OR SCOUR IN THE FILTER MEDIUM, IMPROVE EROSION PROTECTION IF REQUIRED	AS REQUIRED
			REMOVAL OF WEEDS OR MANAGEMENT USING GLYPHOSATE APPLIED DIRECTLY INTO THE WEEDS BY AN APPLICATION RATHER THAN SPRAYING	AS REQUIRED
		REMEDIAL ACTIONS	REMOVAL AND REPLACEMENT FILTER MEDIUM AND VEGETATION ABOVE	AS REQUIRED BUT LIKELY TO BE > 20 YEARS

PROJECT: WSP STANDARD DETAILS		PROJECT No: -	
DATE: March 18 CHECKED: AK APPROVED: JDP		DRAWING NO: SC06	REV: P01
REVISIONS: P01	24/07/18	FILTER DRAINS: OPERATION AND MAINTENANCE	DRAWING STATUS: P01

TITLE:

FILTER DRAINS: OPERATION AND MAINTENANCE

OPERATION AND MAINTENANCE SCHEDULE

ELEMENT	OWNERSHIP	MAINTENANCE SCHEDULE	REQUIRED ACTION	TYPICAL FREQUENCY
FILTER DRAINS		REGULAR MAINTENANCE	REMOVAL OF LITTER (INCLUDING LEAF LITTER) AND DEBRIS FROM FILTER DRAIN SURFACE, ACCESS CHAMBERS AND PRE-TREATMENT DEVICES	MONTHLY OR AS REQUIRED
			INSPECTION OF FILTER DRAIN SURFACE, INLET/OUTLET PIPEWORK AND CONTROL SYSTEMS FOR BLOCKAGES, CLOGGING, STANDING WATER AND STRUCTURAL DAMAGE	MONTHLY
			INSPECTION OF PRE-TREATMENT SYSTEMS, INLETS AND PERFORATED PIPEWORK FOR SILT ACCUMULATION AND ESTABLISH APPROPRIATE SILT REMOVAL; FREQUENCIES	EVERY SIX MONTHS
			REMOVAL OF SEDIMENT FROM PRE-TREATMENT DEVICES	EVERY SIX MONTHS OR AS REQUIRED
		OCCASIONAL MAINTENANCE	REMOVAL 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 OVERLAYING FILTER MEDIUM	EVERY 5 YEARS OR AS REQUIRED
			CLEAR PERFORATED PIPEWORK OF BLOCKAGES	AS REQUIRED

Appendix E

EXISTING SEWER RECORDS

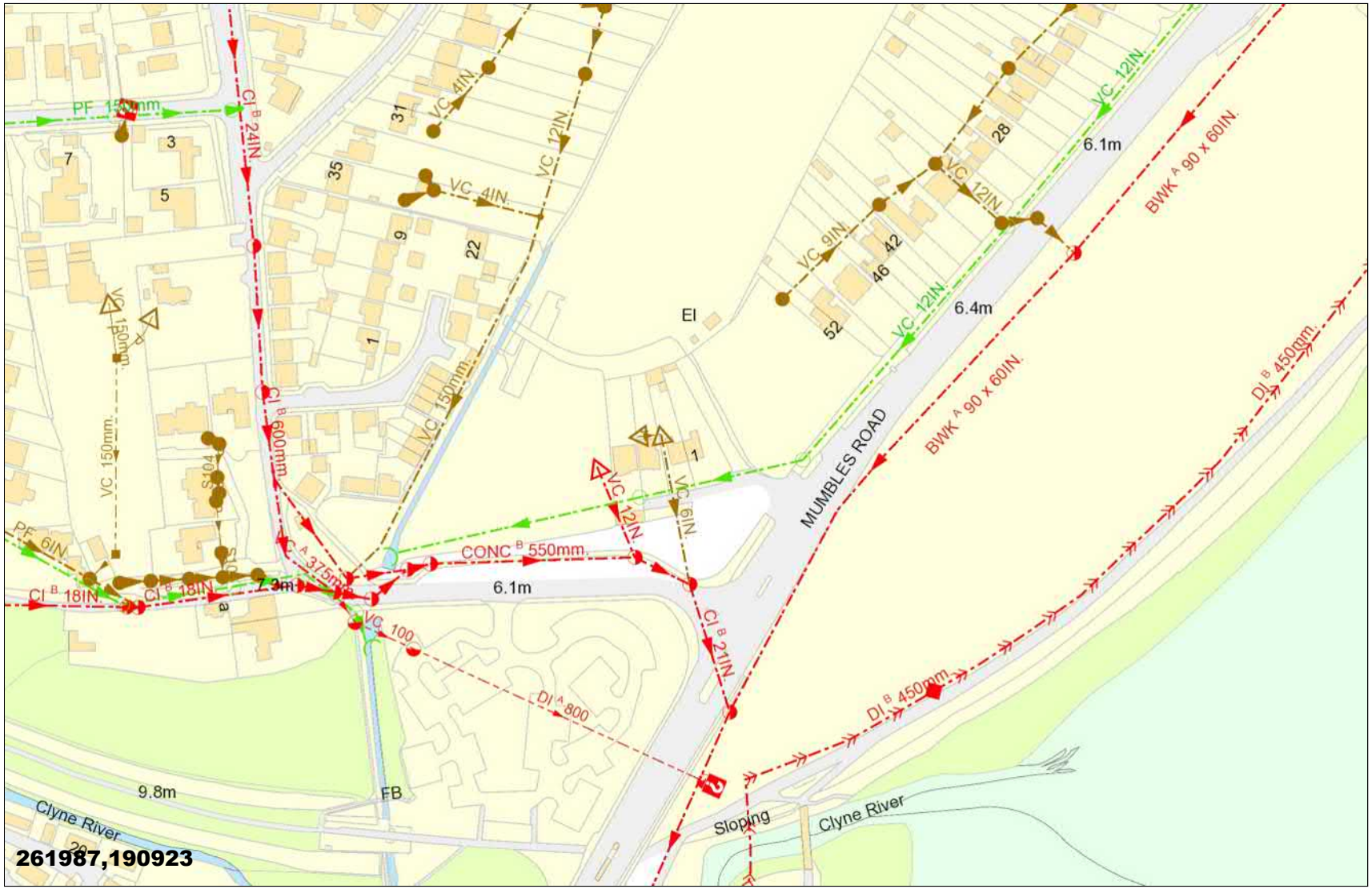
Dŵr Cymru
Welsh Water

Blackpill DCWW Sewerage Plan

18/08/2021

N
W E
S

Scale: 1: 2500



LEGEND

Clean Water

- Sluice Val
- Air Val, SINGLE
- Tap
- Pressure Reducing Valve
- Meter
- BULK Meter
- FH
- Cap
- Existing Main
- NON COMPANY

Sewerage External

- Foul
- Surface Water
- Combined
- Rising Main
- Private
- Treatment Works
- Pumping Station
- Special Purpose
- Unknown End
- Change, Combined Overflow
- Outfall, FOUL
- Lamp Hole, Foul
- Private Sewer Transfer
- Lateral Drain
- Inspection Chamber

Dwr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon In the event of excavations or other works made in the vicinity of the company's apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. The information which is supplied hereby the company, is done so in accordance with statutory requirements of sections 198 and 199 f the water industry Act 1991 based upon the best Information available and in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclosure the existence of a drain sewer or disposal main laid before 1 September 1989, or if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information us entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the company's right to be compensated for any damage to its apparatus.

EXACT LOCATION OF ALL APPARATUS TO BE DETERMINED ON SITE

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be Asbestos Cement (AC) or Pitch Fibre (PF). It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Appendix F

GROUND INVESTIGATION REPORT

PHASE 2
GROUND INVESTIGATION

Lidl Great Britain Ltd

675 Halfway Garage, Mumbles

Client: Lidl Great Britain Ltd

Remada Ltd
www.remada.co.uk

730.03.02
August 2021

Executive Summary

Remada Ltd was commissioned by Lidl Great Britain Ltd (hereafter 'the Client') to undertake a Phase 2 Ground Investigation for a proposed new retail store at Former Halfway Garage, Mumbles Road, Mumbles, Swansea SA3 5AT at the location indicated in ***Figure 1****. This report follows a Phase 1 Preliminary Risk Assessment (Remada report reference 730.02.01) issued in April 2021.*

Summary of Phase 1 Desk Study

The earliest available mapping dated 1878 shows the site to be predominantly occupied by fields, marshland and one residential property occupying the western area. Between 1921 and 1938, a row of residential properties fronting onto Mumbles Road have been constructed. However, by 1948, the central portion of these properties on-site (namely Nos. 54, 56 and 58) have been removed and their position taken by 'Halfway Garage'. By 1993 the garage has been reconfigured and was operating as a Fuel Filling Station. By the time of Remada's site walkover in April 2021, all structures associated with the garage have been removed, as well as the former No. 60 Mumbles Road in the western area.

The Coal Authority Consultants Mining Reports states that no past mining has been recorded and the risk of probable unrecorded shallow mining as 'none'.

The site is in an Intermediate probability radon area (3 to 5% of homes are estimated to be at or above the Action Level). Basic radon protective measures are necessary in the construction of new dwellings or extensions.

Intrusive Investigation

Based on the findings of our Review of Vendors SI & Remediation Reports letter (Ref: 730.01.01) dated 28th January 2020, three (3 No.) cable percussive boreholes were positioned within the proposed store footprint to a depth of 15m or refusal. Four (4 No) CBR tests were conducted in the proposed car park. Four (4 No) ground gas monitoring visits were scheduled for the site to provide the minimum required by C665.

The investigation comprised the drilling of three (3 No) cable percussive boreholes (BH401 – BH403), execution of four (4 No.) CBR tests, two soakage tests (SA1 – SA2) and three trial pits (TP1 – TP3) at locations indicated on ***Figure 2*** *between 27th and 29th April 2021.*

Exploratory holes BH401, BH402 and BH403 were located within the general vicinity of the proposed store. Obvious Made Ground was encountered within all exploratory holes and was present to depths of between 1.45m and 2.4m bgl, where proven. It should be noted that deeper made ground, in excess of 4m, is likely to be encountered in some areas associated with the backfilling of the former tank excavations.

According to the published geology superficial deposits beneath the majority of the site are indicated to comprise Aeolian Blown Sand Deposits. However, the material encountered underlying the made ground on-site typically comprised dark brown sandy gravelly CLAY and dark grey SILT, with localised sand lenses and layers of spongy brown fibrous PEAT. It is considered that these deposits are more consistent with Alluvium, this is indicated to be present along the western part of the site that could also be present beneath the Blown Sand Deposits.

Medium dense to dense clayey sandy GRAVEL with low cobble content was encountered underlying the cohesive deposits within the three cable percussive boreholes at depths of between 6.0m (BH403) and 6.5mbgl (BH402).

Light brown medium to coarse SANDSTONE was encountered within two of the cable percussive boreholes at depths of 6.95m (BH402) and 7.65m bgl (BH403). This bedrock is considered representative of the South Wales Lower Coal Measures Formation identified on the BGS mapping.

Human Health Assessment

The results of soil chemical analysis were compared to Human Health Generic Assessment Criteria for commercial land use. None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

Water Resources Assessment

The groundwater identified within the granular (deeper) deposits is considered to be representative of the Secondary A Aquifer underlying the site. Whilst this is considered to be of low sensitivity, the site is located adjacent to the River Clyne and Swansea Bay, and hydraulic connectivity is anticipated between the groundwater and these water features.

The concentrations of contaminants with groundwater sampled from have been compared with the Water Framework Directive Regulations 2015 Schedule 5 General Quality of Groundwater as an applicable Environmental Quality Standards (EQS) for Secondary Aquifers. The MAC-EQS level has been adopted. There are no recorded exceedances of the adopted MAC-EQS levels for any of the determinands screened within the three groundwater samples.

In addition, it should be noted that the site will be predominantly covered with the building and areas of hardstanding. Therefore, the risk of leaching of contaminants as a result of infiltration of groundwater is likely to be limited. Therefore, the risk to groundwater from contaminants within the made ground at the site is considered to be low and does not warrant further consideration.

Waste Classification

In general, the results of the chemical analyses indicate that the material would be classified as non-hazardous waste.

Elevated concentrations of Total Petroleum Hydrocarbon (TPH) above 1,000mg/kg have been identified. The TPH appears to be weathered diesel and therefore this material would also be classified as non-hazardous waste. While waste generated is likely to be classified as non-hazardous, there is the potential for higher concentrations of TPH to be encountered. If encountered during the redevelopment materials exhibiting evidence of hydrocarbon contamination should be segregated and analysed to determine precise waste classification.

Geotechnical Assessment

Shallow spread foundations are not considered to be a suitable foundation solution due to the depth of made ground and the presence of highly compressible Alluvium beneath. It is therefore considered that a piled foundation solution or potentially ground improvement would be the most suitable option for the site.

Ground improvement techniques such as vibro-replacement stone or concrete columns could be considered for the site. Both ground improvement techniques involve inserting a vibrating poker into the ground, which displaces the soil. The resultant void is then infilled with either stone or concrete. However, the presence of soft Alluvium which included layers of peat may not provide the lateral support required for these techniques to work adequately. In addition, given that the proposed development comprises a car parking area at ground floor with the store located above this design is likely to be more suited to a piled foundation solution.

The proposed development comprises a car park at ground level with the store located at first floor level. Therefore, it is anticipated that there will be limited floor constructed at ground level. Due to the presence of made ground across the site in excess of 600mm it is recommended that the floor slab is fully suspended.

It should also be noted that the site is located in an area that is classified as an intermediate probability radon area and as such basic radon protective measures should be included within the floor slab constructed at ground level.

A Design Sulphate Class DS-1 is considered appropriate for buried concrete and an ACEC Class of AC-1 is considered appropriate for the location.

Six soakaway tests were conducted within the two test pits (SA1 and SA2) located adjacent to Mumbles Road. The results indicated a rapid infiltration into the made ground underlying the site during Remada's intrusive investigation. However, the site has historically been used as a fuel filling station and hydrocarbons have been recorded within the underlying soils circa 2m depth. Furthermore, the natural strata underlying the made ground

typically comprises Alluvium (soft clays with layers of peat) to depths of between 6.0 and 6.3mbgl. Consequently, soakaways are not considered suitable for the proposed development.

Groundwater was found to be resting within the three monitoring wells at depths of between 4.22 and 5.44mbgl. It is recommended that groundwater levels are monitored again prior to construction.

Ground Gas

The results of four rounds of gas monitoring visits placed the site into Characteristic Situation 1 and therefore ground gas protection measures will not be required within the proposed building. However, the site is located in an Intermediate Probability Radon Area and Basic radon protective measures are necessary within the design of the proposed retail store.

TABLES

GRAPHS

FIGURES

EXPLORATORY LOGS

APPENDICES

Issue No	*Date*	*Prepared By*	*Technical Review*	*Authorised*
01	*01.07.2021*	*P Dickinson*	*P Welburn*	*G Jones*
02	*05.08.2021*	*P Dickinson*	*P Welburn*	*G Jones*

1 INTRODUCTION

Remada Ltd was commissioned by Lidl Great Britain Ltd (hereafter 'the Client') to undertake a Phase 2 Ground Investigation for a proposed new retail store at Former Halfway Garage, Mumbles Road, Mumbles, Swansea SA3 5AT at the location indicated in **Figure 1**.

1.1 Objectives

The objectives of this assessment are as follows:

- to examine whether there have been any potentially contaminative uses on the site or nearby land;
- to develop a conceptual model of the site to identify plausible pollutant linkages;
- to assess ground conditions in relation to the proposed development in relation to construction design issues including the presence, nature, likely severity and extent of soil and groundwater contamination, which may be present, its potential environmental impact and likely requirement for further work; and
- Provide preliminary foundation design recommendations for the proposed development.

1.2 Scope of Work

The scope and layout of this investigation and report is generally in accordance with BS10175:2011+A2 2017 and the Environment Agency's Land Contamination Risk Management guidance for land contamination reports.

The scope of work comprised:

- Three (3 No) cable percussive boreholes with in-situ SPTs in proposed store footprint to 15m depth.
- 3 No combined groundwater and gas monitoring standpipes installed within cable percussive boreholes.
- 4 No California Bearing Ratio (CBR) tests;
- 4 No. soakaway tests in accordance with BRE 365.
- Suite of geotechnical classification and strength tests;
- 5 No soil sample suites for chemical analysis of CLEA metals, asbestos, speciated hydrocarbons, cyanide and phenols to delineate any soil contamination;
- 3 No groundwater sample suites for chemical analysis of CLEA metals, asbestos, speciated hydrocarbons, cyanide and phenols;
- 4 No ground gas and groundwater monitoring visits to satisfy planning requirements; and
- Combined Factual & Interpretative Geoenvironmental Report.

1.3 Previous Reports

The following Remada reports have previously been prepared for the site:

- Remada's Review of Vendors SI & Remediation Reports letter (ref: 730.01.01) issued on 28th January 2020.
- Phase 1 Site Investigation & Preliminary Risk Assessment, Remada Ltd Report ref: 730.02.01 issued in April 2021.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the information reviewed and observations during site work. However, there may be conditions pertaining to the site that have not been disclosed by this assessment and therefore could not be taken into account.

2 SUMMARY OF PREVIOUS REPORTS

2.1 Remada's Review of Vendors SI & Remediation Reports letter (January 2020)

The appended review notes from this letter are reproduced below:

2.1.1 Environmental Setting

The site is location at 54 Mumbles Road, Blackpill, Swansea SA3 5AU, within a predominantly residential area. The site was historically a petrol filling station operated by Shell that was decommissioned in 2017. The desk study undertaken by URS indicated that the site was first developed as a garage circa 1948 and was subsequently redeveloped into a petrol filling station circa 1971. The URS desk study indicated that there were records of eight underground storage tanks (USTs) at the site installed in 1975 and an LPG tank (installation date unknown). Subsequent investigation reports indicated that there were also six historical slurry filled tanks present at the site.

The subsequent site investigation reports indicate that in May 2013, Shell identified a potential loss of integrity to a suction fuel line, running between Tank 3 (diesel) to forecourt customer dispenser 1 and 2.

The nearest surface water feature was an unnamed stream located approximately 80m to the north of the site.

Ground conditions beneath the site are indicated to comprise Blown Sands beneath the southeast part of the site and Alluvium beneath the northwest overlying South Wales Lower Coal Measures Formation. The superficial deposits and bedrock are both classified as Secondary A Aquifers. The site is not located with a Source Protection Zone (SPZ).

A review of the BGS GeoIndex provided a slightly different geological interpretation than that given by URS comprising the following:

- *Presence of Artificial Ground comprising undivided landscaped ground;*
- *Blown Sand located beneath the eastern part of the site;*
- *Raised Storm Beach Deposits comprising sand and gravel located beneath the western part of the site.*

According to the Non-Residential Coal Authority Mining Report, the property is not within the zone of likely physical influence on the surface from past underground workings. A review of the Coal Authority website confirmed that the site was not located within a development high risk area and there were no records of mine entries within or within the immediate vicinity of the site.

2.1.2 Environmental Site Assessment Reports

Two phases of intrusive investigation were undertaken by URS in 2013 and 2014 and reported in February 2014 and June 2014 respectively. The purpose of the URS investigations was to support Shell with the provision of environmental information and to assist in approvals to support a possible site redevelopment. The first investigation (February 2014) comprised the drilling of eleven boreholes followed by installation of four soil vapour monitoring wells and seven groundwater monitoring wells. The second investigation (June 2014) comprised the drilling of five further boreholes and installation of groundwater monitoring wells. In 2015 URS undertook a further groundwater and vapour monitoring from the monitoring wells installed during the previous phases of investigation and in 2016 AECOM undertook an intrusive investigation where four additional monitoring wells were installed. Groundwater monitoring was undertaken from the existing and newly installed wells as part of the AECOM 2016 investigation. In addition, further groundwater monitoring was undertaken by AECOM in 2017, prior to decommissioning and demolition of the petrol filling station, with the results presented in a factual report with no interpretation provided.

The investigations encountered made ground to a maximum depth of 3.6m below ground level (bgl) overlying sand to a maximum depth of 3.57m bgl resting upon peat and soft silt with organic material to a maximum recorded depth of 6.0m bgl. The bedrock geology was not encountered within the 6m depth of investigation.

Groundwater was generally found to be resting at depths of between 0.74 and 2.06m bgl across the site.

February 2014 Report

During the intrusive investigations undertaken by URS visual and olfactory evidence of hydrocarbon contaminants of concern were identified in soil and groundwater beneath the site.

A Stage 2 risk assessment was performed on the available soil, groundwater, potable water and vapour data to assess potential risks to human health and controlled water receptors associated with the site.

Concentrations of Contaminants of Concern (CoC) were below the human health generic acceptance criteria (GAC) for continued petroleum use (CPU) and high-density residential use in all soil, vapour and groundwater samples collected during the initial investigation. Asbestos including chrysotile (white), crocidolite (blue) and amosite (brown) asbestos was also identified in made ground taken from seven locations.

However, in soil samples concentrations of CoC exceeded initial Stage 2 controlled waters screening criteria. In groundwater samples, CoC were also identified above the Environmental Quality Standard (EQS) GAC.

June 2014 Report

The report concluded that the identified soil and groundwater key impacts are consistent with historical impacts rather than the suspected loss of integrity from a diesel line between Tank 3 and the pumps, based on chemical signature.

The Stage 2 risk assessment concluded the following:

- *Potential risks to on-site workers and off-site residents were considered acceptable.*
- *Simulated marginal risks to Swansea Bay 160m to the south-east of site from dissolved benzene in BH104 were considered to be acceptable. The absence of significant benzene impact in groundwater at other locations suggests that the benzene may not be as mobile as simulated by the model.*
- *The site is therefore considered suitable for ongoing petroleum use.*

July 2015 Report

The groundwater and vapour monitoring identified that there were concentrations of hydrocarbon CoC above the method detection limits in both groundwater and vapour samples from across the site. No recommendations were provided in the report.

August 2016 Report

Again, concentrations of hydrocarbon contaminants of concern were identified in groundwater and vapour samples above the method detection limits. A Stage 3 risk assessment was undertaken to further assess potential risk to human health and controlled water receptors.

The principal conclusions made by AECOM were as follows:

- *Concentrations of CoC measured at the site were considered unlikely to represent an unacceptable risk to human health receptors*
- *Significant risks to Controlled Waters were not identified as part of the Stage 3 risk assessment.*

February 2018 Report

The groundwater monitoring was undertaken prior to decommissioning and demolition of the petrol filling station. The results indicated that there remained concentrations of hydrocarbon contaminants of concern above the method detection limits.

2.1.3 Decommissioning, Demolition and Remedial Works

AECOM provided environmental support to Shell during the decommissioning and demolition of the fuel infrastructure and undertook environmental verification. The works, undertaken in three phases, included the decommissioning of sixteen groundwater and four vapour monitoring wells by filling with a bentonite grout mix and the removal of 18 (one double compartment) tanks, several of which were only identified during the decommissioning works. According to the AECOM report subsurface concrete footings from the building and canopy were removed along with sub-surface slabs and concrete cradles surrounding the USTs. Twenty five trial pits were excavated across the site to investigate the presence of potentially abandoned USTs. In total 320 tonnes of asphalt/tarmac, 100 tonnes of concrete, 5,758 tonnes of non-hazardous soil and 377 tonnes of hazardous soil were removed from site. This comprised impacted soils from below the former USTs and the removal of the top 1m of soil from across the site. The resulted excavations were infilled with 2,031 tonnes of imported natural quarried materials and 7,987 tonnes of imported MOT Type 1 material. The report indicated that the backfill materials were compacted but no details of the specification/method used to compact the materials was supplied. Planning permission for the demolition works was granted by Swansea City and County Council on 19th January 2017.

The environmental verification report, prepared by AECOM, indicated that a total of 169 soil samples were analysed. Concentrations of CoC encountered at the site are generally below Commercial GAC, with the exception of isolated made ground samples containing PAHs. AECOM stated that 'As these PAHs are not volatile, the viable pathways are by direct contact and ingestion. This pathway is only relevant in the context of a future use scenario in which ground is exposed at surface. Following the replacement of the upper 1 m of the site with clean backfill, there is currently no viable source-pathway-receptor linkage for these.' In addition, AECOM concluded that there was not an unacceptable risk to off-site residents.

With respect to groundwater AECOM stated that 'benzene concentrations in groundwater sampled from BH104 in February 2017 and April 2017 exceeded the 2016 Site Specific Screening Acceptance Criteria (SSAC) for groundwater, by factors of 4 and 3.2 respectively. BH104 was screened in shallow sand immediately beneath the made ground from 1.6 to 2.8m bgl. This area was subsequently excavated to 4.5m bgl as Excavation D.

Given the removal of a significant volume of both unsaturated and saturated soils from Excavation D to 4.5m, and the limited residual impact which remains in this area, the groundwater samples from this location from prior to the excavation works are not considered representative of the post construction site conditions.'

2.1.4 Lidl Site Redevelopment – Environmental and Waste Issues

The AECOM reports indicate that the significantly impacted soils have been removed from site as part of the decommissioning works. In addition, the top 1m of soil has been excavated and replaced with clean imported materials. Therefore, the majority of the Lidl 'works' will be undertaken within clean imported materials. However, it should be recognised that deeper excavations below approximately 1m depth (e.g. for the delivery ramp and attenuation tank, if required) may encounter hydrocarbon impacted materials. There is the potential for some of the hydrocarbon impacted materials to be classified as hazardous waste, although given the remedial works undertaken by AECOM it is considered likely that most of the material would be classified as non hazardous.

It should be noted that the remediation was undertaken on a voluntary basis and as such there has been minimal dialogue with the regulators (Local Authority and Natural Resources Wales). A letter was received from Natural Resources Wales, dated 3 September 2014 which stated 'We welcome the voluntary remediation approach to this site and recognise the resources that gone into this process. We note that the site is 150m away from the nearest surface water receptor and that there are currently limited or no use of the groundwater in the area, other that to baseflow for the River Clyne. We consider the site to be a lower priority and will not be providing comments at this time.'

Therefore, official approval from the regulators, for the remediation has not been achieved. This would only present an issue if the planning permission for the new Lidl store include environmental conditions and the regulators then disagreed with the risk assessment and work undertaken by AECOM. However, given the response from Natural Resources Wales and the quantity of sampling/analysis undertaken by AECOM it is considered unlikely that there would be a problem going forward, but this cannot be guaranteed.

The top 1m of soil now comprises clean imported materials that will effectively act as a clean cover system. However, it will still be necessary to import clean topsoil/subsoil for use in soft landscaping areas as the physical characteristics of the imported materials will not promote a healthy growing environment.

2.1.5 Lidl Site Redevelopment – Geotechnical

The work undertaken by URS/AECOM to date has been entirely environmental focused and no geotechnical information has been collected. In addition, it should be noted that he maximum depth of investigation undertaken by AECOM was 6m bgl. The window sample holes identified made ground to a depth of 3.6m bgl and in the areas of the former tanks it is anticipated that the made ground will now extend to depths in excess of 4m bgl. Given that the top 1m of soil has been removed from site during the decommissioning works it is considered that most of the former foundations and/or obstructions should have been removed.

Beneath the made ground a sequence of sand, peat and soft silt with organic material was encountered. The sand deposit has been interpreted as a Blown Sand which tends to be in a loose condition with a generally open fabric. Blown Sand is not normally considered a suitable founding stratum due to the potential for unacceptable amounts of settlement. In addition, the underlying peat and soft silt are likely to be highly compressible and also not suitable. The silt extended to the base of the exploratory holes. Therefore, it is considered that piled foundations are likely to be required for the proposed development. Lidl's ground investigation standard 04.2018 specified four window samples boreholes i.e., not greater than 6m depth beneath the store footprint but deep boreholes will be required in order to enable pile design. At present, the likely piling depth is not known and it recommended that a minimum of three cable tool boreholes are bored to a depth 15m beneath the proposed store footprint to enable foundation design.

2.1.6 Lidl Site Redevelopment – Ground Gas

To date, permanent ground gas monitoring has not been undertaken and a minimum of four rounds of ground gas monitoring is required by 04.2018 and typically to discharge planning conditions. There are three potential sources of permanent ground gas associated with the site. These comprise the former petrol filling station, the made ground and the natural peat/organic silt deposits. The proposed site redevelopment comprises a car parking area at ground level with the Lidl Store located, at first floor level, above. The main store area will not require protection measures to prevent the ingress of ground gas. However, there are two areas of construction at ground level and it is considered that protection measures may need to be installed in these areas.

2.2 Remada's Phase 1 Desk Study (April 2021)

The Executive Summary and Conceptual Site Model presented within the Phase 1 Desk Study are reproduced below:

Site Setting

The site is an irregular plot to the north-west of Mumbles Road and to the east of Glyn Crescent. Surfacing comprises a crushed gravel material. Heras fencing forms the southern and south-eastern boundaries, whilst wooden fencing forms the north and western boundaries. The site contains existing buildings labelled as No. 52 and 50 Mumbles Road.

Site History

The earliest available mapping dated 1878 shows the site to be predominantly occupied by fields, marshland and one residential property occupying the western area. Between 1921 and 1938, a row of residential properties fronting onto Mumbles Road have been constructed. However, by 1948, the central portion of these properties on-site (namely Nos. 54, 56 and 58) have been removed and their position taken by 'Halfway Garage'. By 1993 the garage has been reconfigured and was operating as a Fuel Filling Station. By the time of Remada's site walkover in April 2021, all structures associated with the garage have been removed, as well as the former No. 60 Mumbles Road in the western area.

Mining

The Coal Authority Consultants Mining Reports states that no past mining has been recorded and the risk of probable unrecorded shallow mining as 'none'.

Radon

The site is in an Intermediate probability radon area (3 to 5% of homes are estimated to be at or above the Action Level). Basic radon protective measures are necessary in the construction of new dwellings or extensions.

Environmental Risk Assessment

The desk study has identified a number of on-site and off-site potential sources of contamination that would require further investigation. The following is recommended:

- *Investigation of the lateral and vertical extent of made ground/fill beneath the proposed store;*
- *BRE 365 compliant soakaway testing;*
- *Collection of soil and groundwater samples from the areas identified above for contaminants of concern; and*
- *Ground gas monitoring.*

Geotechnical Assessment

It is recommended that a ground investigation is undertaken to enable preliminary foundation design.

Potential Source Areas	Potential Contaminant of Concern	Pathways	Potential Receptor	Exposure Route (Human unless otherwise stated)	Potential Identified Linkage (unmitigated)	Findings of Ground investigation	Risk (Un-mitigated)	Proposed Remediation (Mitigation) Measures	Residual Risk Estimation
<u>On-site Sources</u> **Halfway Garage/Shell Garage** **Residential properties** **General Made Ground associated with historical redevelopment.** ***<u>Off-site Sources</u>*** **Oystermouth Tramway/Swansea and Mumbles Railway** **London North Western Railway** **Coal Yard** **Residential Housing** **Electricity Sub Station**	Asbestos / Metals As, Be, Cd, Cu, Cr (VI), Cr (III) Hg, Ni, Se, Va, Zn, *Boron, TPH /PAH.*	Disturbance due to construction plant causing direct contact, dusts, vapours. Direct Contact with occupants of the proposed development Inhalation of fibres / vapours / gases by occupants of proposed development Permeation of water supply pipework Leachate	Occupants of the development / building fabric Adjacent residents during construction Secondary Aquifers &	• Direct Soil Ingestion	• Yes	To be assessed (TBA)	Potential risk	(To be assessed (TBA)	(To be assessed (TBA)
				• Indoor Dust ingestion	• Yes	As above	Potential risk	TBA	TBA
				• Skin Contact with Soils	• Yes	As above	Potential risk	TBA	TBA
				• Skin Contact with Dust	• Yes	As above	Potential risk	TBA	TBA
				• Inhalation of Outdoor Dust	• Yes	As above	Potential risk	TBA	TBA
				• Inhalation of Outdoor Vapours	• Yes	As above	Potential risk	TBA	TBA
				• Inhalation of Indoor Vapours	• Yes	As above	Potential risk	TBA	TBA
				• Inhalation of ground gas	• Yes	As above	Potential risk	TBA	TBA
				• Inhalation of radon gas	• Yes	Intermediate Probability Radon Area	Potential risk	Basic radon protection measures	Negligible
				• Ingestion via permeated water supply pipework	• Yes	As above	Potential risk	TBA	TBA
				• Direct contact with Secondary (A) Aquifer in Superficial Deposits	• Yes	As above	Potential risk	TBA	TBA
				• In-direct contact with Secondary (A) Aquifer in bedrock	• Yes	As above	Potential risk	TBA	TBA

Table 1: Outline Conceptual Site Model

Direct contact with subsurface soil and/or groundwater during redevelopment works are not assessed as part of the CSM. It is considered that risks to workers will be managed as part of any the redevelopment works at the site through the application of health and safety procedures, where required.

3 ENVIRONMENTAL & GEOTECHNICAL INVESTIGATION METHODOLOGY

3.1 Investigation Strategy

Based on the findings of our *Review of Vendors SI & Remediation Reports* letter (Ref: 730.01.01) dated 28th January 2020, three (3 No.) cable percussive boreholes were positioned within the proposed store footprint to a depth of 15m or refusal. Four (4 No) CBR tests were conducted in the proposed car park. Four (4 No) ground gas monitoring visits were scheduled for the site to provide the minimum required by C665.

The investigation comprised the drilling of three (3 No) cable percussive boreholes (BH401 – BH403), execution of four (4 No.) CBR tests, two soakage tests (SA1 – SA2) and three trial pits (TP1 – TP3) at locations indicated on **Figure 2** between 27th and 29th April 2021.

All exploratory holes were logged by a suitably qualified Geo-environmental Engineer in general accordance with the recommendations of BS5930:2015. Detailed descriptions, together with relevant comments, are given in the **Exploratory Hole Logs.**

3.2 Intrusive Investigation

3.2.1 Cable Percussive Boreholes

Three cable percussive boreholes (BH401 – BH403) were undertaken using a Dando 2000 percussive drilling rig and advanced to a target depth of 15m or refusal. However, sandstone bedrock was encountered within two of the boreholes (BH402 at 6.95m, and BH403 at 7.65m) leading to their termination at

Combined Groundwater and Ground Gas monitoring standpipes were installed in all three boreholes.

3.2.2 Trial Pits

All five of the trial pits were excavated using a backhoe excavator, while in full attendance of an experienced geo-environmental consultant. On completion of the trial pits, the materials were replaced in approximately the same order as they were excavated and compacted using the excavator.

3.3 In-Situ Testing

3.3.1 Standard Penetration Tests

Standard Penetration Tests (SPTs) in the window samples were carried out at 1.0m intervals as recorded on the borehole logs to assess the relative density and consistency of soils.

SPTs were conducted in accordance with BS EN ISO 22476-3 and the recorded SPT N-values are summarised on the borehole logs.

The SPT N-values have been corrected based on the Energy Ratio of 65% for the SPT hammer on the window sampling rig. The SPT Hammer Energy Test Report, undertaken in accordance with BS EN ISO 22476-3:2005 is presented in **Appendix A.**

3.3.2 Soakage Tests

Three soakaway tests were undertaken in general in accordance with BRE Digest DG365, Soakaway Design, 2016, at the locations in **Figure 2**. Test results are presented in **Appendix B.**

3.3.3 Falling Weight Deflectometer (FWD) tests

A falling weight deflectometer (FWD) is a device that is designed to simulate the loading of a wheel passing over a roadway and measure its vertical deflection response to that load. During the test, a known weight

is dropped onto a circular load plate on the surface, and the resulting deflection is measured by sensors placed around the load plate. Test results are presented in **Appendix C.**

3.4 Soil Sampling

3.4.1 Environmental

Made ground and natural soils were selected by visual and olfactory means for subsequent analysis. Samples for chemical laboratory testing purposes were collected in amber glass jars, amber glass vials and plastic tubs and retained in a cool box for transport to the laboratory.

3.4.2 Geotechnical

Geotechnical samples were collected at depths indicated on the window sample logs with samples retrieved from within a sleeve line. The disturbed samples were placed in sealed and correctly labelled plastic tubs or bags as appropriate. All geotechnical samples were dispatched to the laboratory for testing with a completed chain of custody.

3.5 Gas & Groundwater

3.5.1 Installations

Combined ground gas and groundwater monitoring standpipes were installed in selected wells with a 50mm diameter slotted HDPE pipe and packed with gravel surround as recorded on the exploratory logs. Wells were completed with 0.5-1m of plain HDPE pipe and bentonite seal, with a gas bung and tap being installed at the top of the pipe.

3.5.2 Monitoring

Ground gas monitoring was undertaken using Geotech GA5000 gas analyser for the parameters reported below. Groundwater levels were measured with a GeoSense OWP30 oil water interface probe.

Permanent ground gas monitoring involved the measurement of the following in the prescribed order:

- Pressure difference between the monitoring well and the atmosphere,
- Peak and steady flow rates of gas into or out of the monitoring well;
- Peak and steady concentrations of carbon dioxide, methane, oxygen (minimum and steady recorded), carbon monoxide, hydrogen sulphide; and
- Depth to groundwater.

Four ground gas monitoring visits were undertaken as a minimum required for a commercial development in accordance with CIRIA C665. Ground gas concentrations were recorded on 6th, 10th, 19th and 25th May 2021 at BH401, BH402 and BH403 and the results are presented in **Table 2**.

3.4.3 Well Development

After installation, all monitoring wells were developed to remove drilling fluids and sediment from the wells.

3.4.4 Well Purging

Prior to groundwater sampling, all wells were purged with a submersible pump. Purging continued until pH, temperature and conductivity values stabilised to silty material, deposits from the bottom of the well, stagnant oxidised water and to attract fresher groundwater from the aquifer into the well.

3.4.5 Well Sampling

Three wells were sampled with submersible pump at the dates indicated in **Table 2**. Dedicated sampling tubes were used for each monitoring well to prevent cross-contamination. An AquaTroll 500 was used to record stabilised pH, temperature and conductivity values during sampling. Groundwater samples were collected in amber glass jars and amber glass vials and retained in a cool box for onwards transport to the laboratory. The low flow sampling test certificates are presented in **Appendix D**.

3.5 Quality Assurance and Quality Control

All samples were submitted to a United Kingdom Accredited Laboratory (UKAS) under a completed chain of custody. The laboratory carried out its own QA/QC programme to ensure that the quality of the analytical data conformed to the appropriate test method protocols.

3.6 Laboratory Analysis & Testing

3.6.1 Chemical Analysis – Soil

Seven (7 No) soil samples were scheduled for the analysis of asbestos, arsenic, barium, beryllium, cadmium, chromium (III & VI), copper, mercury, nickel, lead, selenium, zinc, fraction of organic carbon, Total Petroleum Hydrocarbons (TPHCWG), Polyaromatic Hydrocarbons (PAH), BTEX compounds (benzene, toluene, ethylbenzene and xylene) and phenols.

The results of laboratory chemical analyses are presented at **Appendix E.**

3.6.2 Chemical Analysis - Groundwater

Three (3 No) groundwater samples were scheduled for the analysis of asbestos, arsenic, barium, beryllium, cadmium, chromium (III & VI), copper, mercury, nickel, lead, selenium, zinc, cyanide, fraction of organic carbon, Total Petroleum Hydrocarbons (TPHCWG), Polyaromatic Hydrocarbons (PAH), BTEX compounds (benzene, toluene, ethylbenzene and xylene) and phenols.

The results of laboratory chemical analyses are presented at **Appendix F.**

3.6.3 Geotechnical

Samples recovered from the boreholes were submitted to an accredited laboratory for the following analyses in general accordance with BS1377:1990:

- 5 No Natural Moisture Contents
- 5 No Plasticity Indices
- 5 No Particle Size Distribution tests
- 3 No Quick Undrained Triaxial Compression Tests; and
- 4 No BRE SD1 suites.

The results of the geotechnical testing are presented at **Appendix G.**

4 GEOTECHNICAL & ENVIRONMENTAL INVESTIGATION FINDINGS

4.1 Ground Conditions

A summary of the ground conditions encountered during the intrusive investigation is presented below. Exploratory hole logs are presented at the end of the report.

4.1.1 Made Ground

Obvious Made Ground was encountered within all exploratory holes and was present to depths of between 1.45m and 2.4m bgl, where proven. The Made Ground generally comprised sandy gravel composed of mixed lithologies including limestone, mudstone and quartzite. SPT N values recorded in the Made Ground indicated that the relative density ranged from loose to dense.

In BH401, BH404, TP1 and TP2 a gravelly CLAY was encountered beneath the granular Made Ground. This material is not consistent with the anticipated natural geology and as such is likely to be a reworked material that has been interpreted as 'Possible Made Ground'. Therefore, it is considered that Made Ground extended to a more consistent depth of between 2.0 and 2.5mbgl.

It should be noted that deeper Made Ground (in excess of 4mbgl) is likely to be present in parts of the site as a result of backfilling the former tank excavations.

4.1.2 Superficial Deposits

According to the published geology superficial deposits beneath the majority of the site are indicated to comprise Aeolian Blown Sand Deposits. However, the material encountered underlying the made ground on-site typically comprised dark brown sandy gravelly CLAY and dark grey SILT, with localised sand lenses and layers of spongy brown fibrous PEAT. It is considered that these deposits are more consistent with Alluvium, this is indicated to be present along the western part of the site that could also be present beneath the Blown Sand Deposits.

PEAT was encountered within four of the exploratory holes (BH401 – BH403 and TP1) from depths of 2.4 to 2.5m bgl. The peat ranged in thickness between 0.3m in BH402 and 1.2m in BH403. Within the trial pit TP1, this unit was described as 'spongy brown fibrous PEAT', which corroborated with the strata recovered from the cable percussive boreholes. However, in BH403 below 3.0m bgl, a plastic dark brown mottled light grey clayey fibrous PEAT was also recovered and this was not identified in any of Remada's other exploratory holes.

Medium dense to dense clayey sandy GRAVEL with low cobble content was encountered underlying the cohesive deposits within the three cable percussive boreholes at depths of between 6.0m (BH403) and 6.5mbgl (BH402). The gravel typically comprised angular to rounded mudstone, siltstone, and sandstone, whilst the cobbles were of equivalent stratum types. These deposits have been interpreted as Glaciofluvial Ice Contact Deposits that the BGS indicate to be present in the local area.

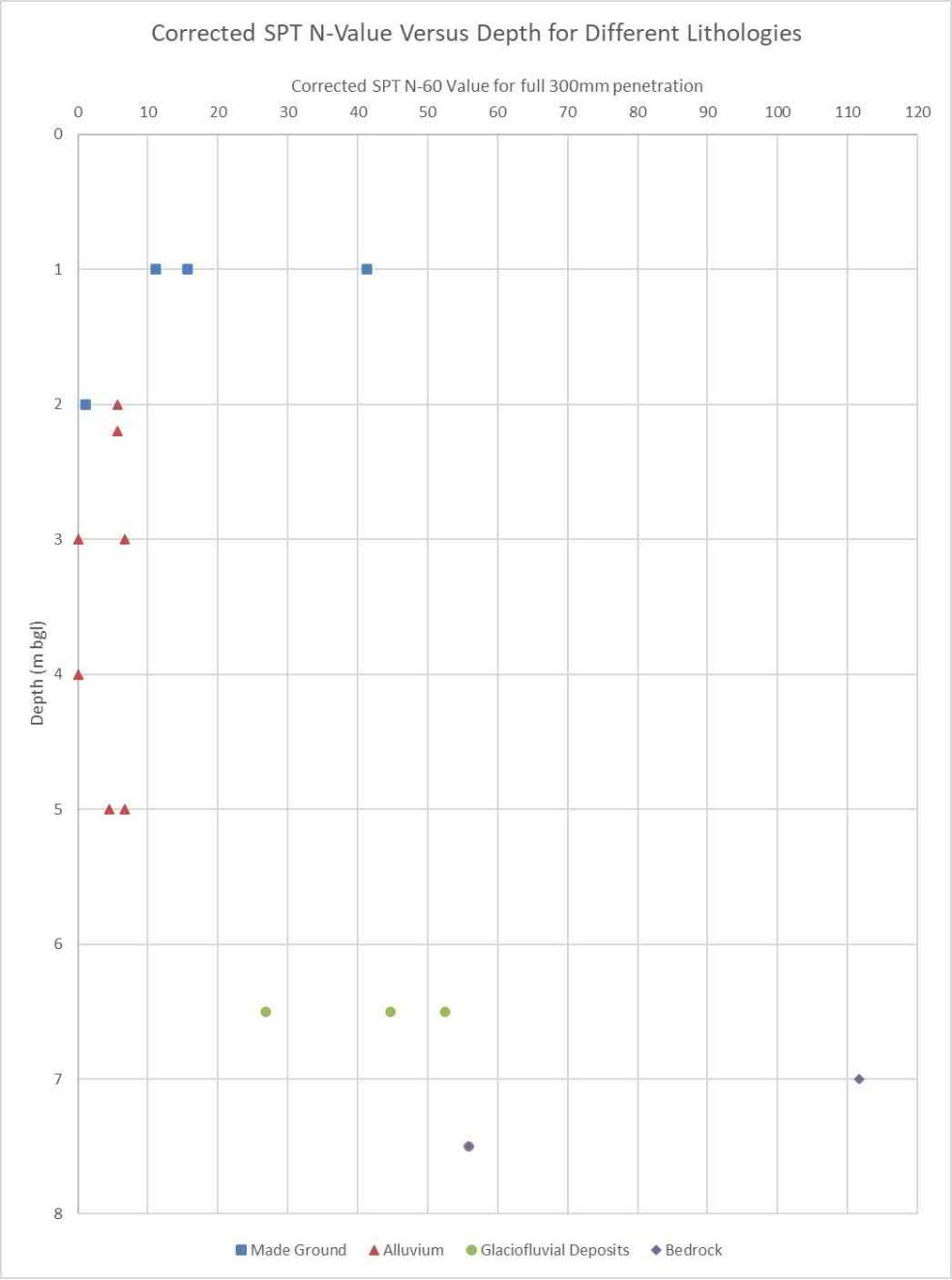
4.1.3 Bedrock

Light brown medium to coarse SANDSTONE was encountered within two of the cable percussive boreholes at depths of 6.95m (BH402) and 7.65m bgl (BH403). This bedrock is considered representative of the South Wales Lower Coal Measures Formation identified on the BGS mapping.

4.2 In-situ Testing

4.2.1 Standard Penetration Tests (SPTs)

In-situ SPTs were undertaken to assist with the interpretation of strata encountered. The results of corrected N60 values versus depth are plotted in the graph below:



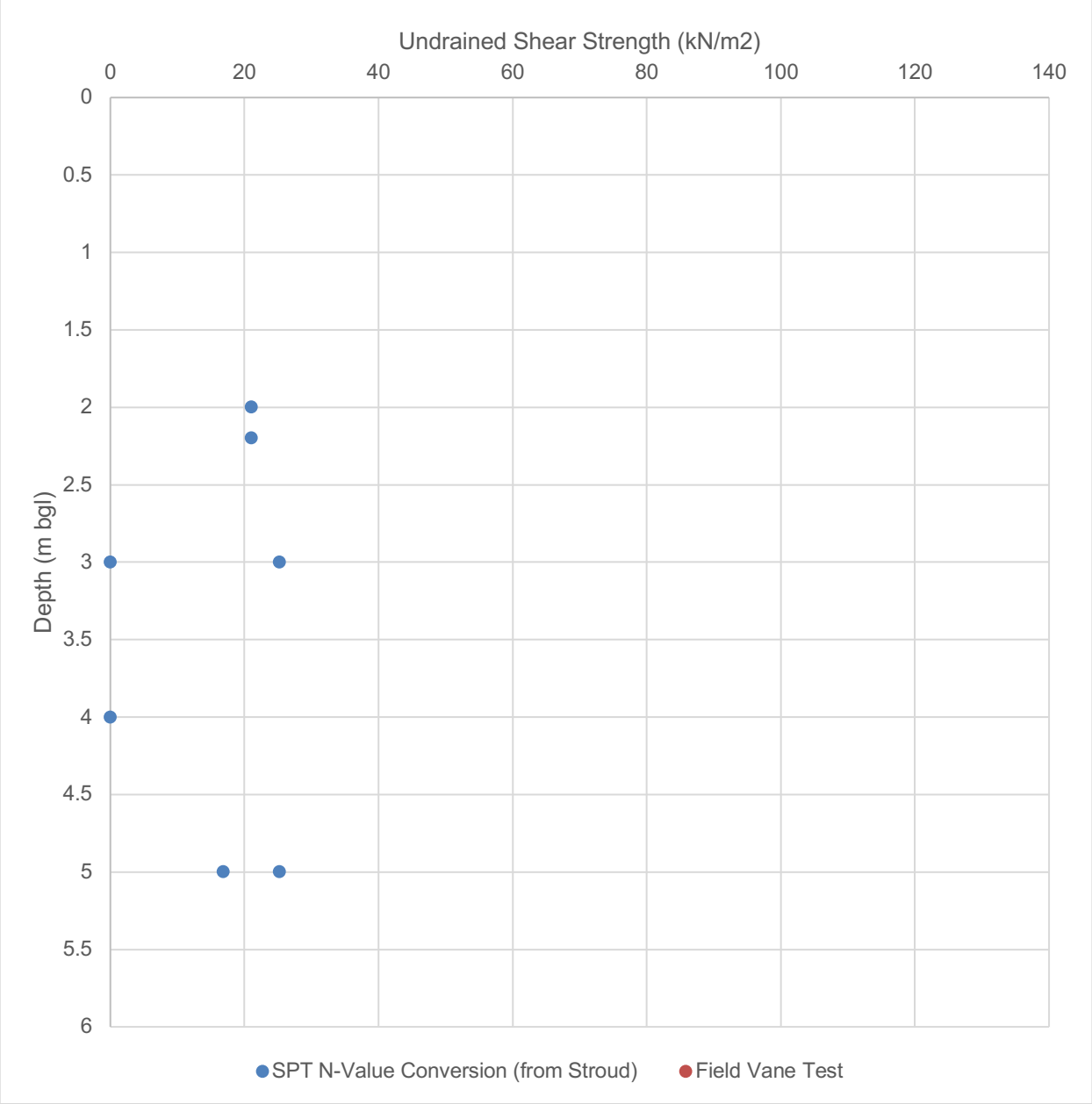
Graph 1: Plot of Corrected SPT N-Values Versus Depth

Undrained shear strengths have been estimated from SPT N values using the relationship developed by Stroud (*The standard penetration test in incentive clays and soft rocks*) and summarised in Tomlinson where:

$$\text{Mass shear strength} = f_1 \times N$$

Where f_1 is based on the plasticity index.

A Plasticity Index of 32% has been assumed (based on geotechnical laboratory testing) which equates to an f_1 factor of 4.2.



Graph 2: Plot of Mass Shear Strength Versus Depth

4.2.3 Infiltration / Soakaway Test

The soakaway tests were undertaken with the two test pits (SA1 and SA2) within the proposed car park area on-site. Due to the rapid infiltration rate, it was not possible to sustain a suitable head of water within either of the test locations. Within the test pits at 1.5m depth, the maximum achievable head of water using a high-flow water pump discharging into the pits was 1.48m bgl.

4.2.4 Dynamic Plate Load Tests

The results of the four Dynamic Plate Load Tests within the proposed car park area produced equivalent CBR values of between 60% and >80% within the near surface made ground.

4.3 Soil Observations

Made Ground was recovered at all locations as a heterogeneous granular material, although consisted predominantly of limestone, mudstone and sandstone gravels.

There were no visible or olfactory indicators of contamination within the sampled soils.

4.4 Groundwater Observations

Groundwater was encountered at depths of between 4.6m and 4.5m bgl within boreholes BH401 and BH402, rising to 4.2m bgl after twenty minutes. A deeper and more rapid groundwater strike was encountered at 6m bgl within BH402 and BH403, rising to 2.0m and 2.2m bgl respectively after twenty minutes.

4.5 Chemical Analysis

4.5.1 Soils

Results of the soil chemical analysis are presented in **Table 3** and summarised as follows.

The average FOC and pH were 0.03 and 8.8 respectively. Asbestos was not detected in the samples analysed. Detectable concentrations of metals were identified, although these are generally within the range that would typically be expected for made ground.

Concentrations of TPH were detected above method detection limit (MDL) in five of the seven samples analysed (from BH401 – 403, TP2 and SA2). A maximum total concentration of 3,400mg/kg was encountered in BH403 at 1.8 – 2.11m. The hydrocarbons were generally heavy end within the C16 to C35 carbon range. However, hydrocarbons in the C8 to C10 carbon range were also encountered in the sample from BH403 at 1.8 – 2.11m.

Concentrations of PAHs were generally low (<20 mg/kg). A maximum concentration (excluding bituminous surfacing sample) of 63 mg/kg was encountered in TP2 at 1.5 – 2.5m.

4.5.2 Groundwater

Results of the groundwater chemical analysis are summarised as follows:

The pH of all three groundwater samples was 8.3, whilst the Dissolved Organic Carbon concentrations ranged between 3.3 and 7.6mg/l. Dissolved concentrations of some metals were identified within the samples, including arsenic, boron and nickel.

The concentrations of Total Petroleum Hydrocarbons were recorded as being below method of detection limit (i.e. <10µg/l) within all three samples.

The total concentrations of PAH-16 were recorded as being below method of detection limit (i.e. <2µg/l) within all three samples.

4.6 Geotechnical Testing

Results of the geotechnical testing are summarised below.

Five plasticity tests undertaken on the recovered cohesive soils indicated the clay to be of low to high plasticity, with plasticity indices ranging 9% and 32%. The corresponding moisture contents ranged between 12% and 56%.

The PSD tests revealed the following:

- Natural strata in BH401 at 5.5 – 6.5m comprised greyish brown sandy, silty, clayey fine to coarse GRAVEL.
- Made Ground in BH401 at 0.0 – 0.1m comprised grey slightly silty/clayey sandy fine to coarse gravel.
- Made Ground in BH402 at 0.0 – 1.0m comprised greyish brown silty, clayey, sandy gravel.
- Alluvium in BH402 at 4.0 – 5.0m comprised greyish brown slightly gravelly sandy silty CLAY.
- Natural strata in BH403 at 5.0 – 6.0m comprised greyish brown sandy, silty, clayey fine to coarse GRAVEL.

Undrained shear strength tests revealed the following:

- Natural strata in BH401 at 4.0 – 4.45m recorded undrained shear strength values of 108, 125 and 147kPa for corresponding respective cell pressures of 80, 160 and 320kPa.
- Natural strata in BH403 at 4.0 – 4.45m recorded undrained shear strength values of 84, 115 and 174kPa for corresponding respective cell pressures of 80, 160 and 320kPa.
- The U100 sample from BH403 at 1.6 – 2.05m fell apart during extrusion at the laboratory.

The water-soluble sulphate contents varied from <0.01 to 0.18 g/l in the seven soil samples analysed with pH varying from 7.8 to 8.2. The total sulphur content varied from 0.12 to 2.10% and acid soluble sulphate varied from 0.045 to 0.16%.

4.7 Ground Gas Monitoring Results

The results of the ground gas and groundwater monitoring programme are summarised below:

- A maximum steady state concentration of methane was recorded as 0.1% v/v within all three monitoring wells over the course of the programme.
- A maximum steady state concentration of carbon dioxide was recorded as 0.2% v/v in BH402 on 10th May 2021. Detectable concentrations of carbon dioxide were recorded in all the monitoring wells;
- A minimum steady state concentration of oxygen was recorded 18.2 % v/v in BH402 on 10th May 2021;
- Ground gas flow rates were recorded at a maximum of 0.6 litres per hour (l/hr) in BH401 and BH402 over the course of the monitoring programme.
- Groundwater was encountered within all three standpipes throughout the monitoring programme, ranging between 1.35m and 2.57m bgl.
- Atmospheric pressure at the time of sampling varied between a high of 1020 millibar (mbar) on 19th May 2021 and a low of 1007 mbar on 10th May 2021.

5 GENERIC QUANTITATIVE RISK ASSESSMENT

5.1 Human Health Risk Assessment

In order to provide an up to date assessment of the risks to human health, Remada has adopted the most recent Generic Assessment Criteria (GAC) published by LQM/CIEH (S4ULs) and CL:AIRE/EIC/AGS for the assessment of potential risks to human health. The derivation of GAC, methodology, input parameters and technical guidance (CLEA) may be obtained upon request.

Default parameters have been adopted for sandy loam of pH 7 and commercial land use. FOC ranged from 0.003 to 0.075 giving a Soil Organic Matter (SOM) content range of between 0.43 to 12.93% with an average result of 5.4%. In order to present a conservative assessment, the SOM content of 2.5% has been adopted for the assessment.

The depth to potential sources of contamination for indoor air pathways has been assumed to be 0.5m below building foundation level. The source has been conservatively assumed to be at ground level for outdoor air and direct contact pathways.

For commercial land use the CLEA version 1.06 critical receptor is conservatively modelled as a female working adult with an exposure duration of 49 years. In accordance with the default parameters it was assumed that employees spend most of their time indoors and that 80% of outdoor area is covered by hardstanding. As such, the potential exposure pathways have been assumed to be:

- Direct Soil and Indoor Dust Ingestion;
- Skin contact with soils and dusts;
- Inhalation of indoor and outdoor dusts and vapours.

Where GAC values for individual TPH fractions are not exceeded, the potential additive effect has been assessed by calculating overall TPH hazard index for each sample.

5.2 Comparison of Soil Analysis Results with Human Health GAC

A comparison of soil chemical analysis with GAC is presented as **Table 3**.

TPH, PAH & BTEX

None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

Metals & Inorganics Excluding Asbestos

None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

Asbestos

There was no asbestos detected in the samples selected for analysis.

5.3 Controlled Waters Risk Assessment

5.3.1 Controlled Waters Sensitivity

The site is not located within a designated Groundwater Source Protection Zone. There are no groundwater abstraction licences within 1000m of the study site.

The available BGS records and the findings of this intrusive investigation have revealed that the site is underlain by superficial deposits, classified as a Secondary A Aquifer. The bedrock geology comprises South Wales Lower Coal Measures Formation, also classified as a Secondary A Aquifer and was encountered at depths of between 6.95m and 7.65m bgl within the cable percussive boreholes.

The nearest surface water feature (a drainage channel / stream) is located 71m to the north-west of the site. The River Clyne is located approximately 220m to the south of the site at its nearest point, whilst the tidal reaches of Swansea Bay are located from circa 160m to the east.

Given the general cohesive nature of the encountered shallow natural soils, it is anticipated that groundwater beneath the site will have limited resource value. However, groundwater strikes were encountered circa 4.5m within the natural clays in two of the boreholes (BH401 and BH402), indicating the presence of perched water within these cohesive deposits. A rapid ingress of water was recorded at 6m within boreholes BH402 and BH403, which corresponded with the penetration into granular (sandy GRAVEL) deposits. The 6m depth correlates with a groundwater ingress within a metre of sea level; the strike being recorded at 0.36 – 0.67m AOD respectively. Therefore, it was considered likely that the water ingress recorded at 6m in these locations is marine in origin.

During the subsequent monitoring visits, groundwater was identified within all three monitoring wells at depths of between 1.35m and 2.57m bgl. When corrected based on the topography, the levels within the wells ranged between 4.22m AOD and 5.44m AOD. The groundwater height within the wells is concurrent with the groundwater rise from 6.0m to 2.0m observed within BH402 and BH403 during the intrusive works.

The groundwater identified within the granular (deeper) deposits is considered to be representative of the Secondary A Aquifer underlying the site. Whilst this is considered to be of low sensitivity, the site is located adjacent to the River Clyne and Swansea Bay, and hydraulic connectivity is anticipated between the groundwater and these water features.

5.3.2 Comparison with EQS Levels

The concentrations of contaminants with groundwater sampled from have been compared with the Water Framework Directive Regulations 2015 Schedule 5 General Quality of Groundwater as an applicable Environmental Quality Standards (EQS) for Secondary Aquifers. The MAC-EQS level has been adopted.

A comparison of groundwater chemical analysis with MAC-EQS levels is presented as **Table 4** and is summarised in detail below:

There are no recorded exceedances of the adopted MAC-EQS levels for any of the determinands screened within the three groundwater samples.

5.4 Ground Gas Assessment

In order to understand the gassing regime at the site, a Characteristic Situation (as defined in CIRIA C665 and BS8576:2013) is determined for the site. CIRIA C665 and BS8576 provides definitions for each Characteristic Situation based on Gas Screening Values (GSV) which are calculated as follows:

- GSV = Gas Concentration (% v/v) x Measured Borehole Flow Rate (l/hr)

BS8576 makes a distinction between the GSV and the Hazardous Gas Flow Rate (Q_{hg}) which is also calculated using the above calculation. BS8576 states that Q_{hg} is calculated for each individual borehole for each monitoring visit, whereas the GSV is taken as the representative value for the site or site zone.

As a worst-case assessment, the GSV for the site is therefore taken as the maximum steady-state carbon dioxide/methane concentration recorded in the boreholes which is multiplied by the maximum flow rate recorded during the same monitoring event.

- Methane GSV = 0.1 % x 0.6 l/hr = 0.0006 l/hr
- Carbon Dioxide GSV = 0.2 % x 0.6 l/hr = 0.0012 l/hr

The calculated GSV of less than 0.07 l/hr for methane and carbon dioxide places the site into Characteristic Situation 1. BS8485 states that for Characteristic Situation 1 the methane concentration would typically be less than 1% and carbon dioxide less than 5% and that if concentrations are above these limits then consideration should be given to placing the site into Characteristic Situation 2. As the concentrations of methane and carbon dioxide were both within these typical limits it is considered that the Characteristic Situation 1 classification is appropriate for the site. Therefore, gas protection measures are not deemed necessary for the proposed development.

However, the site is located in an Intermediate probability radon area and Basic radon protective measures are necessary within the design of the proposed retail store.

5.5 Revised Conceptual Site Model

A revised Conceptual Site Model is presented as **Table 5** below.

5.6 Waste Classification

In general, the results of the chemical analyses indicate that the material would be classified as non-hazardous waste.

Elevated concentrations of Total Petroleum Hydrocarbon (TPH) above 1,000mg/kg have been identified. The TPH appears to be weathered diesel and therefore this material would also be classified as non-hazardous waste. While waste generated is likely to be classified as non-hazardous, there is the potential for higher concentrations of TPH to be encountered. If encountered during the redevelopment materials exhibiting evidence of hydrocarbon contamination should be segregated and analysed to determine precise waste classification.

5.7 Health & Safety Considerations

To ensure direct exposure of construction workers involved in the site redevelopment to any impacted contaminated shallow soils is minimised, the guidance stated in HSG 66 “Protection of Workers and the General Public During Redevelopment of Contaminated Land” should be followed.

Potential Source Areas	Potential Contaminant of Concern	Pathways	Potential Receptor	Exposure Route (Human unless otherwise stated)	Potential Identified Linkage (unmitigated)	Findings of Ground investigation	Risk (Un-mitigated)	Proposed Remediation (Mitigation) Measures	Residual Risk Estimation
<u>On-site Sources</u> **Halfway Garage/Shell Garage** **Residential properties** **General Made Ground associated with historic redevelopment.** ***<u>Off-site Sources</u>*** **Oystermouth Tramway/Swansea and Mumbles Railway** **London North Western Railway** **Coal Yard** **Residential Housing** **Electricity Sub Station**	Asbestos / Metals As, Be, Cd, Cu, Cr (VI), Cr (III) Hg, Ni, Se, Va, Zn, *Boron, TPH /PAH.*	Disturbance due to construction plant causing direct contact, dusts, vapours. Direct Contact with occupants of the proposed development Inhalation of fibres / vapours / gases by occupants of proposed development Permeation of water supply pipework Leachate	Occupants of the development / building fabric Adjacent residents during construction Secondary Aquifers	• Direct Soil Ingestion	• Yes	All soils tested were <GAC	Negligible	None	Negligible
				• Indoor Dust ingestion	• Yes	As above	Negligible	None	Negligible
				• Skin Contact with Soils	• Yes	As above	Negligible	None	Negligible
				• Skin Contact with Dust	• Yes	As above	Negligible	None	Negligible
				• Inhalation of Outdoor Dust	• Yes	As above	Negligible	None	Negligible
				• Inhalation of Outdoor Vapours	• Yes	As above	Negligible	None	Negligible
				• Inhalation of Indoor Vapours	• Yes	As above	Negligible	None	Negligible
				• Inhalation of ground gas	• Yes	CS1	Negligible	None	Negligible
				• Inhalation of radon gas	• Yes	Intermediate Probability Radon Area	Potential risk	Basic radon protection measures	Negligible
				• Ingestion via permeated water supply pipework	• Yes	All soils tested were <GAC	Negligible	None	Negligible
				• Direct contact with Secondary (A) Aquifer in Superficial Deposits	• Yes	All waters tested were <EQS	Negligible	None	Negligible
				• In-direct contact with Secondary (A) Aquifer in bedrock	• Yes	As above	Negligible	None	Negligible

Table 5: Refined Conceptual Site Model

Direct contact with subsurface soil and/or groundwater during redevelopment works are not assessed as part of the CSM. It is considered that risks to workers will be managed as part of any the redevelopment works at the site through the application of health and safety procedures, where required.

6 GEOTECHNICAL SITE ASSESSMENT

6.1 Geotechnical Considerations

An indicative site layout is indicated in **Figure 3** with the Lidl store zone being located in the north-western part of the site with associated car parking located in the south-eastern part, fronting onto Mumbles Road. It is understood that that the proposed site redevelopment comprises a car parking area at ground level with the Lidl Store located, at first floor level, above.

Exploratory holes BH401, BH402 and BH403 were located within the general vicinity of the proposed store, and ground conditions were generally observed to comprise made ground to depths of 2.0 and 2.5m bgl resting upon Alluvium (soft clays with layers of peat) to depths of between 6.0 and 6.3mbgl overlying Glaciofluvial Deposits. Sandstone bedrock was encountered at depths of between 6.95 and 7.65mbgl.

It should be noted that deeper made ground, in excess of 4m, is likely to be encountered in some areas associated with the backfilling of the former tank excavations.

The trial pits and CBR tests were all undertaken in the proposed car park area located in the south-eastern part of the site.

Details of the proposed permanent and variable design loads (actions) are not currently known although an indicative column load of 400kN has been provided.

6.2 Foundations

Shallow spread foundations are not considered to be a suitable foundation solution due to the depth of made ground and the presence of highly compressible Alluvium beneath. It is therefore considered that a piled foundation solution or potentially ground improvement would be the most suitable option for the site.

Ground improvement techniques such as vibro-replacement stone or concrete columns could be considered for the site. Both ground improvement techniques involve inserting a vibrating poker into the ground, which displaces the soil. The resultant void is then infilled with either stone or concrete. However, the presence of soft Alluvium which included layers of peat may not provide the lateral support required for these techniques to work adequately. In addition, given that the proposed development comprises a car parking area at ground floor with the store located above this design is likely to be more suited to a piled foundation solution.

If a piled foundation solution is adopted then either driven or continuous flight auger (CFA) piles could be utilised. Driven piles have the advantage of improving the density of the ground whereas CFA piles could potentially loosen the granular deposits and thus result in a reduced safe working load. The main disadvantage of driven piles is that they can cause unacceptable. If driven piles are used then assurances will need to be sought from the piling contractor that damage will not be caused to nearby structures, including buried infrastructure on the site.

If a piled foundation solution is adopted then either driven or replacement piles (bored or continuous flight auger (CFA)) piles could be utilised. Driven piles have the advantage of improving the density of the ground, but can cause unacceptable amounts of vibration that could potentially damage nearby above and underground structures. It is normal practice to install piles into the bearing stratum by 5 times the pile diameter. This would mean that for a 300mm diameter pile that pile should extend approximately 1.5m into the bearing stratum. While the Glaciofluvial Deposits were in the order of 1.5m thick in BH401 and BH403, a more limited thickness of 1m was recorded in BH402. This means that it is likely that sockets will need to be installed into the bedrock and as such CFA piles may not be suitable. Specialist advice from a piling contractor should be sought to determine whether piles driven into the weathered zone will provide sufficient lateral support or whether a rock socket is required within the un-weathered bedrock.

Alternatively, consideration could be given to bored piles. To install bored piles a void is formed which is then filled with concrete. The sides of the shaft will need to be supported, normally by the use of casing. Support will be required through the made ground and the natural Alluvium and Glaciofluvial Deposits. The majority of the working load will be provided by the end resistance in a rock socket. The rock socket needs to be sufficiently deep to support the sides the pile. Care needs to be taken to remove debris from the base of the rock socket prior to forming the pile. Rapid excavation of the pile sockets in weak rock is recommended to minimise the potential for deterioration in the walls which could result in the swelling of the mudstone. After formation, the pile should be concreted immediately, preferably on the same day.

Remada has undertaken a preliminary assessment of potential safe working loads for pile design based upon the following idealised soil profile based on the information provided in BH401, BH402 and BH403 and the following assumptions:

Depth (m)	Ground Conditions	Assumptions
GL to 6.3m	Made Ground and Alluvium	Ignored in calculations
6.3 to 7.6m	Glaciofluvial Deposits	Average N value of 30.
>7.6m	Bedrock	Assumed to comprise very dense sand with N=50 (ϕ= 41° Tomlinson)

Table 6: Idealised Soil Profile

Groundwater has been assumed to be at >6mbgl.

The following table provides a summary of the estimated safe working loads base on the assumptions detailed above:

Pie Toe Depth (m)	Pile Type	Pile Diameter (mm)	Estimated Safe Working Load (kN)
9.0	CFA	300	365
9.0	CFA	450	805
9.0	CFA	600	1425
9.0	Driven	300	370
9.0	Driven	450	820
9.0	Driven	600	1450

Table 7: Estimated Safe Working Loads

The safe working load has been calculated by two different methods. In the first method, a factor of safety of 2.5 is applied to both the end bearing and skin friction components. In the second method, a factor of safety of 3.0 is applied to the end bearing component and 1.5 to the skin friction component. The safe working load is calculated by both methods and the lower of the two adopted.

The calculated safe working load has been calculated for a single isolated pile. The effect of group action has not been taken into consideration. In addition, negative skin friction in the made ground have not been taken into consideration.

The above table is for preliminary use only and additional ground investigation is required to prove soil characteristics and depths and the piles should be designed by a specialist contractor.

The pile carrying capacities may be determined by the strength of normal pile concrete. It may therefore be necessary to increase the strength of the concrete or reduce the safe working loads accordingly. Care

also needs to be taken if slender piles are used to ensure that there is sufficient lateral support to prevent shearing or buckling.

6.3 Floor Slab

The proposed development comprises a car park at ground level with the store located at first floor level. Therefore, it is anticipated that there will be limited floor constructed at ground level. Due to the presence of made ground across the site in excess of 600mm it is recommended that the floor slab is fully suspended.

It should also be noted that the site is located in an area that is classified as an intermediate probability radon area and as such basic radon protective measures should be included within the floor slab constructed at ground level.

6.4 Imported Fill

All imported fill material should comply with an earthworks specification to be prepared by the engineer and not contain concentrations of contaminants at greater than the Generic Assessment Criteria (GAC) presented in **Table 3.**

6.5 Excavations and Temporary Works

Side slopes within the Made Ground and the underlying natural deposits are unlikely to remain stable even in the short term without support or without being battered back to a safe slope gradient. A detailed inspection of the side slopes should be made during excavation and a risk assessment carried out to fully assess the support measures required.

Groundwater was found to be resting within the three monitoring wells at depths of between 4.22 and 5.44mbgl. It is recommended that groundwater levels are monitored again prior to construction.

6.6 External Car Park Construction

CBR values estimated from the dynamic plate load tests which indicated that the equivalent CBR value for each test was in excess of 60%. This indicates that the materials currently present at surface would form a suitable bearing layer for external surfacing. However, the material is likely to become disturbed during the construction process and therefore the formation should be proof-rolled and any soft/loose pockets encountered should be excavated and replaced with well compacted granular fill prior to pavement construction.

6.7 Protection of Buried Concrete

In accordance with BRE SD1 for buried concrete in a brownfield site with mobile groundwater, analyse of selected soil samples for water soluble sulphate returned values of up to <0.01 to 0.18 g/l and pH varied from 7.8 to 8.2. Therefore, a Design Sulphate Class DS-1 is considered appropriate for buried concrete and an ACEC Class of AC-1 is considered appropriate for the location.

6.8 Soakaway Tests

Six soakaway tests were conducted within the two test pits (SA1 and SA2) located adjacent to Mumbles Road. The results indicated a rapid infiltration into the made ground underlying the site during Remada's intrusive investigation. However, the site has historically been used as a fuel filling station. Whilst no petroleum hydrocarbons were detected within the groundwater samples, concentrations of upto 3400mg/kg were identified within the underlying soils circa 2m depth.

Furthermore, the natural strata underlying the made ground typically comprises Alluvium (soft clays with layers of peat) to depths of between 6.0 and 6.3mbgl. Groundwater was encountered at 4m and 6m depth

during the intrusive investigation but did not seem to be a laterally continuous horizon across the entirety of the site.

Consequently, soakaways are not considered suitable for the proposed development.

6.9 General Construction Advice

All formations should be cleaned, and subsequently inspected, by a suitably qualified engineer prior to placing concrete. Should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by blinding concrete.

Where applicable ground beneath the proposed building footprint and potentially car parking may require to be stripped to reveal localised areas of made ground and structures. Excavations should be backfilled with suitably re-compacted materials to achieve formation level.

7 CONCLUSIONS & RECOMMENDATIONS

7.1 Conclusions

The following conclusions have been made based on the findings of this investigation.

7.1.1 Phase 2 Site Investigation

Exploratory holes BH401, BH402 and BH403 were located within the general vicinity of the proposed store. Obvious Made Ground was encountered within all exploratory holes and was present to depths of between 1.45m and 2.4m bgl, where proven. The Made Ground generally comprised sandy gravel composed of mixed lithologies including limestone, mudstone and quartzite. SPT N-values recorded in the Made Ground indicated that the relative density ranged from loose to dense.

According to the published geology superficial deposits beneath the majority of the site are indicated to comprise Aeolian Blown Sand Deposits. However, the material encountered underlying the made ground on-site typically comprised dark brown sandy gravelly CLAY and dark grey SILT, with localised sand lenses and layers of spongy brown fibrous PEAT. It is considered that these deposits are more consistent with Alluvium, this is indicated to be present along the western part of the site that could also be present beneath the Blown Sand Deposits.

Medium dense to dense clayey sandy GRAVEL with low cobble content was encountered underlying the cohesive deposits within the three cable percussive boreholes at depths of between 6.0m (BH403) and 6.5mbgl (BH402).

Light brown medium to coarse SANDSTONE was encountered within two of the cable percussive boreholes at depths of 6.95m (BH402) and 7.65m bgl (BH403). This bedrock is considered representative of the South Wales Lower Coal Measures Formation identified on the BGS mapping.

It should be noted that deeper made ground, in excess of 4m, is likely to be encountered in some areas associated with the backfilling of the former tank excavations.

7.1.2 Human Health Risk Assessment

The results of soil chemical analysis were compared to Human Health Generic Assessment Criteria for commercial land use. None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

7.1.3 Water Resources Risk Assessment

The groundwater identified within the granular (deeper) deposits is considered to be representative of the Secondary A Aquifer underlying the site. Whilst this is considered to be of low sensitivity, the site is located adjacent to the River Clyne and Swansea Bay, and hydraulic connectivity is anticipated between the groundwater and these water features.

The concentrations of contaminants with groundwater sampled from have been compared with the Water Framework Directive Regulations 2015 Schedule 5 General Quality of Groundwater as an applicable Environmental Quality Standards (EQS) for Secondary Aquifers. The MAC-EQS level has been adopted. There are no recorded exceedances of the adopted MAC-EQS levels for any of the determinands screened within the three groundwater samples.

In addition, it should be noted that the site will be predominantly covered with the building and areas of hardstanding. Therefore, the risk of leaching of contaminants as a result of infiltration of groundwater is likely to be limited. Therefore, the risk to groundwater from contaminants within the made ground at the site is considered to be low and does not warrant further consideration.

7.1.4 Waste Classification

In general, the results of the chemical analyses indicate that the material would be classified as non-hazardous waste.

Elevated concentrations of Total Petroleum Hydrocarbon (TPH) above 1,000mg/kg have been identified. The TPH appears to be weathered diesel and therefore this material would also be classified as non-hazardous waste. While waste generated is likely to be classified as non-hazardous, there is the potential for higher concentrations of TPH to be encountered. If encountered during the redevelopment materials exhibiting evidence of hydrocarbon contamination should be segregated and analysed to determine precise waste classification.

7.2 Recommendations

Shallow spread foundations are not considered to be a suitable foundation solution due to the depth of made ground and the presence of highly compressible Alluvium beneath. It is therefore considered that a piled foundation solution or potentially ground improvement would be the most suitable option for the site.

Ground improvement techniques such as vibro-replacement stone or concrete columns could be considered for the site. Both ground improvement techniques involve inserting a vibrating poker into the ground, which displaces the soil. The resultant void is then infilled with either stone or concrete. However, the presence of soft Alluvium which included layers of peat may not provide the lateral support required for these techniques to work adequately. In addition, given that the proposed development comprises a car parking area at ground floor with the store located above this design is likely to be more suited to a piled foundation solution.

The proposed development comprises a car park at ground level with the store located at first floor level. Therefore, it is anticipated that there will be limited floor constructed at ground level. Due to the presence of made ground across the site in excess of 600mm it is recommended that the floor slab is fully suspended.

It should also be noted that the site is located in an area that is classified as an intermediate probability radon area and as such basic radon protective measures should be included within the floor slab constructed at ground level.

A Design Sulphate Class DS-1 is considered appropriate for buried concrete and an ACEC Class of AC-1 is considered appropriate for the location.

Six soakaway tests were conducted within the two test pits (SA1 and SA2) located adjacent to Mumbles Road. The results indicated a rapid infiltration into the made ground underlying the site during Remada's intrusive investigation. However, the site has historically been used as a fuel filling station and hydrocarbons have been recorded within the underlying soils circa 2m depth. Furthermore, the natural strata underlying the made ground typically comprises Alluvium (soft clays with layers of peat) to depths of between 6.0 and 6.3mbgl. Consequently, soakaways are not considered suitable for the proposed development.

Groundwater was found to be resting within the three monitoring wells at depths of between 4.22 and 5.44mbgl. It is recommended that groundwater levels are monitored again prior to construction.

7.3 Ground Gas

The results of four rounds of gas monitoring visits placed the site into Characteristic Situation 1 and therefore ground gas protection measures will not be required within the proposed building. However, the site is located in an Intermediate Probability Radon Area and Basic radon protective measures are necessary within the design of the proposed retail store.

REFERENCES & GUIDANCE

AGS, Guidance on the Waste Classification for Soils – A Practitioners' Guide 2019.

Barnes, G. 2010, Soil Mechanics Principles and Practice. 3rd Edition.

BRE, Special Digest 1:2005 (3rd Edition), Concrete in Aggressive Ground. 2005.

BS 10175:2011+A1:2013, Investigation of potentially contaminated sites: Code of practice.

BS 1377:1999. Methods of test for soils for civil engineering purposes.

BS 5930:2015, Code of practice for site investigations.

BS 8485:2015, Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

BS 8576:2013, Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs).

BS EN ISO 22476-3:2005, Geotechnical investigation and testing: Field testing - Standard penetration test.

CIRIA, C504, Engineering in glacial tills, 1999.

CIRIA, C665, Assessing risks posed by hazardous ground gases to buildings, 2007.

CIRIA, C682, The VOCs Handbook: Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination, 2009.

CIRIA, C716, Remediating and mitigating risks from volatile organic compound (VOC) vapours from land affected by contamination, 2012.

CIRIA C733, Asbestos in Soil and Made Ground: A Guide to Understanding & Managing Risks.

CL:AIRE/EIC/AGS, The Soil Generic Assessment Criteria for Human Health Risk Assessment, 2009.

CL:AIRE, SP1010, Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination -Final Project Report. 2013.

CL:AIRE, The Definition of Waste: Development Industry Code of Practice Version 2

DEFRA, Circular 01/2006, Contaminated Land Environmental Protection Act 1990, Part 2A. 2006.

DEFRA, SP1010, Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. March 2014.

Environment Agency, Model Procedures for the Management of Land Contamination, CLR 11, 2004.

Environment Agency, Verification of Remediation of Land Contamination Science Report – NC/00/38/SR

Environment Agency, Waste Classification, Guidance on the classification and assessment of waste (1st Edition V1.1) Technical Guidance WM3.

Health & Safety Executive, HSG 66, Protection of Workers and the General Public During Redevelopment of Contaminated Land. 1991.

Highways Agency, IAN 73/06 Rev 1, Design of Pavement Foundations, 2009.

Land Contamination Risk Management www.gov.uk 08.10.2020.

LCM/CIEH, The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, S4UL3146, 2015.

NHBC Standards, 2019.

Tomlinson, M.J., 2001, Foundation Design and Construction, 7th Edition.

The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

The Definition of Waste: Development Industry Code of Practice, CL:AIRE 2011.

Guidance on the classification and assessment of waste (1st Edition v1.1) Technical Guidance WM3 2018.

STUDY LIMITATIONS

IMPORTANT. This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1. This report has been prepared by Remada, Ltd with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with (the 'Client'). Remada does not accept responsibility for any matters outside the agreed scope.

2. This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.

3. Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. Remada is unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have published, more stringent objectives. Further work may be required by these parties.

4. All work carried out in preparing this report has used, and is based on, Remada' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice pending changes in legislation, of which Remada is aware, have been considered. Following delivery of the report Remada has no obligation to advise the Client or any other party of such changes or their repercussions.

5. This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6. Whilst this report and the opinions made are to the best of Remada' belief, Remada cannot guarantee the accuracy or completeness of any information provided by third parties.

7. This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have received.

8. This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the site since the time of the investigation.

9. The content of this report represents the professional opinion of experienced environmental consultants. Remada does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10. Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.

11. If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on site.

12. Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.

13. Unless otherwise stated, samples from the site (soil, groundwater, building fabric or other samples) have NOT been analysed or assessed for waste classification purposes.

TABLES

Table 2: Gas Groundwater Monitoring Data

GAS & GROUNDWATER MONITORING DATA																			Remada
SITE	Former Halfway Garage, 52 Mumbles Road, Swansea SA3 5AT																		
PROJECT No.	730.03		Atmospheric & Ground Conditions																
Visit No:	1 of 4		Atmospheric Pressure Variations During Visit										Ground Surface Conditions						
Carried Out by:	Idris Shafqat		1008mb										Dry						
Date:	06.05.2021																		
Instrument Details	GA 5000 G501261		Atmospheric Pressure Trend Over Previous 48hrs										Weather Conditions						
			Rising										Sunny, warm, blue skies						

Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH_4 (% v/v)		CH_4 Steady LEL (%)	CO_2 (% v/v)		O_2 (% v/v)		Duration (secs)^	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
BH401	6.940	50	0.1	0.1	2.0	0.0	0.0	19.3	20.1	60	0.3	0.21	-	-	1008	2.150	4.790	7.500	
BH402	6.360	50	0.0	0.1	2.0	0.0	0.0	17.9	18.3	60	0.4	0.27	-	-	1008	1.750	4.610	7.000	
BH403	6.670	50	0.1	0.0	0.0	0.3	0.1	20.0	20.3	60	0.4	0.34	-	-	1008	2.190	4.480	7.500	

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

GAS & GROUNDWATER MONITORING DATA																			Remada
SITE	Former Halfway Garage, 52 Mumbles Road, Swansea SA3 5AT																		
PROJECT No.	730.03		Atmospheric & Ground Conditions																
Visit No:	2 of 4		Atmospheric Pressure Variations During Visit										Ground Surface Conditions						
Carried Out by:	Idris Shafqat		1007mb										Dry						
Date:	10.05.2021																		
Instrument Details	GA 5000 G501261		Atmospheric Pressure Trend Over Previous 48hrs										Weather Conditions						
			Rising										Sunny, warm, blue skies						

Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH_4 (% v/v)		CH_4 Steady LEL (%)	CO_2 (% v/v)		O_2 (% v/v)		Duration (secs)^	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
BH401	6.940	50	0.1	0.0	0.0	0.1	0.0	19.7	20.6	60	0.5	0.51	-	-	1007	2.570	4.370	7.500	
BH402	6.360	50	0.1	0.0	0.0	0.1	0.1	17.5	18.2	60	0.6	0.38	-	-	1007	1.950	4.410	7.000	
BH403	6.670	50	0.1	0.0	0.0	0.5	0.2	19.3	20.0	60	0.5	0.43	-	-	1007	2.430	4.240	7.500	

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

GAS & GROUNDWATER MONITORING DATA

Remada

SITE	Former Halfway Garage, 52 Mumbles Road, Swansea SA3 5AT
PROJECT No.	730.03
Visit No:	3 of 4
Carried Out by:	Idris Shafqat
Date:	19.05.2021
Instrument Details	GA 5000 G501261

Atmospheric & Ground Conditions

Atmospheric Pressure Variations During Visit	Ground Surface Conditions
1020mb	Dry
Atmospheric Pressure Trend Over Previous 48hrs	**Weather Conditions**
Rising	Sunny, warm, blue skies

Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH_4 (% v/v)		CH_4 Steady LEL (%)	CO_2 (% v/v)		O_2 (% v/v)		Duration (secs)^	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
BH401	6.940	50	0.1	0.0	0.0	0.1	0.1	19.5	20.3	60	0.6	0.56	-	-	1020	2.520	4.420	7.500	
BH402	6.360	50	0.0	0.0	0.0	0.1	0.0	17.6	18.3	60	0.5	0.45	-	-	1020	1.970	4.390	7.000	
BH403	6.670	50	0.1	0.0	0.0	0.4	0.1	19.2	20.1	60	0.5	0.39	-	-	1020	2.450	4.220	7.500	

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

GAS & GROUNDWATER MONITORING DATA

Remada

SITE	Former Halfway Garage, 52 Mumbles Road, Swansea SA3 5AT
PROJECT No.	730.03
Visit No:	4 of 4
Carried Out by:	Idris Shafqat
Date:	25.05.2021
Instrument Details	GA 5000 G501261

Atmospheric & Ground Conditions

Atmospheric Pressure Variations During Visit	Ground Surface Conditions
1016mb	Wet
Atmospheric Pressure Trend Over Previous 48hrs	**Weather Conditions**
Rising	Raining, Grey Skies

Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH_4 (% v/v)		CH_4 Steady LEL (%)	CO_2 (% v/v)		O_2 (% v/v)		Duration (secs)^	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
BH401	6.940	50	0.1	0.0	0.0	0.1	0.0	19.1	20.3	60	0.5	0.27	-	-	1016	1.500	5.440	7.500	
BH402	6.360	50	0.1	0.0	0.0	0.1	0.0	17.1	18.5	60	0.6	0.28	-	-	1016	1.980	4.380	7.000	
BH403	6.670	50	0.1	0.1	2.0	0.6	0.1	19.3	20.5	60	0.5	0.35	-	-	1016	1.350	5.320	7.500	

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

Table 2: Gas and Groundwater Monitoring Data

Table 4 Comparison of Groundwater Chemical Analyses with EQS

Client: Remada Ltd	Water Framework Directive Regs 2015 Table 1 Maxium Allowable Concentrations			21-18404	21-18404	21-18404
Quotation No.:				1211805	1211806	1211807
				BH401	BH402	BH403
				WATER	WATER	WATER
				25-May-2021	25-May-2021	25-May-2021
Determinand		**Units**	**LOD**			
pH			N/A	8.3	8.3	8.3
Arsenic (Dissolved)		µg/l	1.0	2.0	3.3	3.0
Boron (Dissolved)		µg/l	20	320	310	180
Beryllium (Dissolved)		µg/l	1.0	< 1.0	< 1.0	< 1.0
Cadmium (Dissolved)	0.45 - 1.5 depending on class	µg/l	0.080	< 0.11	< 0.11	< 0.11
Copper (Dissolved)		µg/l	1.0	0.51	< 0.50	< 0.50
Mercury (Dissolved)	0.07	µg/l	0.50	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	34	µg/l	1.0	< 0.50	0.64	< 0.50
Lead (Dissolved)	14	µg/l	1.0	< 0.50	< 0.50	< 0.50
Selenium (Dissolved)		µg/l	1.0	< 0.50	< 0.50	< 0.50
Vanadium (Dissolved)		µg/l	1.0	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)		µg/l	1.0	< 2.5	< 2.5	< 2.5
Chromium (Trivalent)		µg/l	20	[B] < 20	[B] < 20	[B] < 20
Chromium (Hexavalent)		µg/l	20	[B] < 20	[B] < 20	[B] < 20
Dissolved Organic Carbon		mg/l	2.0	7.6	4.8	3.3
Aliphatic TPH >C5-C6		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C6-C8		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C8-C10		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C10-C12		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C12-C16		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C16-C21		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C21-C35		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C35-C44		µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Aliphatic Hydrocarbons		µg/l	5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C7-C8		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C8-C10		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C10-C12		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C12-C16		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C16-C21		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C21-C35		µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C35-C44		µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Aromatic Hydrocarbons		µg/l	5.0	< 5.0	< 5.0	< 5.0
Total Petroleum Hydrocarbons		µg/l	10	< 10	< 10	< 10
Naphthalene	130	µg/l	0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Fluorene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Phenanthrene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Anthracene	0.1	µg/l	0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	0.12	µg/l	0.10	< 0.10	< 0.10	< 0.10
Pyrene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Chrysene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	0.017	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	0.017	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	0.27	µg/l	0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	N/A	µg/l	0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene		µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	0.0082	µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's		µg/l	2.0	< 2.0	< 2.0	< 2.0
Phenol		mg/l	0.0050	< 0.0050	< 0.0050	< 0.0050

Solubilty of Benzene in water =. 1780 ug/l. TPH concentrations as Benzene are greater than the limit of solublity

Less than EQS
LOD>EQS
>EQS

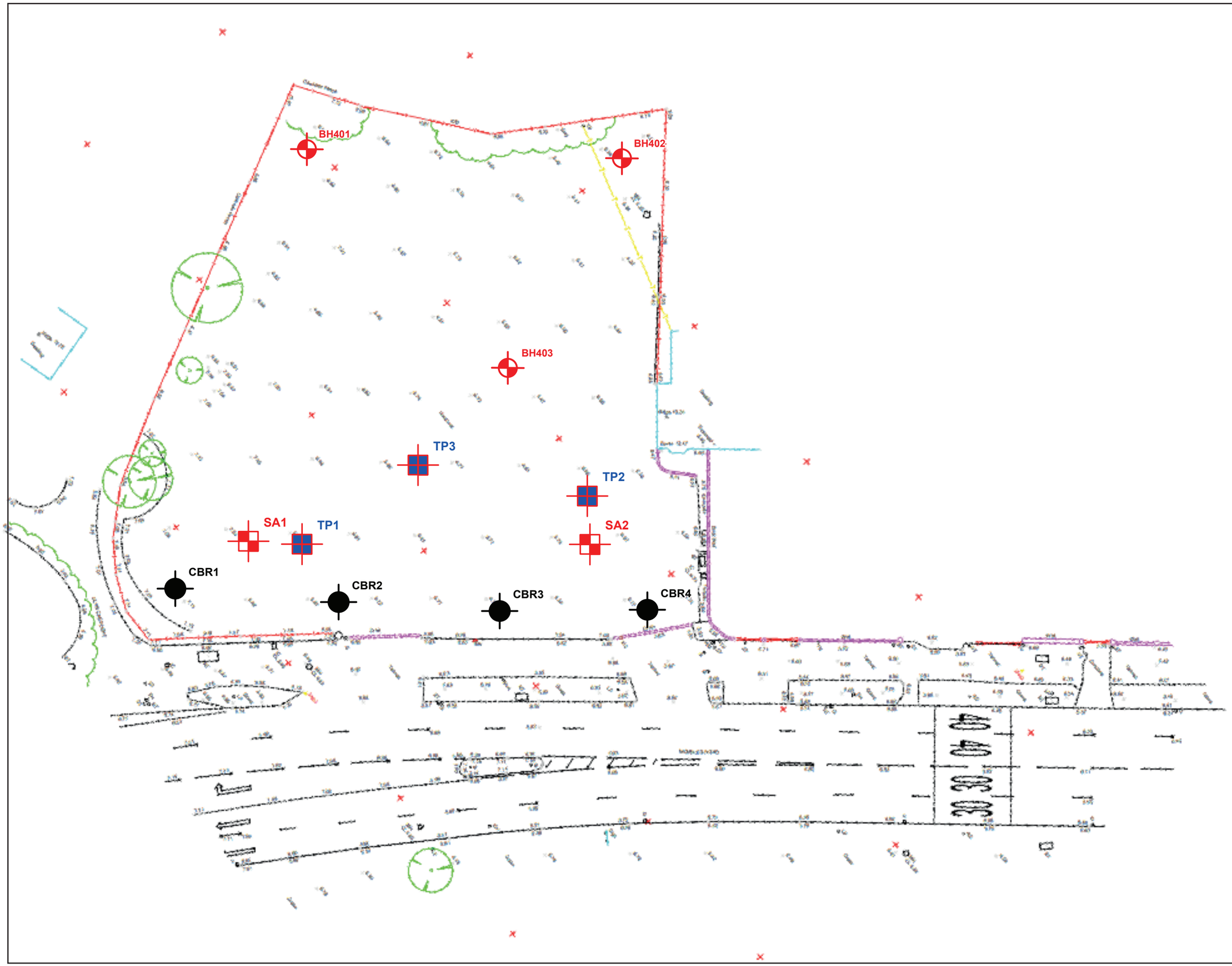
FIGURES

Notes

Promap
LANDMARK INFORMATION

Plotted Scale - 1:50000. Paper Size – A4

Project Title	Scale	Drawn	Size
Mumbles Road, Mumbles	as shown	DW	A4
Drawing Title	**Date**	**Job No.**	**Drawing /Rev No.**
Site Location Plan	18.03.21	730	Fig1
Client			
Lidl Great Britain Ltd		Remada	



Legend

BH Cable Tool Borehole

CBR CBR Test

SA Soakaway Test

TP Trial Pit Locations

Notes

Project Title
Mumbles

Drawing Title
Figure 2: Existing Layout & Exploratory Location Plan

Client
Lidl GB Ltd

Scale	Drawn	Size
as shown	IS	A4
Date	Job No.	Drawing /Rev No.
28.05.21	730.03	01

Remada

EXPLORATORY LOGS

Percussion Drilling Log

Remada

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 27/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E261998.00 N190959.00
Project No. : 730.03	Crew Name:	Drilling Equipment: Dando 2500

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
BH401	CP	6.94m AoD	DW	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.10	D		0.02	6.92		MADE GROUND: Light grey angular fine to coarse gravel of mixed lithologies including limestone, quartzite, calcite, mudstone/shale and sandstone.
		0.30 - 0.35	ES					MADE GROUND: Light grey sandy gravel. Sand is medium to coarse. Gravel is angular fine to medium of mixed lithologies including limestone and mudstone.
		1.00 - 1.10	ES		1.00	5.94		MADE GROUND: Dense dark grey sandy angular fine to coarse gravel of mixed lithologies including limestone, mudstone and quartzite. Sand is medium to coarse.
		1.00 - 2.00	B					
		1.00	SPT	N=37 (2,3/8,9,10,10)				
					1.80	5.14		Grey sandy gravelly CLAY. Sand is fine to course. gravel is fine to medium of sandstone. "Possible Made Ground".
		2.00 - 3.00	D		2.00	4.94		Soft dark grey SILT.
		2.00	SPT	N=5 (1,2/1,1,2,1)	2.45	4.49		Spongy brown fibrous PEAT.
		3.00 - 3.20	ES					
		3.00 - 4.00	B		3.20	3.74		Soft light grey CLAY.
		3.00	SPT	N=6 (2,1/1,2,1,2)				
		3.30	D					
		3.45	D					
		3.90 - 4.00	ES					
		4.00 - 4.45	U					
	▼	4.00 - 5.00	D					
		5.00	SPT	N=6 (2,1/1,2,1,2)				
		6.10 - 7.50	B		6.10	0.84		Medium dense light grey clayey sandy GRAVEL. Sand is medium to coarse. Gravel is medium to coarse of mixed lithologies including mudstone, siltstone and sandstone.
		6.50	SPT	N=24 (4,4/7,9,6,2)				
		7.50 - 7.85	D		7.50	-0.56		Very dense grey GRAVEL with low-medium cobble content. Gravel is coarse rounded of mixed lithologies including mudstone and siltstone. Cobbles are sub-rounded to rounded of mudstone and siltstone.
		7.50	SPT	N=50 (6,8/11,13,16,10)	7.85	-0.91		End of Borehole at 7.850m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

1. Groundwater encountered at 4.6m bgl, rising to 4.2m bgl after 20 min.
2. Install to 7.5m bgl, 4m plain pipe, 3.5m slotted pipe.

AGS

Percussion Drilling Log

Remada

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 28/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262022.00 N190983.00
Project No. : 730.03	Crew Name:	Drilling Equipment: Dando 2500

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
BH402	CP	6.36m AoD	DW	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	D		0.02	6.34		MADE GROUND: Light grey angular fine to coarse gravel of mixed lithologies including limestone, quartzite, calcite, mudstone/shale and sandstone.
		0.00 - 1.00	B					MADE GROUND: Light grey sandy gravel. Sand is medium to coarse. Gravel is angular fine to medium of mixed lithologies including limestone and mudstone.
		1.00	SPT	N=10 (4,5/4,3,2,1)				
		1.70 - 1.80	ES		1.70	4.66		MADE GROUND: Very loose dark grey sandy angular fine to coarse gravel of mixed lithologies including limestone, mudstone and quartzite Sand is medium to coarse.
		1.80	D					
		2.00	SPT	N=1 (1,0/0,0,0,1)				
		2.40 - 2.50	ES		2.40	3.96		Spongy brown fibrous PEAT.
		2.50	D					
		2.70	D		2.70	3.66		Very soft light grey CLAY.
		2.70 - 2.80	ES					
		3.00	SPT	N=0 (0,0/0,0,0,0)				
		4.00 - 5.00	B					
		4.00	SPT	N=0 (0,0/0,0,0,0)				
	▼							
	▼				6.00	0.36		Dense light grey clayey sandy GRAVEL with rare cobble contents. Sand is medium to coarse. Gravel is medium to coarse of mixed lithologies including mudstone, siltstone and sandstone. Cobbles are sub-angular to sub-rounded of siltstone.
		6.10	D					*Cobble encountered between 6.4 and 6.5m bgl.*
		6.50	SPT	N=40 (7,10/6,15,11,8)	6.50	-0.14		
		6.70	D					
		7.00	D		6.95	-0.59		Very dense grey gravelly medium to coarse SAND. Gravel is angular to sub-angular fine to medium of mixed lithologies including mudstone and siltstone.
		7.00	SPT	50 (22,3/50 for 150mm)	7.00	-0.64		Light brown medium to coarse SANDSTONE.
								End of Borehole at 7.000m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

1. Groundwater encountered at 4.5m bgl, rising to 4.2m bgl after 20 minutes. Groundwater ingress recorded at 6m bgl, rising to 2.0m bgl after 30 minutes.
2. Install to 7.0m, 3.0m plain, 4m slotted.

AGS

Percussion Drilling Log

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 29/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262025.00 N190968.00
Project No. : 730.03	Crew Name:	Drilling Equipment: Dando 2500

Borehole Number	Hole Type	Level	Logged By	Scale	Page Number
BH403	CP	6.67m AoD	DW	1:50	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20	D		0.02	6.65		MADE GROUND: Light grey angular fine to coarse gravel of mixed lithologies including limestone, quartzite, calcite, mudstone/shale and sandstone.
		1.00	SPT	N=14 (10,9/7,3,2,2)				MADE GROUND: Light brown sandy angular fine to medium gravel of mixed lithologies including limestone and mudstone. Sand is medium to coarse.
		1.16 - 1.45	ES					*Becoming light grey below 1.16m*
		1.30	D					
		1.50	D		1.45	5.22		Dark brown sandy gravelly CLAY. Sand is medium to coarse. Gravel is fine to medium of mixed lithologies including limestone and mudstone. "Possible Made Ground".
		1.60 - 2.05	U					
		1.80 - 2.10	ES					
		2.00 - 2.40	ES					
		2.00 - 3.00	B					
		2.20	SPT	N=5 (1,2/1,1,1,2)				
		2.55	D		2.50	4.17		Spongy dark brown fibrous PEAT.
					3.00	3.67		Plastic dark brown mottled light grey clayey fibrous PEAT.
		3.70	D		3.70	2.97		Soft light grey organic CLAY.
		4.00 - 4.45	U					
		5.00 - 5.50	B					
		5.00	SPT	N=4 (1,2/1,1,1,1)				
					5.40	1.27		Light grey medium to coarse SAND.
		5.60	D		5.45	1.22		Soft light grey CLAY with rare shell fragments.
	▼				6.00	0.67		Dense grey sandy GRAVEL with moderate cobble content. Sand is medium to coarse. Gravel is sub-rounded fine to coarse of mixed lithologies including mudstone, siltstone and sandstone. Cobbles are sub-rounded to rounded of mudstone, siltstone and sandstone.
		6.20	D					
		6.50	SPT	N=47 (7,7/15,13,11,8)				
		7.50	SPT	N=50 (17,8/11,14,12,13)	7.65	-0.98		Light brown medium to coarse SANDSTONE.
		7.80	D		7.95	-1.28		End of Borehole at 7.950m

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

1. Groundwater encountered at 6.0m bgl rising to 2.2m bgl after 20 minutes.
2. install to 7.65m, 4m plain pipe, 3.65m slotted.

Trial Pit Log

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 27/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262029.00 N190930.00
Project No. : 730.03	Crew Name:	Equipment: Tracked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
SA1	TP	7.00m AoD	IS	1:20	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Light grey angular fine to coarse gravel.
					0.30	7.00		MADE GROUND: Light grey slightly sandy angular fine to coarse gravel.
					0.80	6.70		MADE GROUND: Light greyish brown sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.50	6.20		End of Borehole at 1.500m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

Trial Pit Log

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 27/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262054.00 N190959.00
Project No. : 730.03	Crew Name:	Equipment: Tracked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
SA2	TP	6.75m AoD	IS	1:20	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Light grey angular fine to coarse gravel.
					0.30	6.75		MADE GROUND: Light grey slightly sandy angular fine to coarse gravel.
					1.00	6.45		MADE GROUND: Light greyish brown sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.60	5.75		End of Borehole at 1.600m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

Trial Pit Log

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 27/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262030.00 N190932.00
Project No. : 730.03	Crew Name:	Equipment: Tracked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP1	TP	6.91m AoD	IS	1:20	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Light grey angular fine to coarse gravel.
					0.30	6.91		MADE GROUND: Light grey slightly sandy angular fine to coarse gravel.
					1.00	6.61		MADE GROUND: Light greyish brown sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.50	5.91		Dark brown gravelly CLAY.
					2.50	5.41		Spongy brown fibrous PEAT.
					3.00	4.41		End of Borehole at 3.000m

1
2
3
4

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

Trial Pit Log

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 27/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262049.00 N190963.00
Project No. : 730.03	Crew Name:	Equipment: Tracked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP2	TP	6.64m AoD	IS	1:20	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Light grey angular fine to coarse gravel.
					0.50	6.64		MADE GROUND: Light grey slightly sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.00	6.14		MADE GROUND: Light greyish brown sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.50	5.64		Dark brown silty gravelly CLAY.
					2.50	5.14		End of Borehole at 2.500m

1
2
3
4

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

Trial Pit Log

Project Name: Halfway Garage	Client: Lidl Great Britain Ltd	Date: 27/04/2021
Location: Mumbles, Swansea	Contractor:	Co-ords: E262035.00 N190950.00
Project No. : 730.03	Crew Name:	Equipment: Tracked Excavator

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP3	TP	6.83m AoD	IS	1:20	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Light grey angular fine to coarse gravel.
					0.40	6.83		MADE GROUND: Light grey slightly sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.00	6.43		MADE GROUND: Light greyish brown sandy angular fine to coarse gravel. Sand is medium to coarse.
					1.50	5.83		Dark brown sandy gravelly CLAY.
					2.50	5.33		End of Borehole at 2.500m

1
2
3
4

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

APPENDIX A
SPT Hammer Energy Test Certificate

ARCHWAY
ENGINEERING (U.K) LTD

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

ARCHWAY ENGINEERING
AINLEYS INDUSTRIAL ESTATE
ELLAND
WEST YORKSHIRE
HX5 9JP

SPT Hammer Ref:	AR2462
Test Date:	16/09/2020
Report Date:	16/09/2020
File Name:	AR2462.spt
Test Operator:	JL

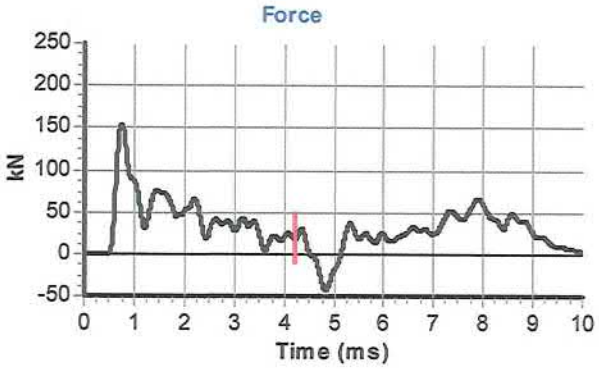
Instrumented Rod Data

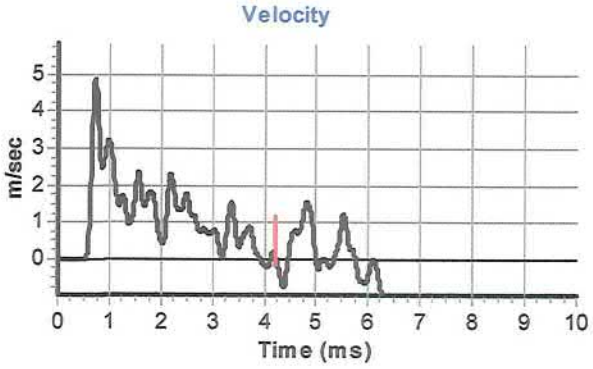
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.3
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	7080
Accelerometer No.2:	11609

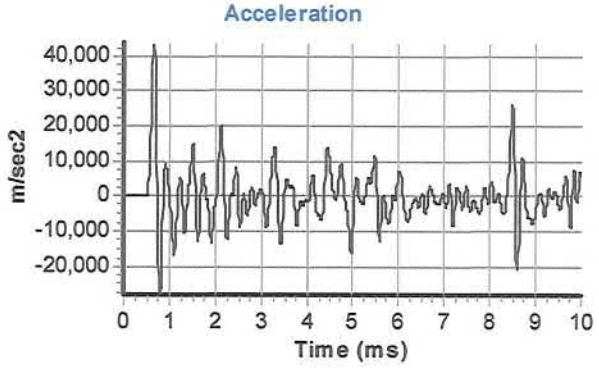
SPT Hammer Information

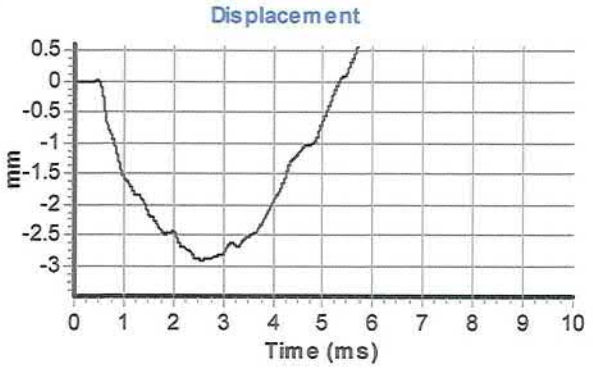
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

Comments / Location
GEOTRON









Calculations

Area of Rod A (mm2):	944
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	317

Energy Ratio E_r (%): **67**

Signed: J.LOCK
Title: FITTER

The recommended calibration interval is 12 months

APPENDIX B
Soakage Test Results

Soakaway Test Report

Remada

Client:	Lidl GB Limited
Job Name:	Mumbles, Swansea
Job No.:	730.03

Test Date: 27.04.2021

Soil Description: See corresponding trial pit log for SA1

Trial Pit No.	SA1
Test No.	1
Coordinates:	

Weather Conditions: Dry & sunny

Time	Elapsed Time	Depth to water from ground level	
	(sec)	(m)	(mm)
10.15.05	0	1.490	1490
10.15.10	5	1.500	1500
10.15.15	10	1.500	1500
10.15.20	15	1.500	1500
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

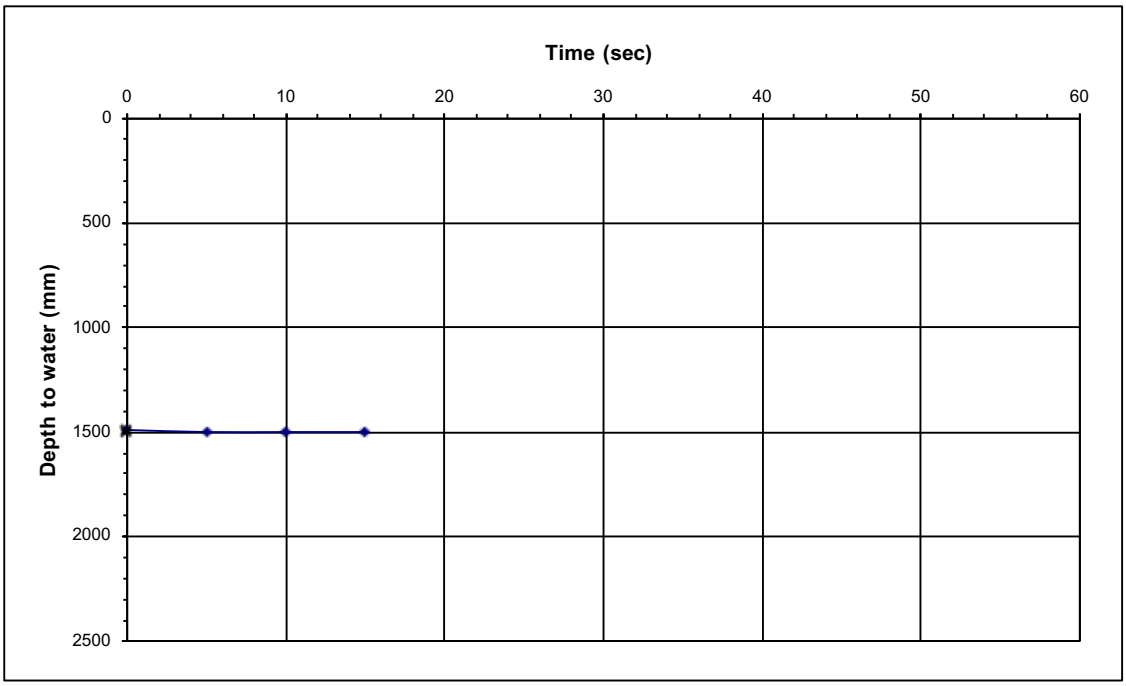
Soakaway Dimensions		(m)	(mm)
Length	=	1.50	1500
Width	=	0.65	650
Depth	=	1.50	1500

Effective depth (empty)		m	mm
75%	=	1.50	1497.5
50%	=	1.50	1495.0
25%	=	1.49	1492.5

Depth at start of test (mm)	=	1490
Depth at end of test (mm)	=	1500

Base area of pit	=	0.975
a_{p50} - 50% internal surface area inc. base	=	0.997
V_{p75-25} - Volume 75 - 25%	=	0.005

$t_{p\ 75}$ (min) = (Read from graph)	N/A
$t_{p\ 25}$ (min) = (Read from graph)	N/A
t_p values extrapolated from graph data =	#VALUE!
t_p value (seconds) =	#VALUE!



Soil infiltration rate, f, (m/s) = **#VALUE!** **(normal test)**

Soil infiltration rate, f, (m/s) = ***~~(pit filled with stone)~~***

Notes: *Unable to maintain head of water in test pit due to infiltration rate, despite using rapid flow from water tan*

Logged By	*IS*	*Checked by*	GSJ

Soakaway Test Report

Remada

Client:	Lidl GB Limited
Job Name:	Mumbles, Swansea
Job No.:	730.03

Test Date: 27.04.2021

Soil Description: See corresponding trial pit log for SA1

Weather Conditions: Dry & sunny

Trial Pit No.	SA1
Test No.	2
Coordinates:	

Time	Elapsed Time	Depth to water from ground level	
	(sec)	(m)	(mm)
11.16.01	0	1.480	1480
11.16.06	5	1.490	1490
11.06.11	10	1.500	1500
11.06.16	15	1.500	1500
11.06.21	20	1.500	1500
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

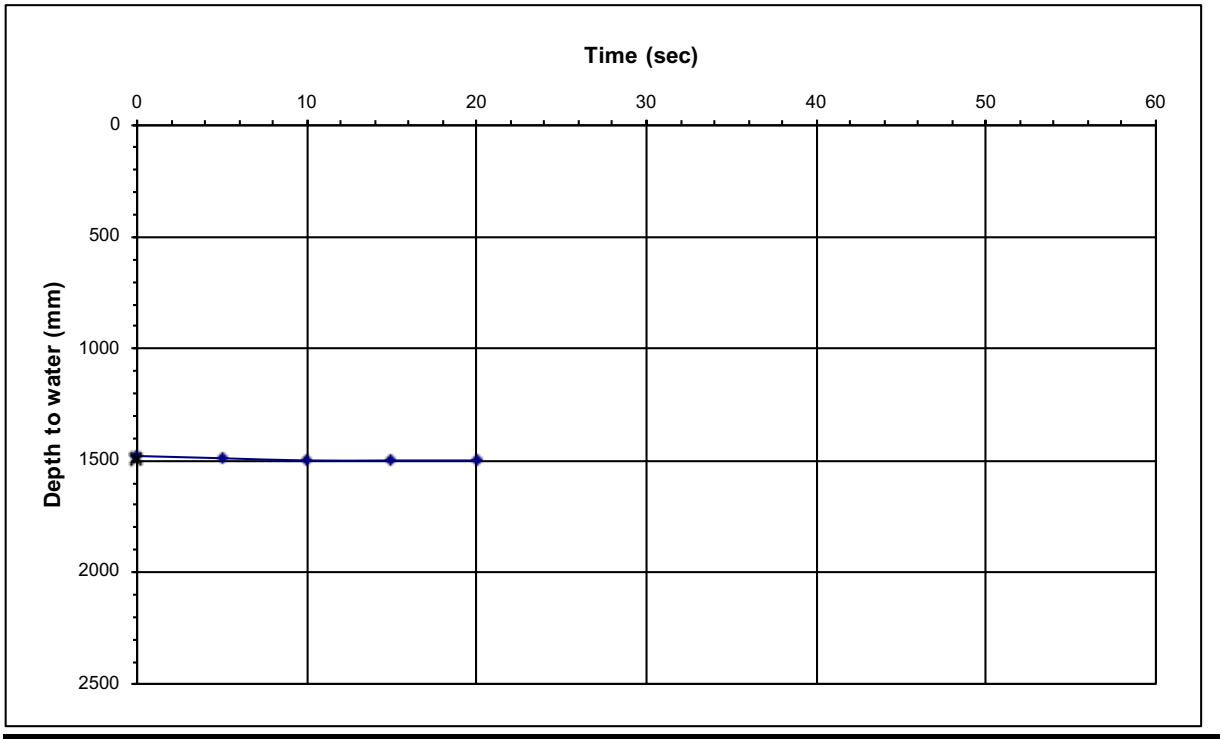
Soakaway Dimensions		(m)	(mm)
Length	=	1.50	1500
Width	=	0.65	650
Depth	=	1.50	1500

Effective depth (empty)		m	mm
75%	=	1.50	1495.0
50%	=	1.49	1490.0
25%	=	1.49	1485.0

Depth at start of test (mm)	=	1480
Depth at end of test (mm)	=	1500

Base area of pit	=	0.975
a_{p50} - 50% internal surface area inc. base	=	1.018
V_{p75-25} - Volume 75 - 25%	=	0.010

$t_{p\,75}$ (min) = (Read from graph)	N/A
$t_{p\,25}$ (min) = (Read from graph)	N/A
t_p values extrapolated from graph data =	#VALUE!
t_p value (seconds) =	#VALUE!



Soil infiltration rate, f, (m/s) = **#VALUE!** **(normal test)**

Soil infiltration rate, f, (m/s) = ~~***(pit filled with stone)***~~

Notes: *Unable to maintain head of water in test pit due to infiltration rate, despite using rapid flow from water tan*

Logged By	*DF*	*Checked by*	GSJ

Soakaway Test Report

Remada

Client:	Lidl GB Limited
Job Name:	Mumbles, Swansea
Job No.:	730.03

Test Date: 27.04.2021

Soil Description: See corresponding trial pit log for SA1

Trial Pit No.	SA1
Test No.	3
Coordinates:	

Weather Conditions: Dry & sunny

Time	Elapsed Time	Depth to water from ground level	
	(sec)	(m)	(mm)
12.26.31	0	1.480	1480
13.26.36	5	1.490	1490
13.26.41	10	1.500	1500
13.26.46	15	1.500	1500
13.26.51	20	1.500	1500
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

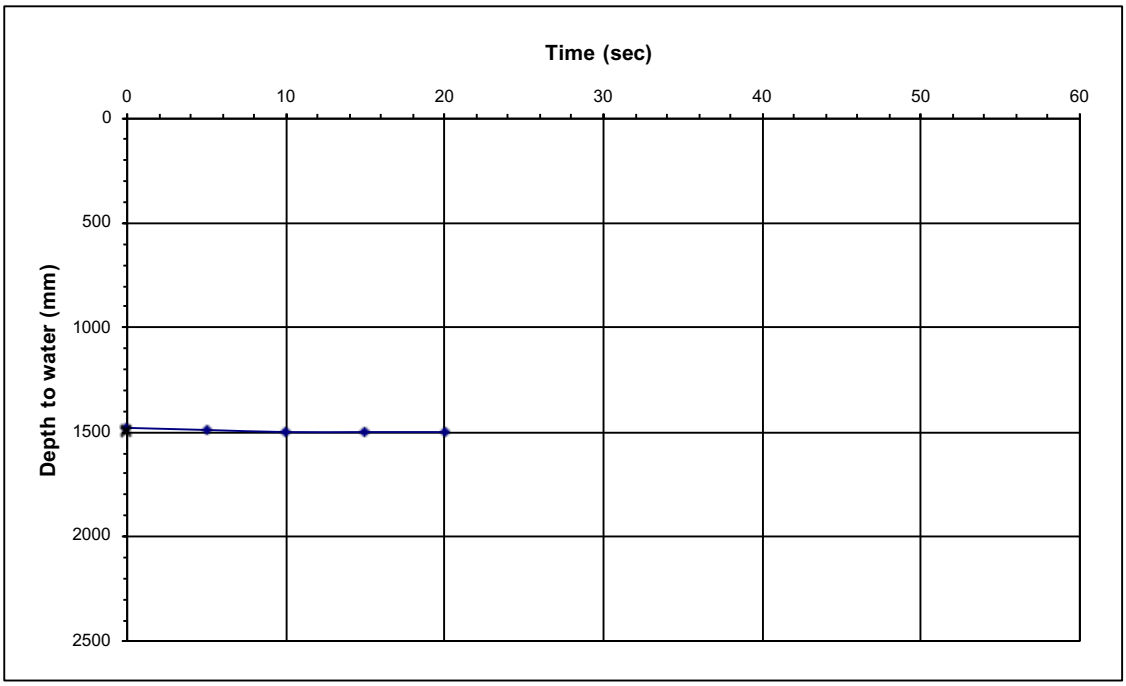
Soakaway Dimensions		(m)	(mm)
Length	=	1.50	1500
Width	=	0.65	650
Depth	=	1.50	1500

Effective depth (empty)		m	mm
75%	=	1.50	1495.0
50%	=	1.49	1490.0
25%	=	1.49	1485.0

Depth at start of test (mm)	=	1480
Depth at end of test (mm)	=	1500

Base area of pit	=	0.975
a_{p50} - 50% internal surface area inc. base	=	1.018
V_{p75-25} - Volume 75 - 25%	=	0.010

$t_{p\ 75}$ (min) = (Read from graph)	N/A
$t_{p\ 25}$ (min) = (Read from graph)	N/A
t_p values extrapolated from graph data =	#VALUE!
t_p value (seconds) =	#VALUE!



Soil infiltration rate, f, (m/s) = **#VALUE!** **(normal test)**

Soil infiltration rate, f, (m/s) = ***~~(pit filled with stone)~~***

Notes: *Unable to maintain head of water in test pit due to infiltration rate, despite using rapid flow from water tan*

Logged By	*DF*	*Checked by*	GSJ

Soakaway Test Report

Remada

Client:	Lidl GB Limited
Job Name:	Mumbles, Swansea
Job No.:	730.03

Test Date: 27.04.2021

Soil Description: See corresponding trial pit log for SA2

Weather Conditions: Dry & sunny

Trial Pit No.	SA2
Test No.	1
Coordinates:	

Time	Elapsed Time	Depth to water from ground level	
	(sec)	(m)	(mm)
10.40.04	0	1.590	1590
10.40.09	5	1.600	1600
10.40.14	10	1.600	1600
10.40.19	15	1.600	1600
10.40.24	20	1.600	1600
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

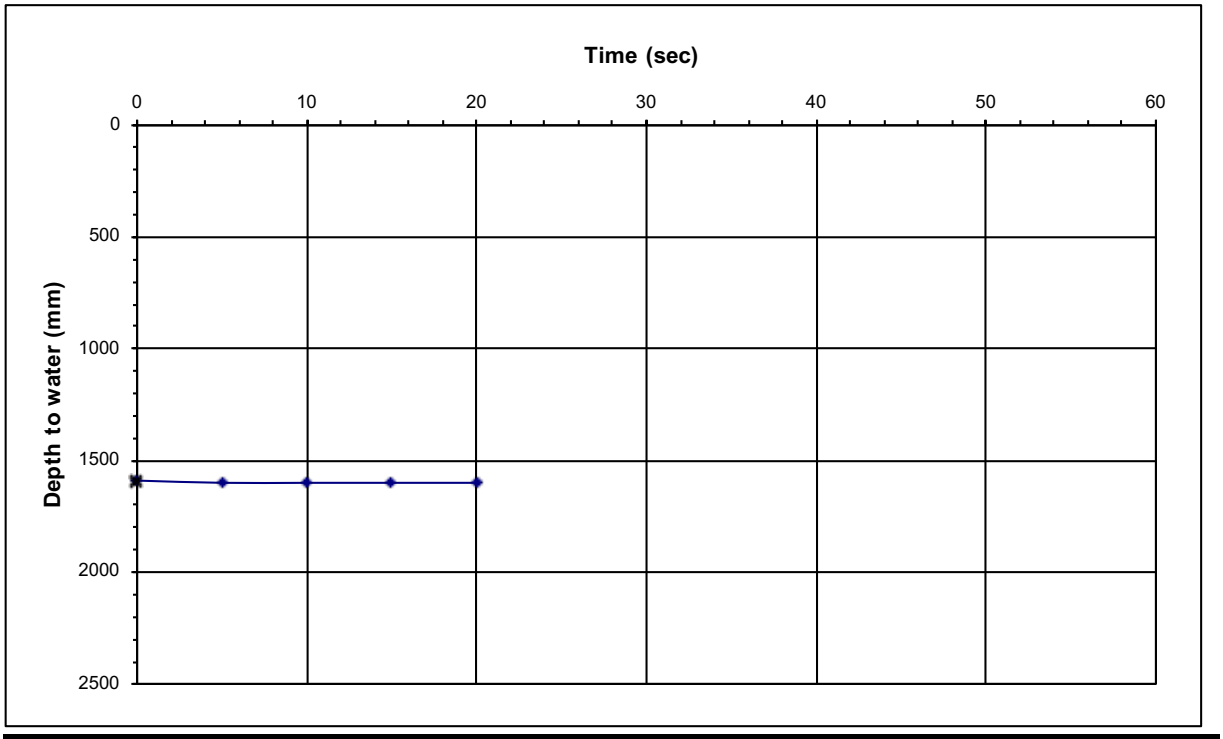
Soakaway Dimensions		(m)	(mm)
Length	=	1.55	1550
Width	=	0.65	650
Depth	=	1.60	1600

Effective depth (empty)		m	mm
75%	=	1.60	1597.5
50%	=	1.60	1595.0
25%	=	1.59	1592.5

Depth at start of test (mm)	=	1590
Depth at end of test (mm)	=	1600

Base area of pit	=	1.008
a_{p50} - 50% internal surface area inc. base	=	1.030
V_{p75-25} - Volume 75 - 25%	=	0.005

$t_{p\,75}$ (min) = (Read from graph)	N/A
$t_{p\,25}$ (min) = (Read from graph)	N/A
t_p values extrapolated from graph data =	#VALUE!
t_p value (seconds) =	#VALUE!



Soil infiltration rate, f, (m/s) = **#VALUE!** **(normal test)**

Soil infiltration rate, f, (m/s) = ~~***(pit filled with stone)***~~

Notes: *Unable to maintain head of water in test pit due to infiltration rate, despite using rapid flow from water tan*

Logged By	*IS*	*Checked by*	GSJ

Soakaway Test Report

Remada

Client:	Lidl GB Limited
Job Name:	Mumbles, Swansea
Job No.:	730.03

Test Date: 27.04.2021

Soil Description: See corresponding trial pit log for SA2

Weather Conditions: Dry & sunny

Trial Pit No.	SA2
Test No.	2
Coordinates:	

Time	Elapsed Time	Depth to water from ground level	
	(sec)	(m)	(mm)
11.40.04	0	1.580	1580
11.40.09	5	1.590	1590
11.40.14	10	1.600	1600
11.40.19	15	1.600	1600
11.40.24	20	1.600	1600
11.40.29	25	1.600	1600
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

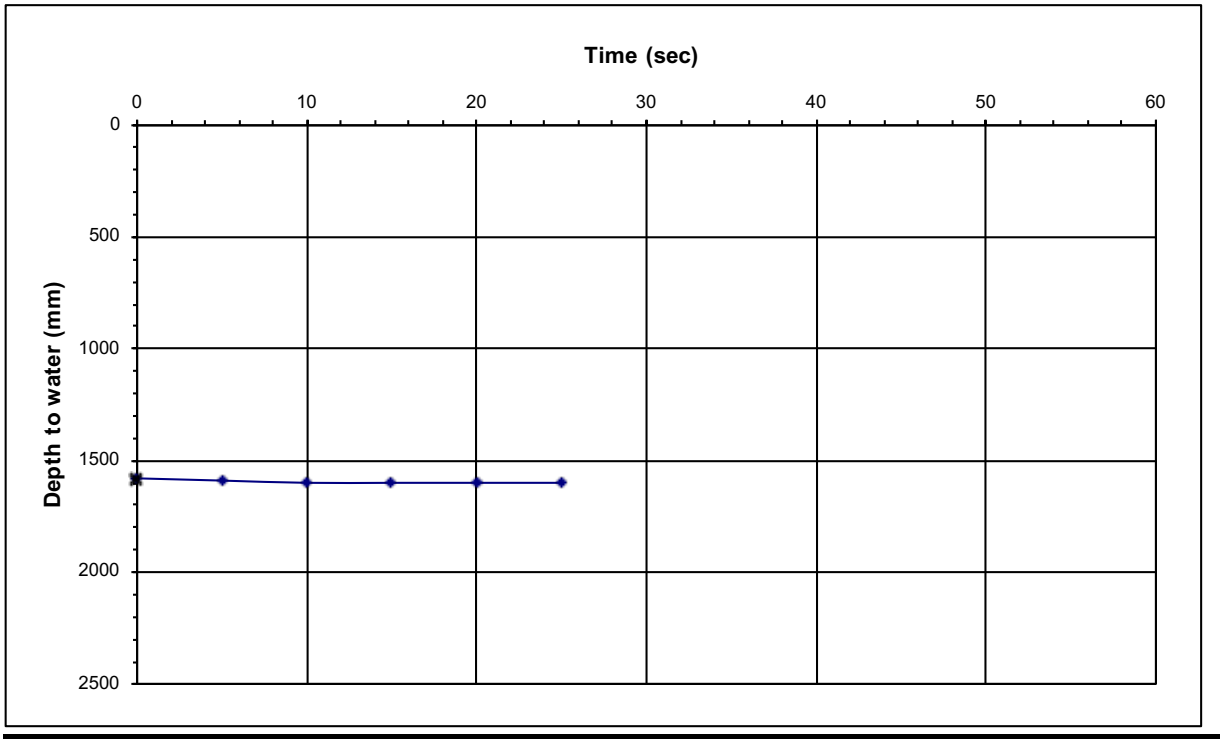
Soakaway Dimensions		(m)	(mm)
Length	=	1.55	1550
Width	=	0.65	650
Depth	=	1.60	1600

Effective depth (empty)		m	mm
75%	=	1.60	1595.0
50%	=	1.59	1590.0
25%	=	1.59	1585.0

Depth at start of test (mm)	=	1580
Depth at end of test (mm)	=	1600

Base area of pit	=	1.008
a_{p50} - 50% internal surface area inc. base	=	1.052
V_{p75-25} - Volume 75 - 25%	=	0.010

$t_{p\,75}$ (min) = (Read from graph)	N/A
$t_{p\,25}$ (min) = (Read from graph)	N/A
t_p values extrapolated from graph data =	#VALUE!
t_p value (seconds) =	#VALUE!



Soil infiltration rate, f, (m/s) = **#VALUE!** **(normal test)**

Soil infiltration rate, f, (m/s) = ~~***(pit filled with stone)***~~

Notes: *Unable to maintain head of water in test pit due to infiltration rate, despite using rapid flow from water tan*

Logged By	*IS*	*Checked by*	GSJ

Soakaway Test Report

Remada

Client:	Lidl GB Limited
Job Name:	Mumbles, Swansea
Job No.:	730.03

Test Date: 27.04.2021

Soil Description: See corresponding trial pit log for SA2

Weather Conditions: Dry & sunny

Trial Pit No.	SA2
Test No.	3
Coordinates:	

Time	Elapsed Time	Depth to water from ground level	
	(sec)	(m)	(mm)
12.54.10	0	1.580	1580
12.54.15	5	1.590	1590
12.54.20	10	1.600	1600
12.54.25	15	1.600	1600
12.54.30	20	1.600	1600
12.54.35	25	1.600	1600
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0

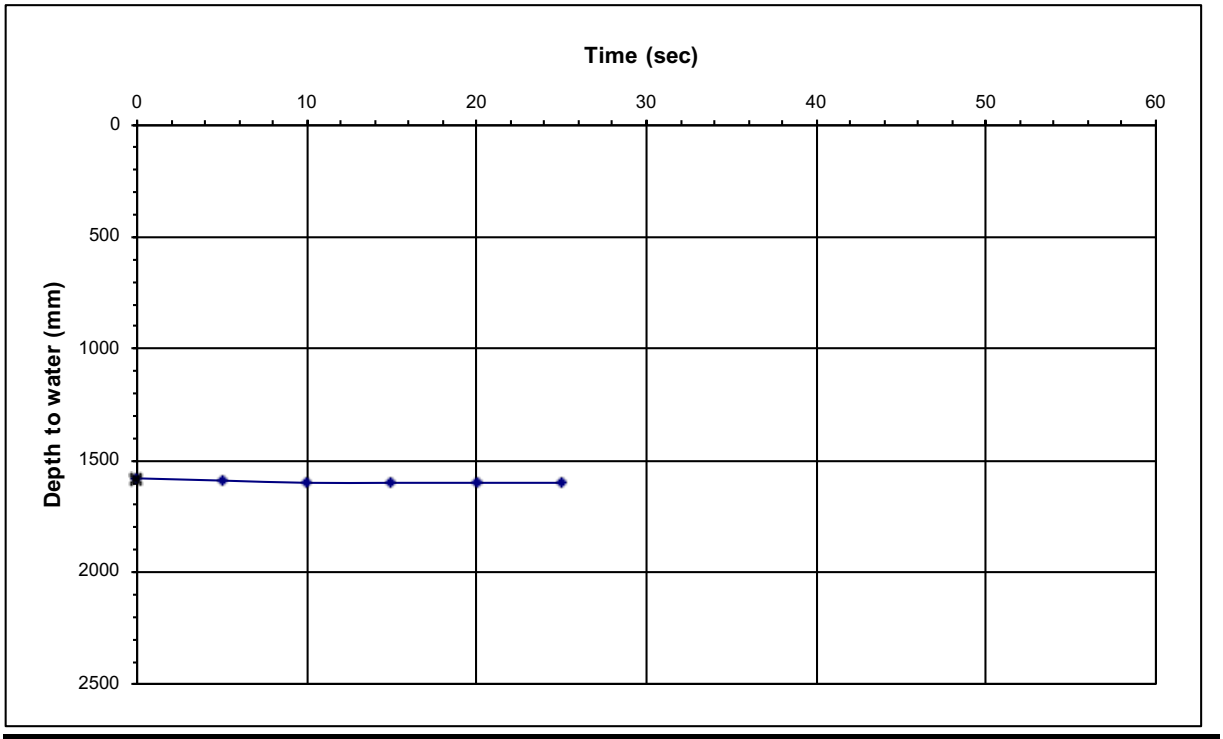
Soakaway Dimensions		(m)	(mm)
Length	=	1.55	1550
Width	=	0.65	650
Depth	=	1.60	1600

Effective depth (empty)		m	mm
75%	=	1.60	1595.0
50%	=	1.59	1590.0
25%	=	1.59	1585.0

Depth at start of test (mm)	=	1580
Depth at end of test (mm)	=	1600

Base area of pit	=	1.008
a_{p50} - 50% internal surface area inc. base	=	1.052
V_{p75-25} - Volume 75 - 25%	=	0.010

$t_{p\,75}$ (min) = (Read from graph)	N/A
$t_{p\,25}$ (min) = (Read from graph)	N/A
t_p values extrapolated from graph data =	#VALUE!
t_p value (seconds) =	#VALUE!



Soil infiltration rate, f, (m/s) = **#VALUE!** **(normal test)**

Soil infiltration rate, f, (m/s) = ~~***(pit filled with stone)***~~

Notes: *Unable to maintain head of water in test pit due to infiltration rate, despite using rapid flow from water tan*

Logged By	*IS*	*Checked by*	GSJ

APPENDIX C
Dynamic Plate Load Test Results

Dynamic Plate Load Test Report

Remada

Test carried out according to BS-STB Part B 8.3

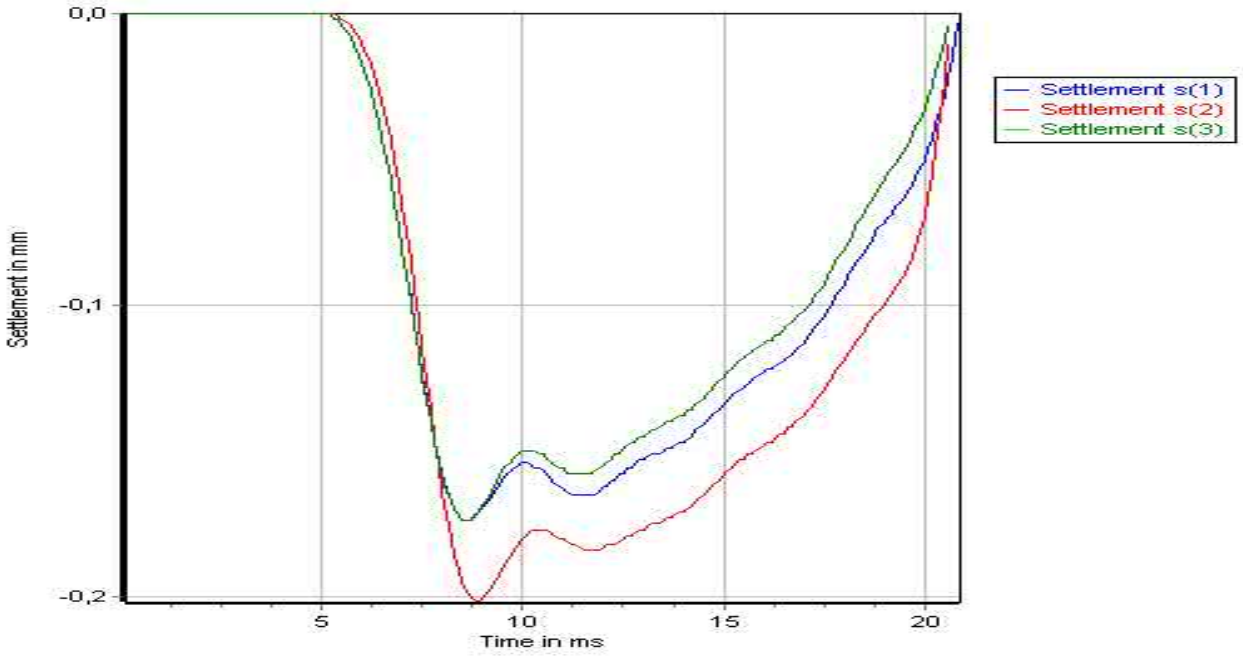
Client :	Lidl Great Britain Ltd
Job Name:	Halfway Garage
Job Number:	730.03
Site:	Mumbles Road, Swansea, SA3 5AT

Report Date:	28/04/2021
Device:	HMP LFG4

Test Location:	1
Test Layer:	Surface
Test Strata:	Crushed Concrete
Ground Condition	Dry
Weather:	Sunny, warm, blue skies

Results	
S/V (m)	1.97
EvD (MN/m2)=	122.95
Equivalent CBR %	>80

Settlement Readings (mm)	
S(1)	0.174
S(2)	0.202
S(3)	0.174
S(m)	0.183



Notes

Report Prepared by:	Idris Shafqat	Date:	28.04.2021
Approved By:	Greg Jones	Date:	28.04.2021

Dynamic Plate Load Test Report

Remada

Test carried out according to BS-STB Part B 8.3

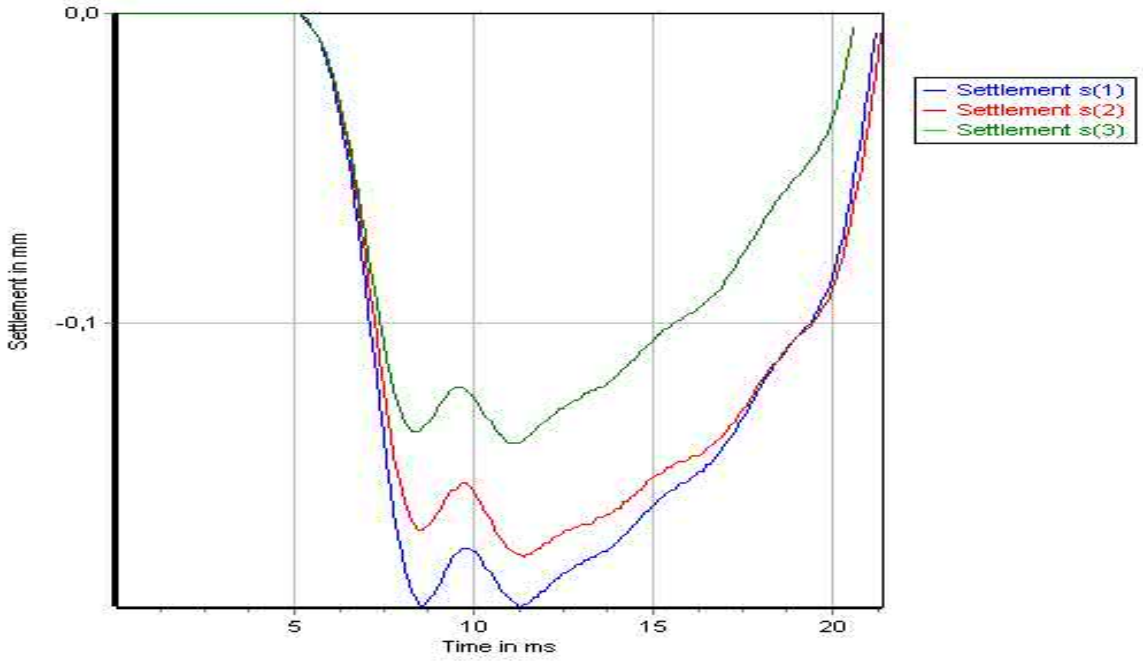
Client :	Lidl Great Britain Ltd
Job Name:	Halfway Garage
Job Number:	730.03
Site:	Mumbles Road, Swansea, SA3 5AT

Report Date:	28/04/2021
Device:	HMP LFG4

Test Location:	2
Test Layer:	Surface
Test Strata:	Crushed Concrete
Ground Condition	Dry
Weather:	Sunny, warm, blue skies

Results	
S/V (m)	1.98
EvD (MN/m2)=	133.14
Equivalent CBR %	>80

Settlement Readings (mm)	
S(1)	0.192
S(2)	0.176
S(3)	0.139
S(m)	0.169



Notes

Report Prepared by:	Idris Shafqat	Date:	28.04.2021
Approved By:	Greg Jones	Date:	28.04.2021

Dynamic Plate Load Test Report

Remada

Test carried out according to BS-STB Part B 8.3

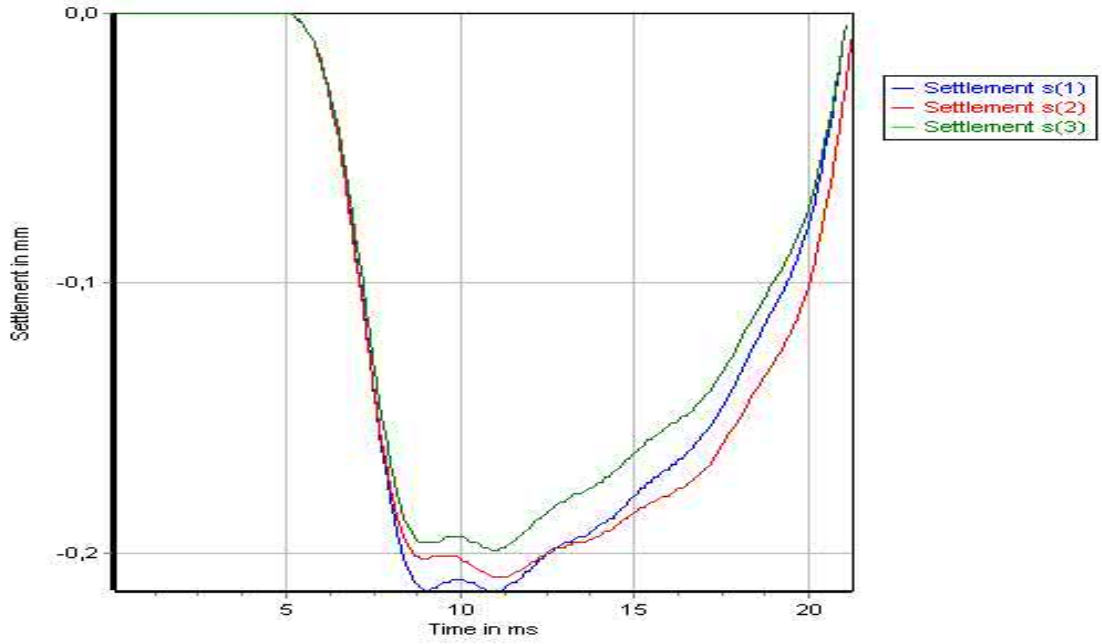
Client :	Lidl Great Britain Ltd
Job Name:	Halfway Garage
Job Number:	730.03
Site:	Mumbles Road, Swansea, SA3 5AT

Report Date:	28/04/2021
Device:	HMP LFG4

Test Location:	3
Test Layer:	Surface
Test Strata:	Crushed Concrete
Ground Condition	Dry
Weather:	Sunny, warm, blue skies

Results	
S/V (m)	2.16
EvD (MN/m2)=	108.17
Equivalent CBR %	>80

Settlement Readings (mm)	
S(1)	0.214
S(2)	0.210
S(3)	0.199
S(m)	0.208



Notes

Report Prepared by:	Idris Shafqat	Date:	28.04.2021
Approved By:	Greg Jones	Date:	28.04.2021

Dynamic Plate Load Test Report

Remada

Test carried out according to BS-STB Part B 8.3

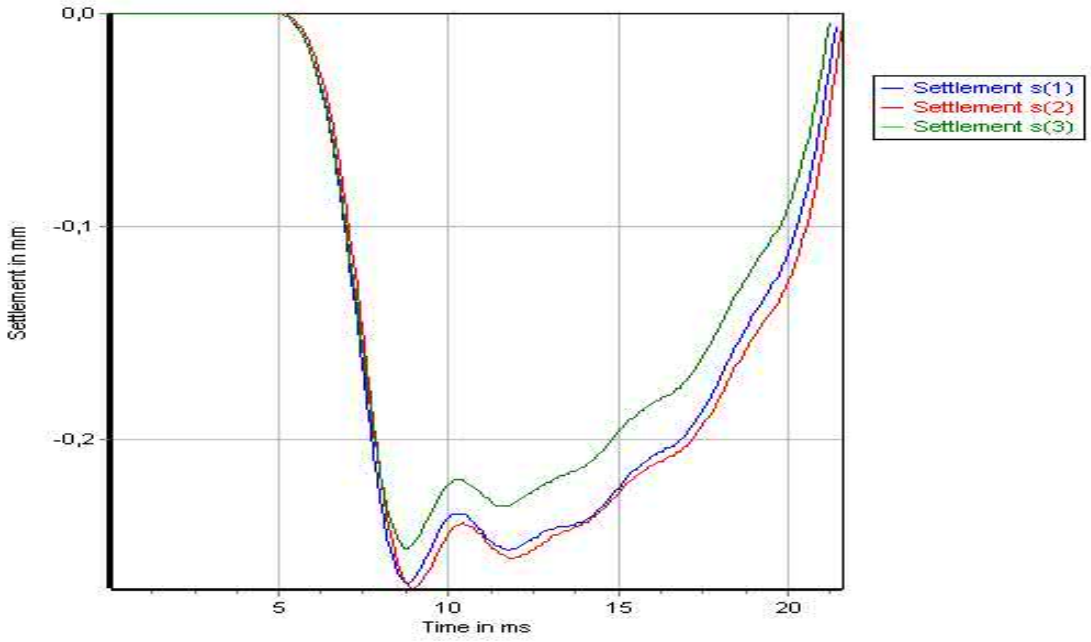
Client :	Lidl Great Britain Ltd
Job Name:	Halfway Garage
Job Number:	730.03
Site:	Mumbles Road, Swansea, SA3 5AT

Test Location:	4
Test Layer:	Surface
Test Strata:	Crushed Concrete
Ground Condition	Dry
Weather:	Sunny, warm, blue skies

Report Date:	28/04/2021
Device:	HMP LFG4

Results	
S/V (m)	2.05
EvD (MN/m2)=	85.55
Equivalent CBR %	60

Settlement Readings (mm)	
S(1)	0.268
S(2)	0.270
S(3)	0.251
S(m)	0.263



Notes

Report Prepared by:	Idris Shafqat	Date:	28.04.2021
Approved By:	Greg Jones	Date:	28.04.2021

APPENDIX D
Low Flow Testing Certificates

Low-Flow Test Report:

Test Date / Time: 5/25/2021 4:33:48 PM
Project: 730.02
Operator Name: Idris

Location Name: BH401 **Well Diameter: 5 cm** **Screen Length: 3.5 m** **Top of Screen: 4 m** **Total Depth: 7.5 m** **Initial Depth to Water: 1.5 m**	**Flow Cell Volume: 130 ml** **Final Draw Down: 0 m**	**Instrument Used: Aqua TROLL 500** **Serial Number: 714274**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth To Water
		+/- 0.1	+/- 0.5	+/- 3 %	+/- 0.3	+/- 10	+/- 10	+/- 5
5/25/2021 4:33 PM	00:00		12.35 °C	819.95 µS/cm	8.63 mg/L	2,246.9 NTU		150.00 cm
5/25/2021 4:34 PM	00:59		12.31 °C	1.22 µS/cm	6.90 mg/L	16.05 NTU		150.00 cm
5/25/2021 4:36 PM	02:48		12.65 °C	0.92 µS/cm	10.63 mg/L	17.61 NTU		150.00 cm
5/25/2021 4:37 PM	03:48		12.31 °C	740.12 µS/cm	0.68 mg/L	2,863.9 NTU		150.00 cm
5/25/2021 4:38 PM	04:48		12.36 °C	773.72 µS/cm	0.29 mg/L	3,390.0 NTU		150.00 cm
5/25/2021 4:39 PM	05:48		12.35 °C	822.39 µS/cm	0.21 mg/L	2,900.9 NTU		150.00 cm
5/25/2021 4:40 PM	06:48		12.40 °C	886.47 µS/cm	0.33 mg/L	3,417.6 NTU		150.00 cm
5/25/2021 4:41 PM	07:48		12.37 °C	940.64 µS/cm	0.27 mg/L	3,442.1 NTU		150.00 cm
5/25/2021 4:42 PM	08:48		12.42 °C	1,003.7 µS/cm	0.38 mg/L	3,956.5 NTU		150.00 cm
5/25/2021 4:43 PM	09:48		12.44 °C	1,040.7 µS/cm	0.48 mg/L	3,695.6 NTU		150.00 cm
5/25/2021 4:44 PM	10:48		12.45 °C	1,071.3 µS/cm	0.75 mg/L	3,378.4 NTU		150.00 cm
5/25/2021 4:45 PM	11:48		12.46 °C	1,096.0 µS/cm	0.96 mg/L	2,805.7 NTU		150.00 cm
5/25/2021 4:46 PM	12:48		12.46 °C	1,111.7 µS/cm	0.63 mg/L	2,266.6 NTU		150.00 cm
5/25/2021 4:47 PM	13:48		12.46 °C	1,132.9 µS/cm	0.55 mg/L	2,152.7 NTU		150.00 cm
5/25/2021 4:48 PM	14:48		12.46 °C	1,140.0 µS/cm	0.56 mg/L	1,899.3 NTU		150.00 cm
5/25/2021 4:49 PM	15:48		12.47 °C	1,156.6 µS/cm	0.58 mg/L	1,824.1 NTU		150.00 cm
5/25/2021 4:50 PM	16:48		12.48 °C	1,167.3 µS/cm	0.62 mg/L	1,384.7 NTU		150.00 cm

Samples

Sample ID:	Description:

Low-Flow Test Report:

Test Date / Time: 5/25/2021 5:05:12 PM
Project: Low-Flow Test 2
Operator Name: Idris

Location Name: BH402 **Well Diameter: 5 cm** **Screen Length: 4 m** **Top of Screen: 3 m** **Total Depth: 7 m** **Initial Depth to Water: 1.35 m**	**Flow Cell Volume: 130 ml** **Final Draw Down: 0 m**	**Instrument Used: Aqua TROLL 500** **Serial Number: 714274**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth To Water
		+/- 0.1	+/- 0.5	+/- 3 %	+/- 0.3	+/- 10	+/- 10	+/- 5
5/25/2021 5:05 PM	00:00		12.33 °C	3.56 µS/cm	5.99 mg/L	17.51 NTU		135.00 cm
5/25/2021 5:08 PM	02:49		12.30 °C	3.11 µS/cm	8.40 mg/L	16.14 NTU		135.00 cm
5/25/2021 5:09 PM	04:25		12.33 °C	2,727.6 µS/cm	8.17 mg/L	192.10 NTU		135.00 cm
5/25/2021 5:13 PM	08:37		12.32 °C	2,762.2 µS/cm	6.92 mg/L	74.72 NTU		135.00 cm
5/25/2021 5:14 PM	09:37	7.37 pH	12.21 °C	2,748.2 µS/cm	0.16 mg/L	59.71 NTU	-180.0 mV	135.00 cm
5/25/2021 5:15 PM	10:37	7.38 pH	12.22 °C	2,739.5 µS/cm	0.00 mg/L	45.40 NTU	-188.3 mV	135.00 cm
5/25/2021 5:16 PM	11:37	7.38 pH	12.22 °C	2,724.1 µS/cm	0.00 mg/L	38.59 NTU	-192.7 mV	135.00 cm
5/25/2021 5:17 PM	12:37	7.39 pH	12.23 °C	2,719.3 µS/cm	0.00 mg/L	32.40 NTU	-195.9 mV	135.00 cm
5/25/2021 5:18 PM	13:37	7.39 pH	12.23 °C	2,710.8 µS/cm	0.00 mg/L	26.23 NTU	-198.4 mV	135.00 cm
5/25/2021 5:19 PM	14:37	7.40 pH	12.23 °C	2,700.6 µS/cm	0.00 mg/L	22.39 NTU	-200.4 mV	135.00 cm
5/25/2021 5:20 PM	15:37	7.40 pH	12.24 °C	2,686.0 µS/cm	0.00 mg/L	21.33 NTU	-202.1 mV	135.00 cm

Samples

Sample ID:	Description:

Low-Flow Test Report:

Test Date / Time: 5/25/2021 5:34:58 PM
Project: Low-Flow Test 3
Operator Name: Idris

Location Name: BH403 **Well Diameter: 5 cm** **Screen Length: 3.5 m** **Top of Screen: 4 m** **Total Depth: 7.5 m** **Initial Depth to Water: 1.98 m**	**Flow Cell Volume: 130 ml** **Final Draw Down: 0 m**	**Instrument Used: Aqua TROLL 500** **Serial Number: 714274**

Test Notes:

Low-Flow Readings:

Date Time	Elapsed Time	pH	Temperature	Specific Conductivity	RDO Concentration	Turbidity	ORP	Depth To Water
		+/- 0.1	+/- 0.5	+/- 3 %	+/- 0.3	+/- 10	+/- 10	+/- 5
5/25/2021 5:34 PM	00:00		12.64 °C	1,231.9 µS/cm	4.36 mg/L	1,052.6 NTU		198.00 cm
5/25/2021 5:35 PM	01:00	7.41 pH	12.70 °C	1,234.6 µS/cm	0.17 mg/L	203.00 NTU	-169.6 mV	198.00 cm
5/25/2021 5:36 PM	02:00	7.44 pH	12.75 °C	1,236.7 µS/cm	0.01 mg/L	118.52 NTU	-179.4 mV	198.00 cm
5/25/2021 5:37 PM	03:00	7.45 pH	12.78 °C	1,229.5 µS/cm	0.00 mg/L	129.95 NTU	-185.4 mV	198.00 cm
5/25/2021 5:38 PM	04:00	7.45 pH	12.79 °C	1,223.3 µS/cm	0.00 mg/L	126.51 NTU	-189.7 mV	198.00 cm
5/25/2021 5:39 PM	05:00	7.46 pH	12.78 °C	1,219.7 µS/cm	0.00 mg/L	95.38 NTU	-193.1 mV	198.00 cm
5/25/2021 5:40 PM	06:00	7.46 pH	12.79 °C	1,217.5 µS/cm	0.00 mg/L	65.64 NTU	-195.8 mV	198.00 cm
5/25/2021 5:41 PM	07:00	7.46 pH	12.79 °C	1,216.7 µS/cm	0.00 mg/L	43.59 NTU	-198.2 mV	198.00 cm
5/25/2021 5:42 PM	08:00	7.46 pH	12.80 °C	1,215.4 µS/cm	0.00 mg/L	31.71 NTU	-200.1 mV	198.00 cm
5/25/2021 5:43 PM	09:00	7.46 pH	12.80 °C	1,215.2 µS/cm	0.00 mg/L	24.14 NTU	-201.7 mV	198.00 cm
5/25/2021 5:44 PM	10:00	7.46 pH	12.79 °C	1,214.5 µS/cm	0.00 mg/L	18.52 NTU	-203.1 mV	198.00 cm
5/25/2021 5:45 PM	11:00	7.47 pH	12.80 °C	1,213.8 µS/cm	0.00 mg/L	14.96 NTU	-204.4 mV	198.00 cm
5/25/2021 5:46 PM	12:00	7.47 pH	12.80 °C	1,213.7 µS/cm	0.00 mg/L	12.09 NTU	-205.6 mV	198.00 cm
5/25/2021 5:47 PM	13:00	7.47 pH	12.80 °C	1,213.7 µS/cm	0.00 mg/L	10.07 NTU	-206.7 mV	198.00 cm
5/25/2021 5:48 PM	14:00	7.47 pH	12.80 °C	1,212.8 µS/cm	0.00 mg/L	11.56 NTU	-207.6 mV	198.00 cm
5/25/2021 5:49 PM	15:00	7.47 pH	12.79 °C	1,214.9 µS/cm	0.00 mg/L	17.12 NTU	-207.8 mV	198.00 cm

Samples

Sample ID:	Description:

APPENDIX E
Laboratory Chemical Analyses - Soils

eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	21-14451-1
Initial Date of Issue:	10-May-2021
Client	Remada Ltd
Client Address:	Forward House 17 High Street Henley in Arden B95 5AA
Contact(s):	Greg Jones Peter Dickinson
Project	730.02 Mumbles
Quotation No.:	Q19-18614
Order No.:	730.02
No. of Samples:	11
Turnaround (Wkdays):	5
Date Approved:	10-May-2021
Approved By:	
Details:	Glynn Harvey, Technical Manager

Date Received:	30-Apr-2021
Date Instructed:	04-May-2021
Results Due:	10-May-2021

Results - Soil

Project: 730.02 Mumbles

Client: Remada Ltd			**Chemtest Job No.:**		21-14451	21-14451	21-14451	21-14451	21-14451	21-14451	21-14451	21-14451
Quotation No.: Q19-18614			**Chemtest Sample ID.:**		1192091	1192093	1192094	1192095	1192097	1192099	1192100	1192101
			Sample Location:		BH401	BH401	BH401	BH402	BH402	BH403	BH403	TP1
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.3	3	3.9	1.7	2.4	1.8	2	1
			Bottom Depth (m):		0.35	3.2	4	1.8	2.5	2.11	2.4	1.5
			Date Sampled:		27-Apr-2021	27-Apr-2021	27-Apr-2021	28-Apr-2021	28-Apr-2021	29-Apr-2021	29-Apr-2021	27-Apr-2021
			Asbestos Lab:		COVENTRY			COVENTRY		COVENTRY		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
ACM Type	U	2192		N/A	-			-		-		-
Asbestos Identification	U	2192		N/A	No Asbestos Detected			No Asbestos Detected		No Asbestos Detected		No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-			-		-		-
Moisture	N	2030	%	0.020	4.2	52	32	12	50	19	28	1.6
Chromatogram (TPH)	N			N/A	See Attached			See Attached		See Attached		See Attached
pH	U	2010		4.0	9.0	7.9	8.2	8.8	8.1	8.5	7.8	8.7
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	< 0.40			< 0.40		< 0.40		< 0.40
Magnesium (Water Soluble)	N	2120	g/l	0.010		< 0.010	< 0.010		0.015		< 0.010	
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010		0.15	< 0.010		0.18		< 0.010	
Total Sulphur	U	2175	%	0.010		1.6	0.23		2.1		0.12	
Chloride (Water Soluble)	U	2220	g/l	0.010		0.077	0.031		0.089		0.016	
Nitrate (Water Soluble)	N	2220	g/l	0.010		< 0.010	< 0.010		< 0.010		< 0.010	
Ammonium (Water Soluble)	U	2120	g/l	0.01		0.01	< 0.01		< 0.01		< 0.01	
Sulphate (Acid Soluble)	U	2430	%	0.010		0.16	0.045		0.15		0.071	
Arsenic	U	2450	mg/kg	1.0	21			25		31		32
Beryllium	U	2450	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Cadmium	U	2450	mg/kg	0.10	0.27			0.41		2.0		0.38
Copper	U	2450	mg/kg	0.50	2.3			27		71		6.2
Mercury	U	2450	mg/kg	0.10	< 0.10			< 0.10		0.33		< 0.10
Nickel	U	2450	mg/kg	0.50	1.5			7.8		15		2.2
Lead	U	2450	mg/kg	0.50	3.5			69		110		7.6
Selenium	U	2450	mg/kg	0.20	< 0.20			< 0.20		< 0.20		< 0.20
Vanadium	U	2450	mg/kg	5.0	< 5.0			< 5.0		7.7		< 5.0
Zinc	U	2450	mg/kg	0.50	5.6			51		230		6.4
Chromium (Trivalent)	N	2490	mg/kg	1.0	5.0			7.1		11		6.1
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50			< 0.50		< 0.50		< 0.50
Fraction of Organic Carbon	U	2625		0.0010	0.0025			0.049		0.051		0.022
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0			< 1.0		18		< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0			14		100		< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0			25		1500		< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0			< 1.0		560		< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0			39		2200		< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0

Results - Soil

Project: 730.02 Mumbles

Client: Remada Ltd			**Chemtest Job No.:**		21-14451	21-14451	21-14451	21-14451	21-14451	21-14451	21-14451	21-14451
Quotation No.: Q19-18614			**Chemtest Sample ID.:**		1192091	1192093	1192094	1192095	1192097	1192099	1192100	1192101
			Sample Location:		BH401	BH401	BH401	BH402	BH402	BH403	BH403	TP1
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.3	3	3.9	1.7	2.4	1.8	2	1
			Bottom Depth (m):		0.35	3.2	4	1.8	2.5	2.11	2.4	1.5
			Date Sampled:		27-Apr-2021	27-Apr-2021	27-Apr-2021	28-Apr-2021	28-Apr-2021	29-Apr-2021	29-Apr-2021	27-Apr-2021
			Asbestos Lab:		COVENTRY			COVENTRY		COVENTRY		COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0			< 1.0		3.5		< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0			< 1.0		11		< 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0			21		940		< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0			< 1.0		200		< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0			21		1200		< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10			60		3400		< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10			< 0.10		0.76		< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10			< 0.10		0.40		< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10			< 0.10		0.54		< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10			< 0.10		0.80		< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10			< 0.10		4.7		< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10			< 0.10		0.85		< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10			0.46		5.4		< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10			0.68		6.4		< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10			< 0.10		9.3		< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10			< 0.10		5.8		< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0			< 2.0		35		< 2.0
Benzene	U	2760	µg/kg	1.0	< 1.0			< 1.0		2.6		< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0			< 1.0		2.8		< 1.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0			< 1.0		< 1.0		< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0			< 1.0		8.8		< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0			< 1.0		3.1		< 1.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10			< 0.10		< 0.10		< 0.10

Results - Soil

Project: 730.02 Mumbles

Client: Remada Ltd			**Chemtest Job No.:**		21-14451	21-14451	21-14451
Quotation No.: Q19-18614			**Chemtest Sample ID.:**		1192105	1192109	1192110
			Sample Location:		TP2	SA1	SA2
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		1.5	1	1
			Bottom Depth (m):		2.5	1.5	1.6
			Date Sampled:		27-Apr-2021	27-Apr-2021	27-Apr-2021
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
ACM Type	U	2192		N/A	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-	-
Moisture	N	2030	%	0.020	22	5.2	5.0
Chromatogram (TPH)	N			N/A	See Attached	See Attached	See Attached
pH	U	2010		4.0	8.5	8.9	9.4
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	0.41	< 0.40	< 0.40
Magnesium (Water Soluble)	N	2120	g/l	0.010			
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010			
Total Sulphur	U	2175	%	0.010			
Chloride (Water Soluble)	U	2220	g/l	0.010			
Nitrate (Water Soluble)	N	2220	g/l	0.010			
Ammonium (Water Soluble)	U	2120	g/l	0.01			
Sulphate (Acid Soluble)	U	2430	%	0.010			
Arsenic	U	2450	mg/kg	1.0	53	27	28
Beryllium	U	2450	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Cadmium	U	2450	mg/kg	0.10	1.2	0.44	0.42
Copper	U	2450	mg/kg	0.50	160	10	18
Mercury	U	2450	mg/kg	0.10	1.7	< 0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	22	4.5	12
Lead	U	2450	mg/kg	0.50	480	33	120
Selenium	U	2450	mg/kg	0.20	0.68	< 0.20	< 0.20
Vanadium	U	2450	mg/kg	5.0	14	< 5.0	6.1
Zinc	U	2450	mg/kg	0.50	480	27	66
Chromium (Trivalent)	N	2490	mg/kg	1.0	12	7.1	8.7
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Fraction of Organic Carbon	U	2625		0.0010	0.075	0.014	0.0069
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	260	< 1.0	3.1
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	260	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0

Results - Soil

Project: 730.02 Mumbles

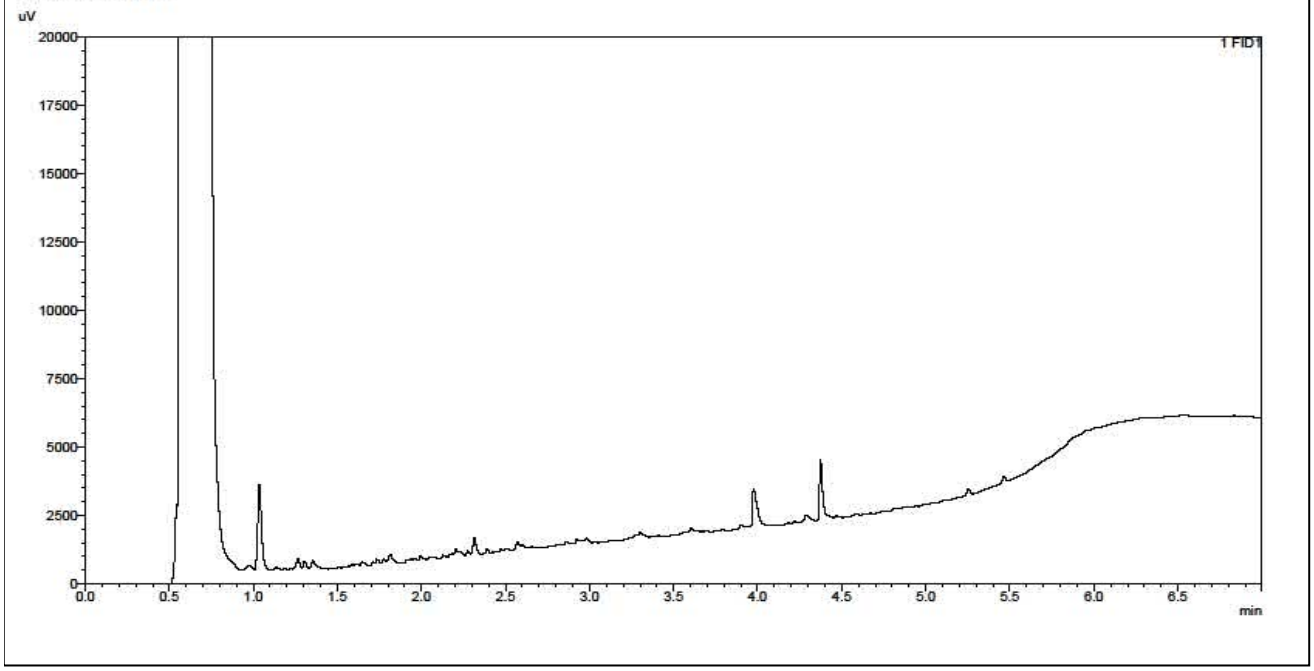
Client: Remada Ltd			**Chemtest Job No.:**		21-14451	21-14451	21-14451
Quotation No.: Q19-18614			**Chemtest Sample ID.:**		1192105	1192109	1192110
			Sample Location:		TP2	SA1	SA2
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		1.5	1	1
			Bottom Depth (m):		2.5	1.5	1.6
			Date Sampled:		27-Apr-2021	27-Apr-2021	27-Apr-2021
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	4.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	50	< 1.0	7.6
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	590	< 1.0	47
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	650	< 5.0	54
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	910	< 10	58
Naphthalene	U	2700	mg/kg	0.10	0.98	< 0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	1.2	< 0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	0.78	< 0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	1.0	< 0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	5.8	1.6	1.2
Anthracene	U	2700	mg/kg	0.10	1.5	0.48	0.30
Fluoranthene	U	2700	mg/kg	0.10	9.1	4.2	2.3
Pyrene	U	2700	mg/kg	0.10	8.3	4.2	2.4
Benzo[a]anthracene	U	2700	mg/kg	0.10	4.6	2.7	1.2
Chrysene	U	2700	mg/kg	0.10	4.1	2.3	0.84
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	6.4	3.6	1.8
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	2.0	1.2	0.62
Benzo[a]pyrene	U	2700	mg/kg	0.10	4.6	2.4	1.1
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	4.9	< 0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	1.1	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	6.4	< 0.10	< 0.10
Total Of 16 PAH's	U	2700	mg/kg	2.0	63	23	12
Benzene	U	2760	µg/kg	1.0	11	< 1.0	1.2
Toluene	U	2760	µg/kg	1.0	56	< 1.0	2.2
Ethylbenzene	U	2760	µg/kg	1.0	24	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	110	< 1.0	2.7
o-Xylene	U	2760	µg/kg	1.0	70	< 1.0	< 1.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10

TPH Chromatogram on Soil Sample: 1192091

<Sample Information>

Sample Name : 1192091 21-14451
Data Filename : 05 May 2021_05052021_1192091 21-14451_109.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 55
Date Acquired : 06/05/2021 04:11:58
Date Processed : 06/05/2021

<Chromatogram>

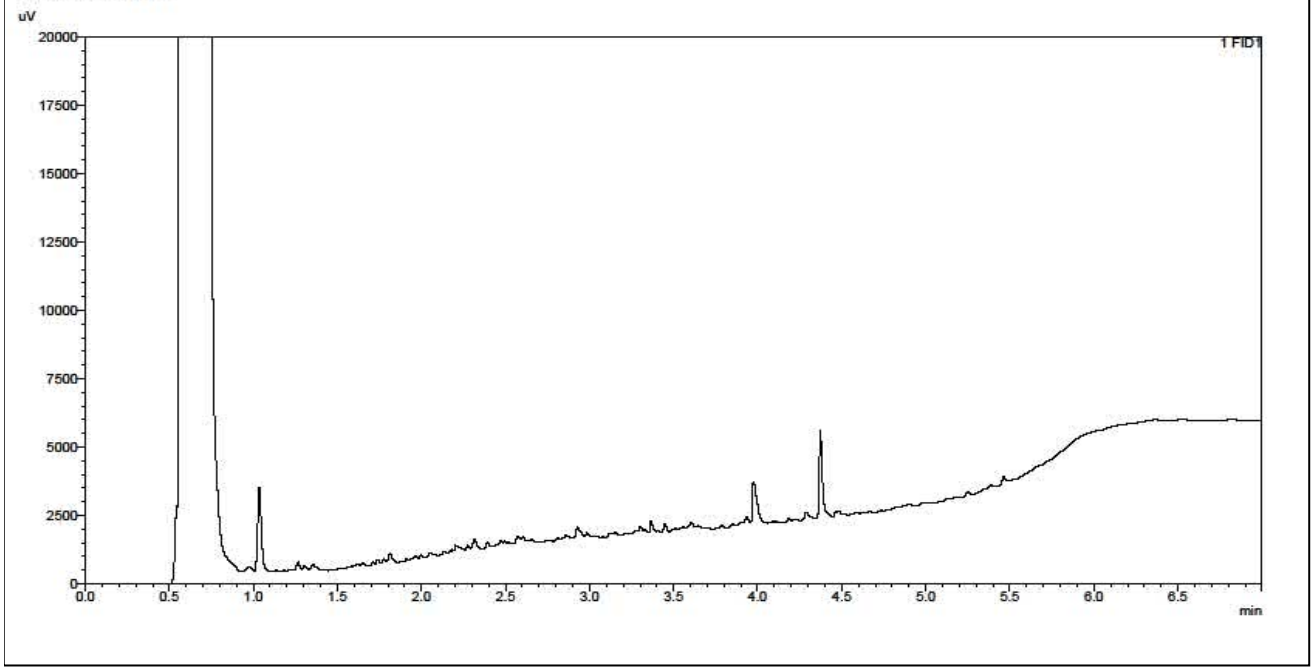


TPH Chromatogram on Soil Sample: 1192095

<Sample Information>

Sample Name : 1192095 21-14451
Data Filename : 05 May 2021_05052021_1192095 21-14451_111.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 56
Date Acquired : 06/05/2021 04:24:31
Date Processed : 06/05/2021

<Chromatogram>

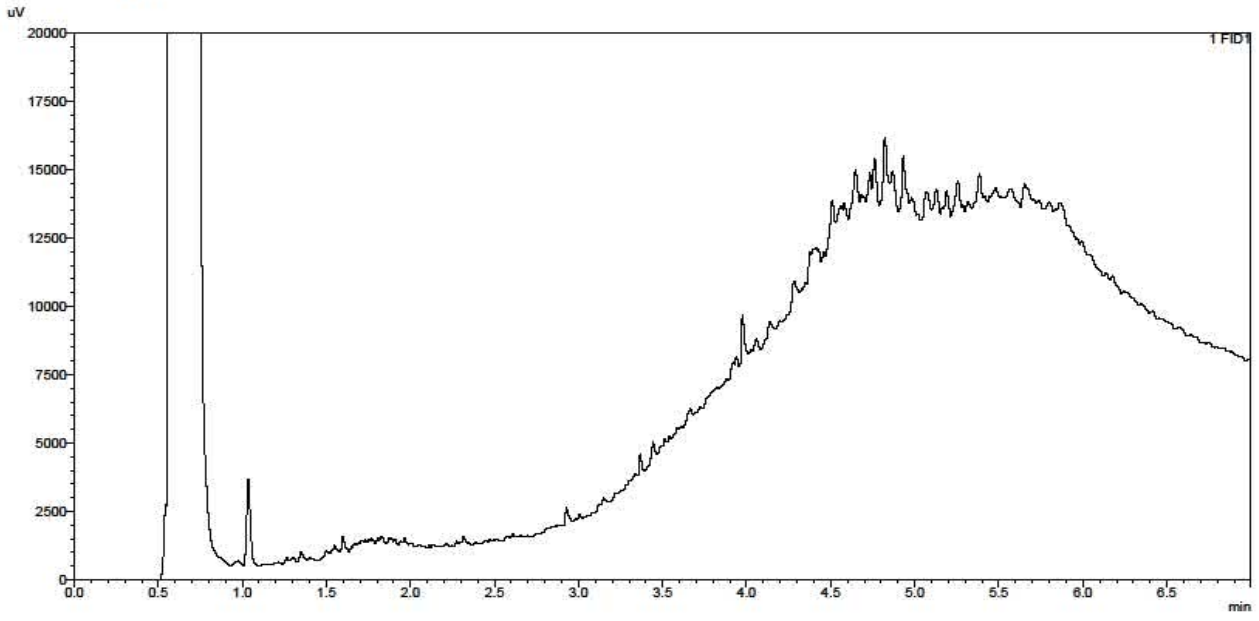


TPH Chromatogram on Soil Sample: 1192099

<Sample Information>

Sample Name : 1192099 21-14451
Data Filename : 05 May 2021_05052021_1192099 21-14451_113.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 57
Date Acquired : 06/05/2021 04:37:12
Date Processed : 06/05/2021

<Chromatogram>

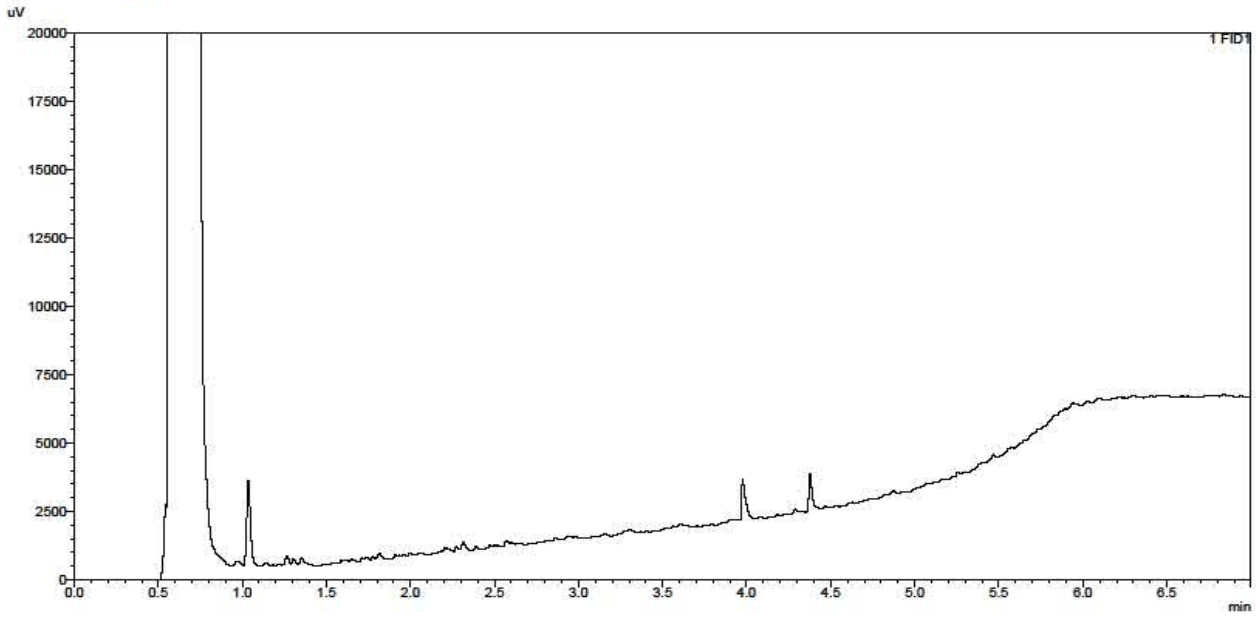


TPH Chromatogram on Soil Sample: 1192101

<Sample Information>

Sample Name : 1192101 21-14451
Data Filename : 05 May 2021_05052021_1192101 21-14451_115.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 58
Date Acquired : 06/05/2021 04:49:55
Date Processed : 06/05/2021

<Chromatogram>

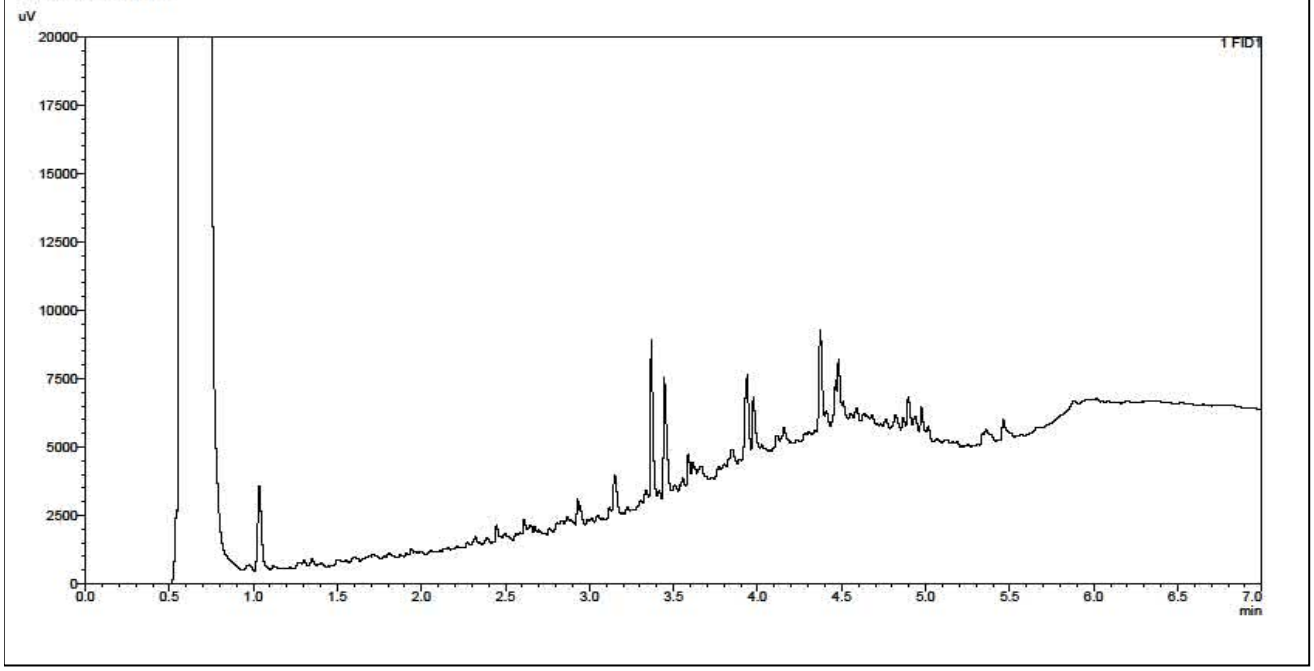


TPH Chromatogram on Soil Sample: 1192105

<Sample Information>

Sample Name : 1192105 21-14451
Data Filename : 05 May 2021_05052021_1192105 21-14451_117.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 59
Date Acquired : 06/05/2021 05:02:26
Date Processed : 06/05/2021

<Chromatogram>

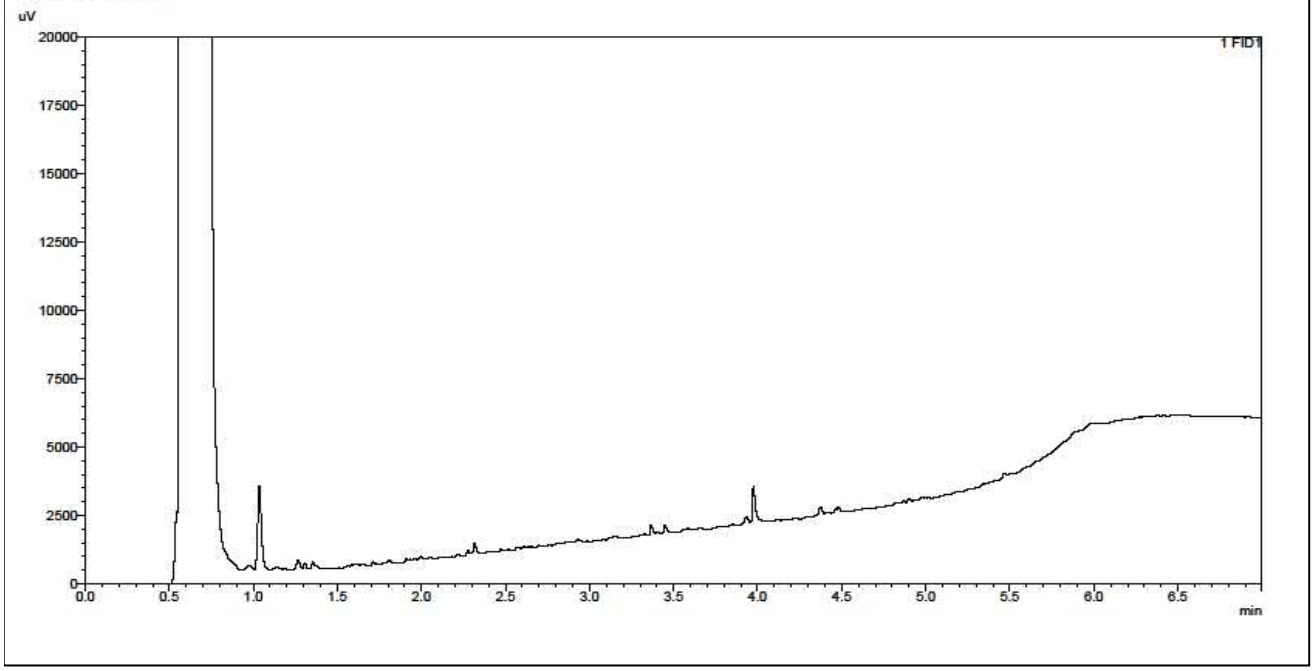


TPH Chromatogram on Soil Sample: 1192109

<Sample Information>

Sample Name : 1192109 21-14451
Data Filename : 05 May 2021_05052021_1192109 21-14451_119.gcd
Method Filename : TPH 12m Fast OSv2.gcm
Sample # : 60
Date Acquired : 06/05/2021 05:14:50
Date Processed : 06/05/2021

<Chromatogram>



TPH Chromatogram on Soil Sample: 1192110

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measurememrnt by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX F
Laboratory Chemical Analyses - Groundwater

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	21-18404-1		
Initial Date of Issue:	07-Jun-2021		
Client	Remada Ltd		
Client Address:	Forward House 17 High Street Henley in Arden B95 5AA		
Contact(s):	Greg Jones Peter Dickinson		
Project	730.03 Former Halfway Garage, Mumbles		
Quotation No.:	Q19-18614	**Date Received:**	27-May-2021
Order No.:	730.03	**Date Instructed:**	01-Jun-2021
No. of Samples:	3		
Turnaround (Wkdays):	5	**Results Due:**	07-Jun-2021
Date Approved:	07-Jun-2021		

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Water

Project: 730.03 Former Halfway Garage, Mumbles

Client: Remada Ltd			**Chemtest Job No.:**		21-18404	21-18404	21-18404
Quotation No.: Q19-18614			**Chemtest Sample ID.:**		1211805	1211806	1211807
			Sample Location:		BH401	BH402	BH403
			Sample Type:		WATER	WATER	WATER
			Date Sampled:		25-May-2021	25-May-2021	25-May-2021
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
pH	U	1010		N/A	8.3	8.3	8.3
Arsenic (Dissolved)	U	1455	µg/l	0.20	2.0	3.3	3.0
Boron (Dissolved)	U	1455	µg/l	10.0	320	310	180
Beryllium (Dissolved)	U	1455	µg/l	1.00	< 1.0	< 1.0	< 1.0
Cadmium (Dissolved)	U	1455	µg/l	0.11	< 0.11	< 0.11	< 0.11
Copper (Dissolved)	U	1455	µg/l	0.50	0.51	< 0.50	< 0.50
Mercury (Dissolved)	U	1455	µg/l	0.05	< 0.05	< 0.05	< 0.05
Nickel (Dissolved)	U	1455	µg/l	0.50	< 0.50	0.64	< 0.50
Lead (Dissolved)	U	1455	µg/l	0.50	< 0.50	< 0.50	< 0.50
Selenium (Dissolved)	U	1455	µg/l	0.50	< 0.50	< 0.50	< 0.50
Vanadium (Dissolved)	U	1455	µg/l	0.50	< 0.50	< 0.50	< 0.50
Zinc (Dissolved)	U	1455	µg/l	2.5	< 2.5	< 2.5	< 2.5
Chromium (Trivalent)	N	1490	µg/l	20	[B] < 20	[B] < 20	[B] < 20
Chromium (Hexavalent)	U	1490	µg/l	20	[B] < 20	[B] < 20	[B] < 20
Dissolved Organic Carbon	U	1610	mg/l	2.0	7.6	4.8	3.3
Aliphatic TPH >C5-C6	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C6-C8	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C8-C10	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C10-C12	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C12-C16	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C16-C21	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C21-C35	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aliphatic TPH >C35-C44	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Aliphatic Hydrocarbons	N	1675	µg/l	5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C7-C8	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C8-C10	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C10-C12	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C12-C16	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C16-C21	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C21-C35	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Aromatic TPH >C35-C44	N	1675	µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Aromatic Hydrocarbons	N	1675	µg/l	5.0	< 5.0	< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	1675	µg/l	10	< 10	< 10	< 10
Naphthalene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10

Results - Water

Project: 730.03 Former Halfway Garage, Mumbles

Client: Remada Ltd			**Chemtest Job No.:**		21-18404	21-18404	21-18404
Quotation No.: Q19-18614			**Chemtest Sample ID.:**		1211805	1211806	1211807
			Sample Location:		BH401	BH402	BH403
			Sample Type:		WATER	WATER	WATER
			Date Sampled:		25-May-2021	25-May-2021	25-May-2021
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Pyrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Chrysene	N	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	N	1700	µg/l	2.0	< 2.0	< 2.0	< 2.0
Phenol	U	1920	mg/l	0.0050	< 0.0050	< 0.0050	< 0.0050

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
1211805			BH401	25-May-2021	B	Coloured Winchester 1000ml
1211805			BH401	25-May-2021	B	EPA Vial 40ml
1211806			BH402	25-May-2021	B	Coloured Winchester 1000ml
1211806			BH402	25-May-2021	B	EPA Vial 40ml
1211807			BH403	25-May-2021	B	Coloured Winchester 1000ml
1211807			BH403	25-May-2021	B	EPA Vial 40ml

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1490	Hexavalent Chromium in Waters	Chromium [VI]	Automated colorimetric analysis by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1675	TPH Aliphatic/Aromatic split in Waters by GC-FID(cf. Texas Method 1006 / TPH CWG)	Aliphatics: >C5–C6, >C6–C8, >C8– C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Pentane extraction / GCxGC FID detection
1700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Waters by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX G
Laboratory Geotechnical Tests

Laboratory Report

2788

GEO Site & Testing Services Ltd

Contract Number: 53774

Client Ref: **730.20**
Client PO:

Report Date: **20-05-2021**

Client **Remada Limited**
Forward house, 17 high street, Henley in Arden
B95 5AA

Contract Title: **Mumbles, Swansea**
For the attention of: **Dom Williams**

Date Received: **04-05-2021**
Date Completed: **20-05-2021**

Test Description	Qty
Samples Received - @ Non Accredited Test	4
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	4
4 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.3 & 5.3 - * UKAS	4
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	4
Quick Undrained Triaxial Compression Test - Multi-stage Loading of a single specimen (100mm diameter) BS 1377:1990 - Part 7 : 9 - * UKAS	2
Samples Received - @ Non Accredited Test	10
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Emma Sharp (Office Manager) - Paul Evans (Director) - Richard John (Quality/Technical Manager)
Shaun Jones (Laboratory manager) - Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	53774	
Site Name	Mumbles, Swansea	
Date Tested	14/05/2021	
	DESCRIPTIONS	

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
BH401		D	4.00	-	5.00	Greyish brown silty CLAY.
BH402		D	2.70	-		Greyish brown silty CLAY.
BH403		D	2.70	-		Brown fine to medium gravelly silty CLAY.
BH403		D	1.50	-		Greyish brown clayey SILT.
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		

Operators	Checked	20/05/2021	Richard John (Advanced Testing Manager)
Clayton Jenkins	Approved	20/05/2021	Paul Evans (Quality/Technical Manager)

UKAS TESTING
2788

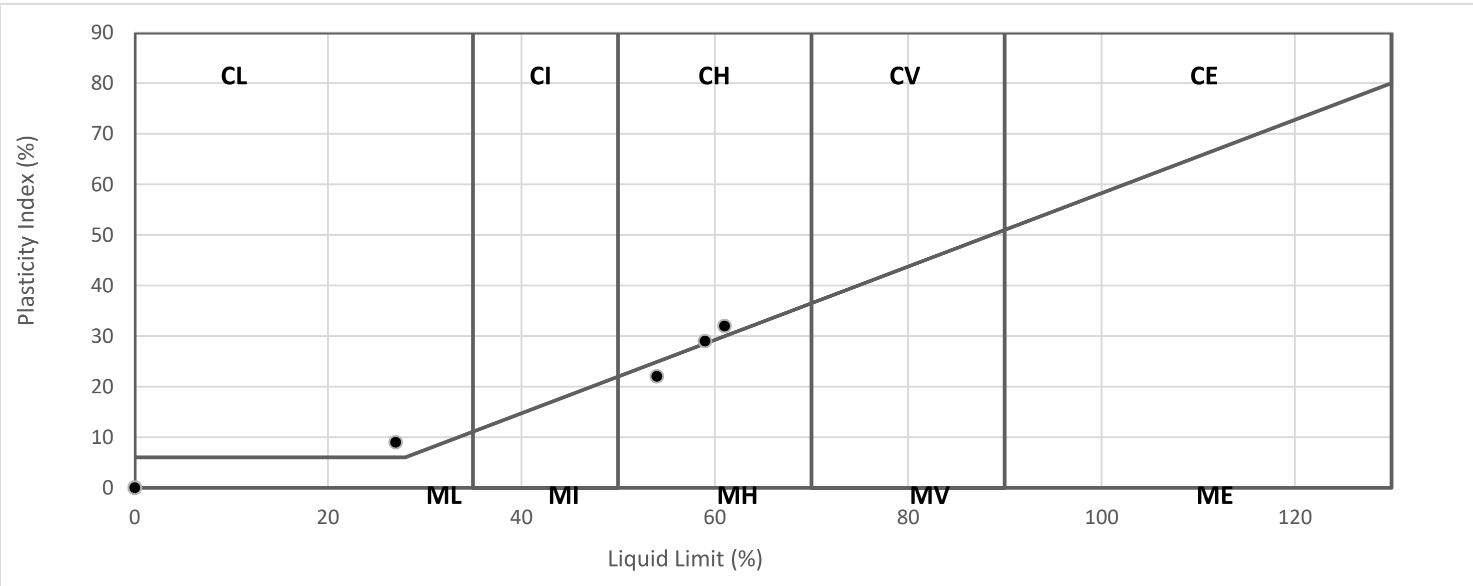
NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
(BS 1377 : Part 2 : 1990 Method 5)

Contract Number	53774
Project Location	Mumbles, Swansea
Date Tested	14/05/2021

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing 0.425mm %	Remarks
BH401		D	4.00	-	5.00	56	59	30	29	100	CH High Plasticity
BH402		D	2.70	-		43	61	29	32	100	CH High Plasticity
BH403		D	2.70	-		12	27	18	9	80	CL Low Plasticity
BH403		D	1.50	-		46	54	32	22	100	MH High Plasticity
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

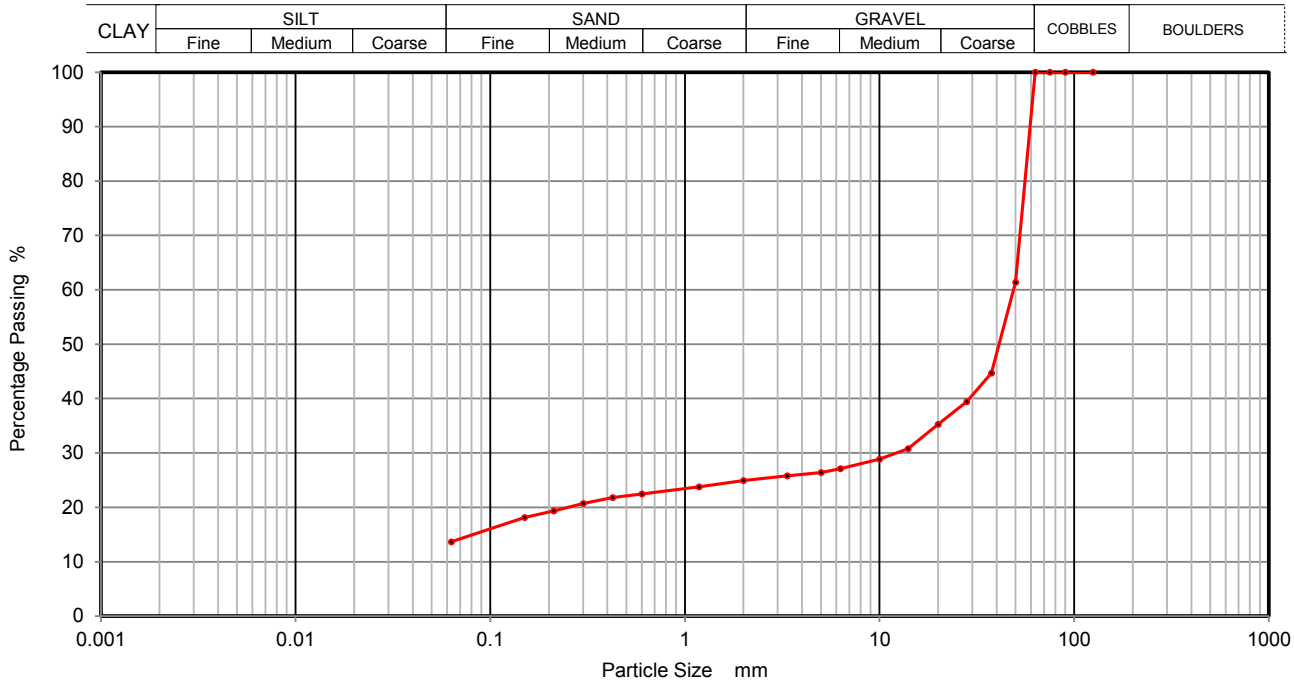
PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	20/05/2021	Richard John (Advanced Testing Manager)
Clayton Jenkins	Approved	20/05/2021	Paul Evans (Quality/Technical Manager)

UKAS TESTING 2788

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve, Clause 9.2	Contract Number	53774
		Borehole/Pit No.	BH401
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Greyish brown fine to medium sandy silty clayey fine to coarse GRAVEL.	Depth Top	6.10
		Depth Base	7.50
Date Tested	18/05/2021	Sample Type	D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	61		
37.5	45		
28	39		
20	35		
14	31		
10	29		
6.3	27		
5	26		
3.35	26		
2	25		
1.18	24		
0.6	22		
0.425	22		
0.3	21		
0.212	19		
0.15	18		
0.063	14		

Sample Proportions	% dry mass
Cobbles	0
Gravel	75
Sand	11
Silt and Clay	14

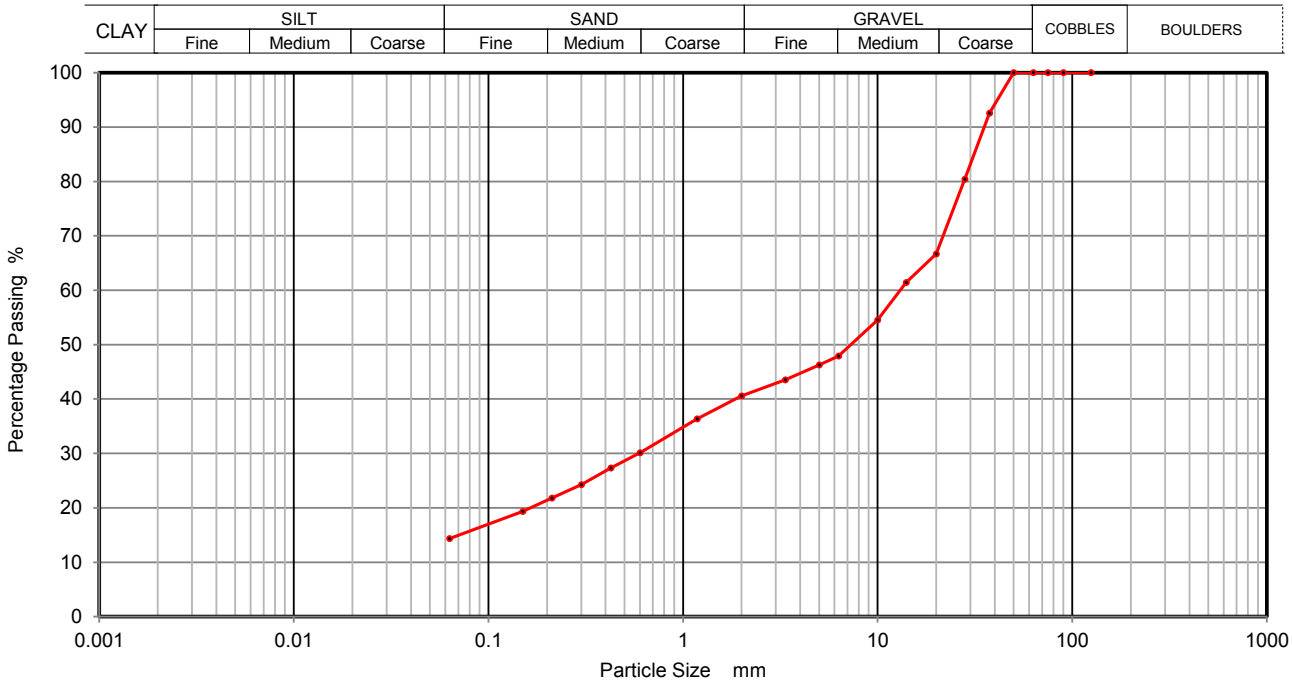
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	22/06/2021	Richard John	
David	Approved	23/06/2021	Paul Evans	

UKAS TESTING
2788

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve, Clause 9.2	Contract Number	53774
		Borehole/Pit No.	BH402
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Greyish brown silty clayey fine to coarse sandy GRAVEL.	Depth Top	0.00
		Depth Base	1.00
Date Tested	18/05/2021	Sample Type	D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	93		
28	80		
20	67		
14	61		
10	55		
6.3	48		
5	46		
3.35	44		
2	41		
1.18	36		
0.6	30		
0.425	27		
0.3	24		
0.212	22		
0.15	19		
0.063	14		

Sample Proportions	% dry mass
Cobbles	0
Gravel	59
Sand	27
Silt and Clay	14

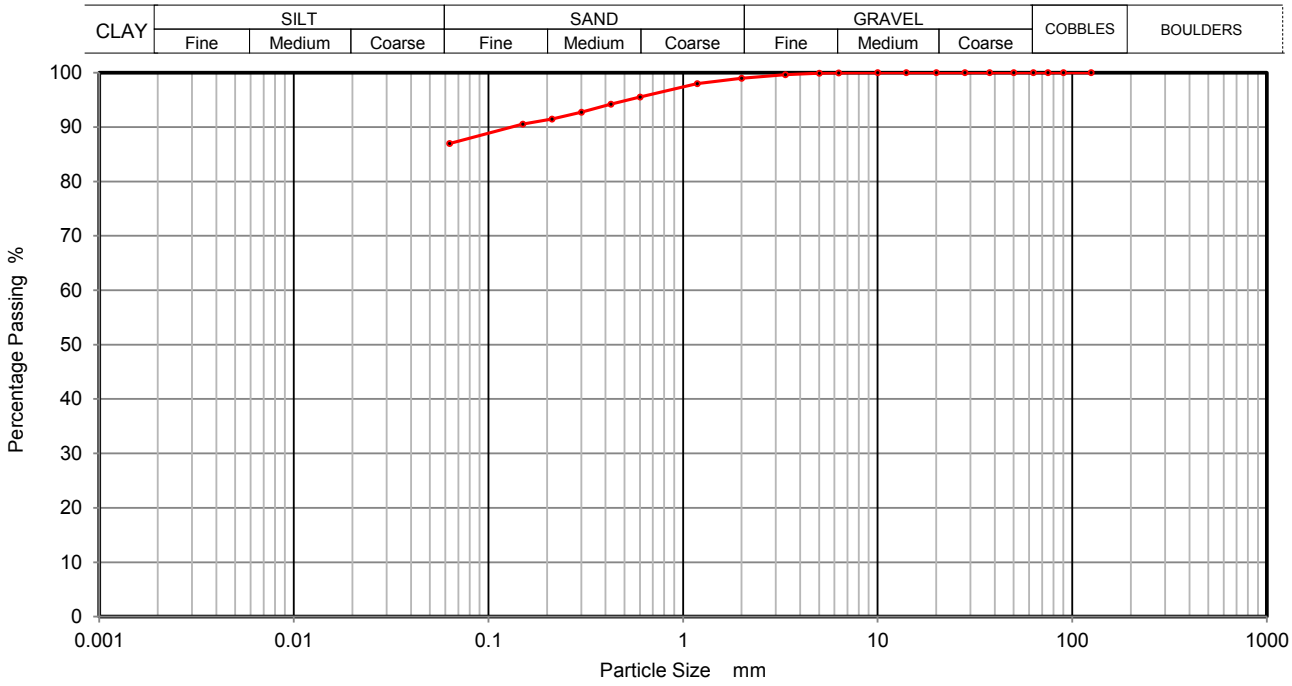
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	19/05/2021	Richard John	
David	Approved	20/05/2021	Paul Evans	D P Evans

UKAS TESTING
2788

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve, Clause 9.2	Contract Number	53774
		Borehole/Pit No.	BH402
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Greyish brown fine slightly gravelly fine to medium sandy silty CLAY.	Depth Top	4.00
		Depth Base	5.00
Date Tested	18/05/2021	Sample Type	D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	99		
1.18	98		
0.6	96		
0.425	94		
0.3	93		
0.212	91		
0.15	91		
0.063	87		

Sample Proportions	% dry mass
Cobbles	0
Gravel	1
Sand	12
Silt and Clay	87

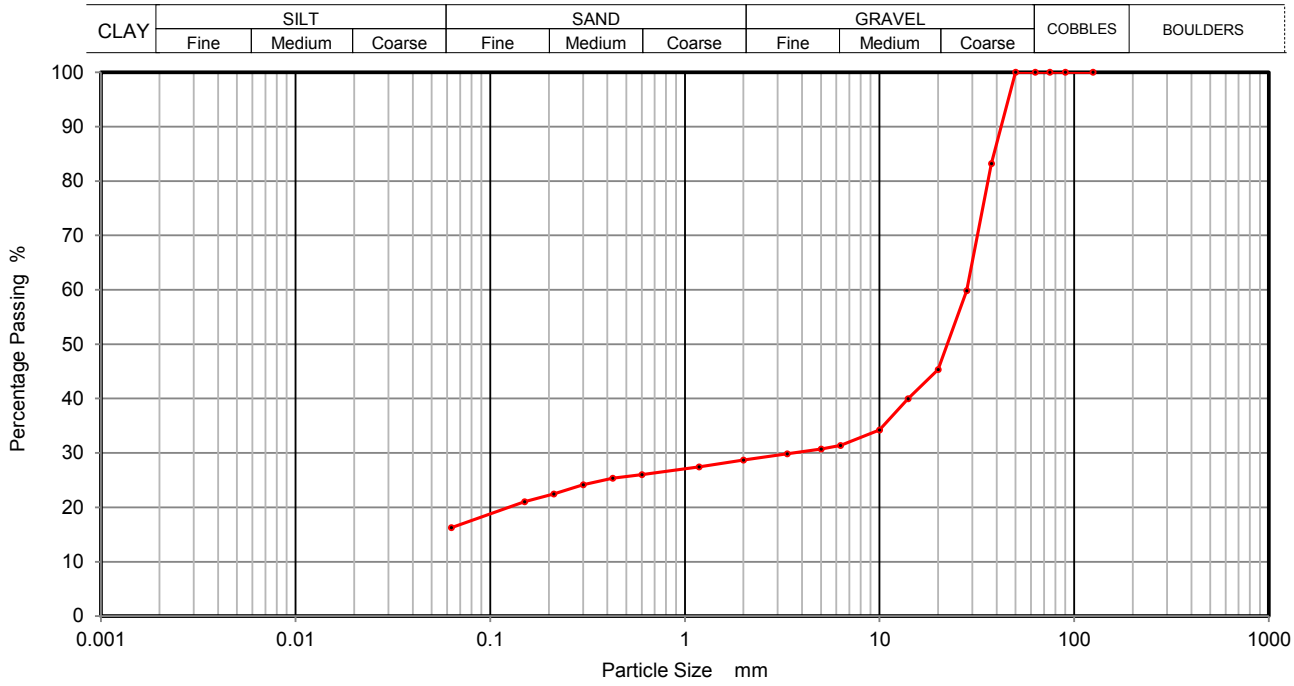
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	19/05/2021	Richard John	
David	Approved	20/05/2021	Paul Evans	

UKAS TESTING
2788

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve, Clause 9.2	Contract Number	53774
		Borehole/Pit No.	BH403
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Greyish brown fine to medium sandy silty clayey fine to coarse GRAVEL.	Depth Top	5.00
		Depth Base	5.50
Date Tested	18/05/2021	Sample Type	D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	83		
28	60		
20	45		
14	40		
10	34		
6.3	31		
5	31		
3.35	30		
2	29		
1.18	27		
0.6	26		
0.425	25		
0.3	24		
0.212	22		
0.15	21		
0.063	16		

Sample Proportions	% dry mass
Cobbles	0
Gravel	71
Sand	13
Silt and Clay	16

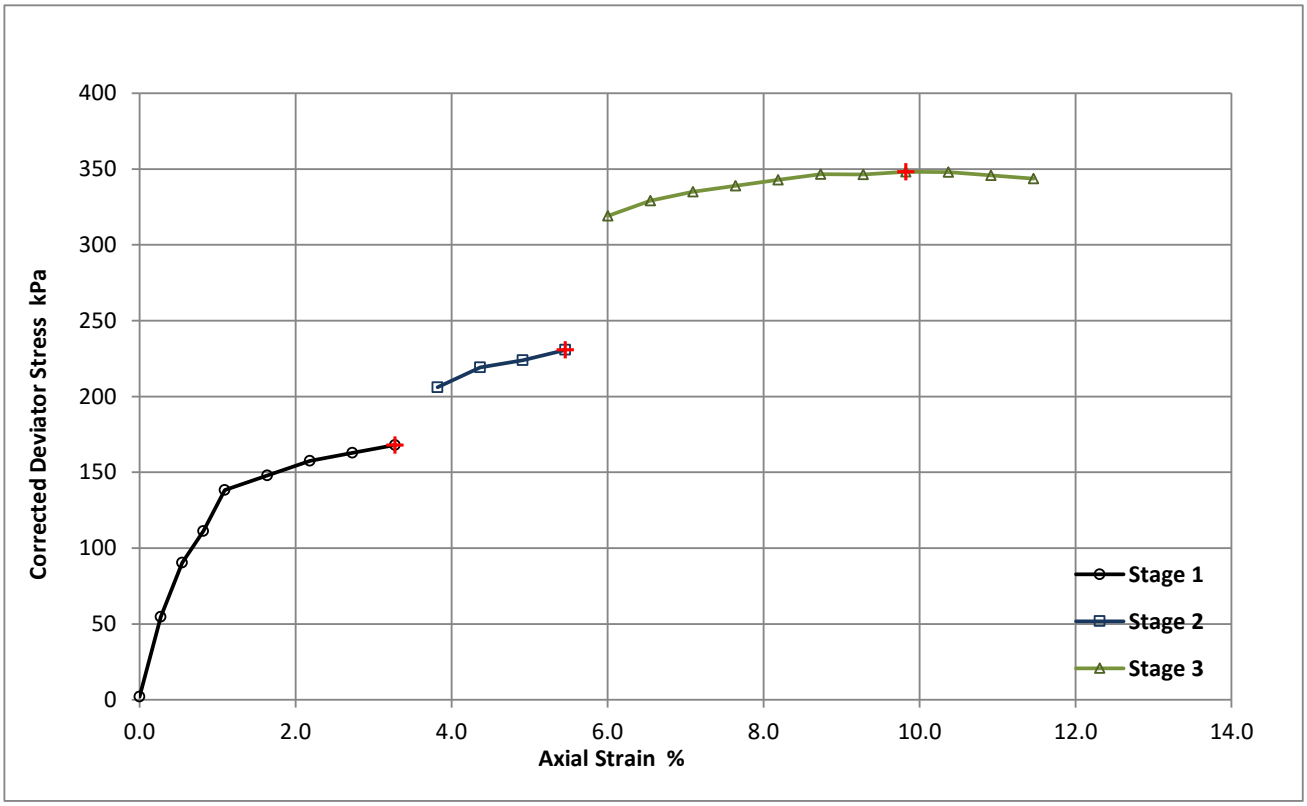
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	23/06/2021	Richard John	
David	Approved	24/06/2021	Paul Evans	

UKAS TESTING
2788

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	53774
		Borehole/Pit No.	BH403
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Greyish brown fine gravelly silty CLAY.	Depth Top	4.00
		Depth Base	4.45
Date Tested	12/05/2021	Sample Type	U
		Technician	Daniel



Moisture Content (%)	41		
Bulk Density (Mg/m^3)	1.76		
Dry Density (Mg/m^3)	1.24		
Specimen Length (mm)	183.2		
Specimen Diamteter (mm)	105		
Cell Pressures (kPa)	80	160	320
Deviator Stress (kPa)	168	231	348
Undrained Shear Strength (kPa)	84	115	174
Failure Strain (%)	3.3	5.5	9.8
Mode Of Failure	Plastic		
Membrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

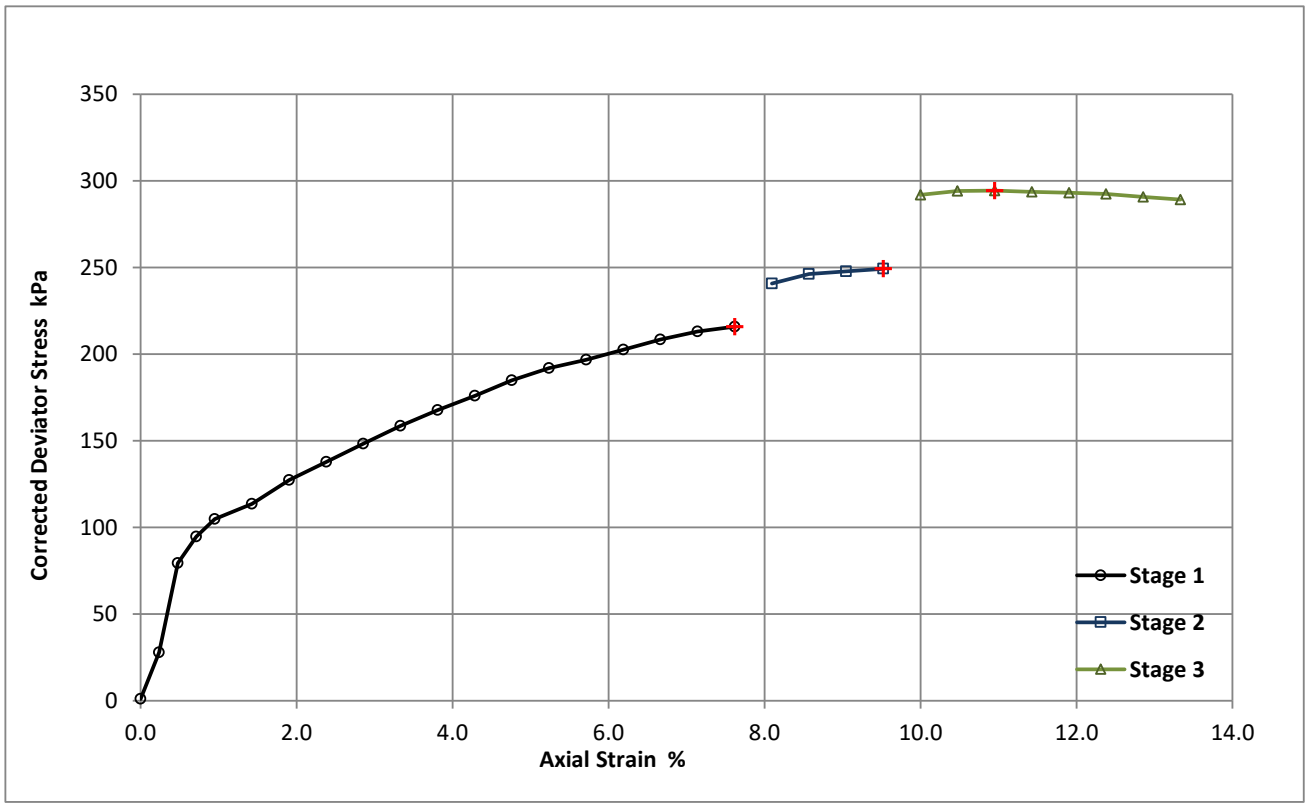
Specimen Post Test

Sample Split

Checked	19/05/2021	Richard John	
Approved	20/05/2021	Paul Evans	

UKAS TESTING
2788

GSTL	Multi Stage Unconsolidated-Undrained Triaxial Test BS 1377 : 1990 Part 7 : 9	Contract Number	53774
		Borehole/Pit No.	BH401
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Greyish brown fine gravelly silty CLAY.	Depth Top	4.00
		Depth Base	4.45
Date Tested	12/05/2021	Sample Type	U
		Technician	Daniel



Moisture Content (%)	46		
Bulk Density (Mg/m^3)	0.84		
Dry Density (Mg/m^3)	0.58		
Specimen Length (mm)	210		
Specimen Diamteter (mm)	150		
Cell Pressures (kPa)	80	160	320
Deviator Stress (kPa)	216	249	294
Undrained Shear Strength (kPa)	108	125	147
Failure Strain (%)	7.6	9.5	11
Mode Of Failure	Plastic		
Membrane Used/Thickness	Rubber/0.3mm		
Rate of Strain (%/min)	3.00		

Specimen Post Test

Sample Split

Checked	19/05/2021	Richard John	
Approved	20/05/2021	Paul Evans	

UKAS TESTING
2788

Laboratory Report

2788

GEO Site & Testing Services Ltd

Contract Number: 54099

Client Ref: **730.20**
Client PO:

Report Date: **28-05-2021**

Client **Remada Limited**
Forward house, 17 high street, Henley in Arden
B95 5AA

Contract Title: **Mumbles, Swansea**
For the attention of: **Dom Williams**

Date Received: **21-05-2021**
Date Completed: **28-05-2021**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	1
4 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.3 & 5.3 - * UKAS	1
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Emma Sharp (Office Manager) - Paul Evans (Director) - Richard John (Quality/Technical Manager)
Shaun Jones (Laboratory manager) - Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	54099	
Site Name	Mumbles, Swansea	
Date Tested	27/05/2021	
	DESCRIPTIONS	

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
BH401		D	2.00	-	3.00	Brown gravelly silty CLAY
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		

Operators	Checked	28/05/2021	Richard John (Advanced Testing Manager)
Clayton Jenkins	Approved	28/05/2021	Paul Evans (Quality/Technical Manager)

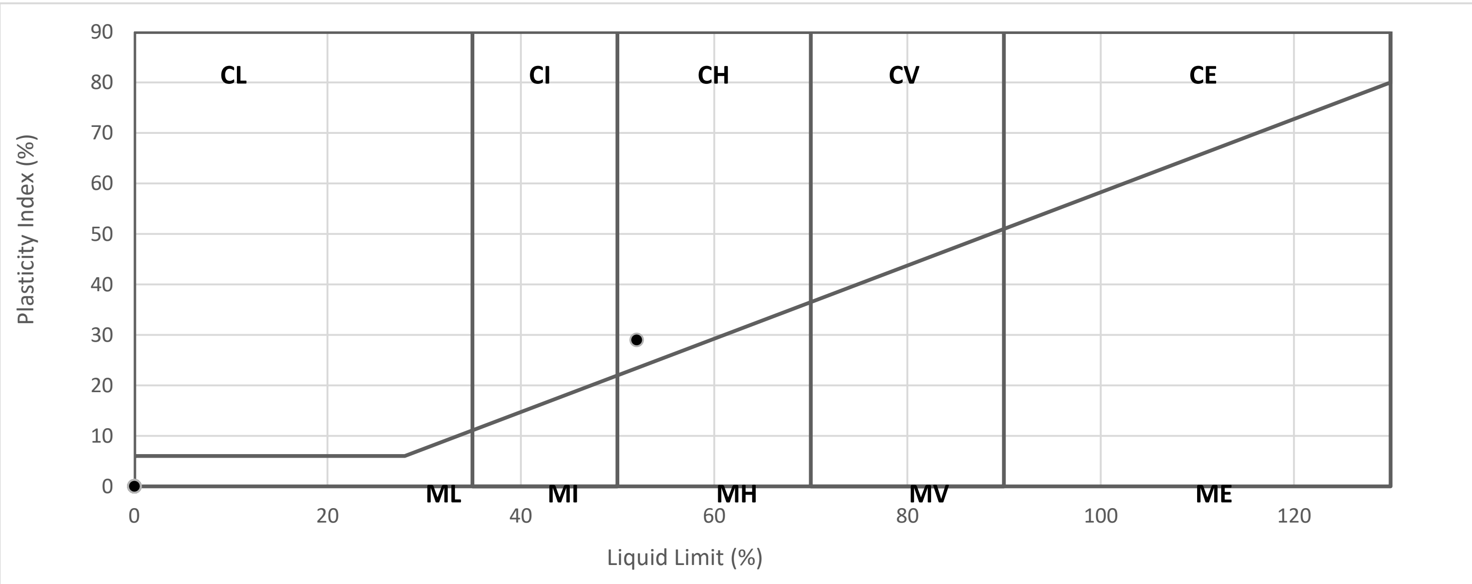
UKAS TESTING
2788

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)	
Contract Number	54099	
Project Location	Mumbles, Swansea	
Date Tested	27/05/2021	

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing 0.425mm %	Remarks
BH401		D	2.00	-	3.00	31	52	23	29	82	CH High Plasticity
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							
				-							

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

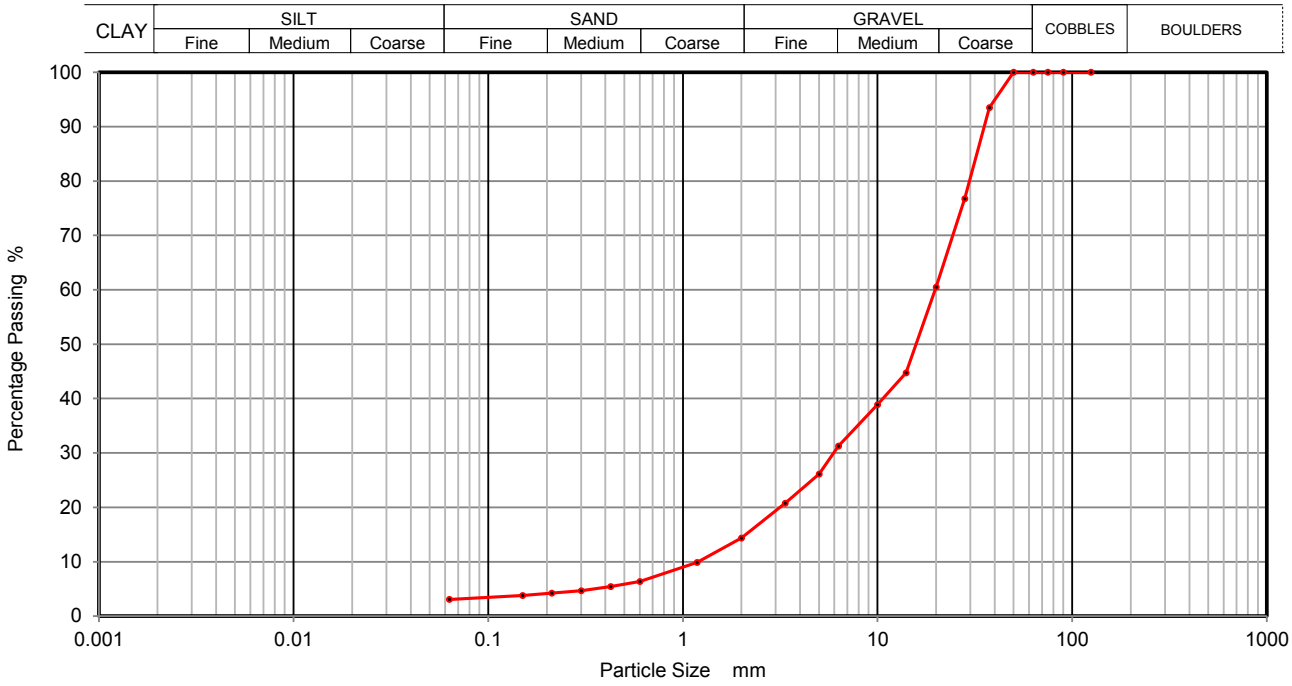
PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	28/05/2021	Richard John (Advanced Testing Manager)
Clayton Jenkins	Approved	28/05/2021	Paul Evans (Quality/Technical Manager)

UKAS TESTING 2788

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve, Clause 9.2	Contract Number	54099
		Borehole/Pit No.	BH401
Site Name	Mumbles, Swansea	Sample No.	
Soil Description	Grey slightly silty/ clayey fine to coarse sandy fine to coarse GRAVEL	Depth Top	0.00
		Depth Base	0.10
Date Tested	24/05/2021	Sample Type	D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	93		
28	77		
20	61		
14	45		
10	39		
6.3	31		
5	26		
3.35	21		
2	14		
1.18	10		
0.6	6		
0.425	5		
0.3	5		
0.212	4		
0.15	4		
0.063	3		

Sample Proportions	% dry mass
Cobbles	0
Gravel	86
Sand	11
Silt and Clay	3

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	27/05/2021	Richard John	
David	Approved	28/05/2021	Paul Evans	

UKAS TESTING
2788

1 Capital Quarter
Tyndall Street
Cardiff
CF10 4BZ

wsp.com