GROUNDTECH
CONSULTING

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SUMMARY

Site Details		
Site Location	*The site is located in Porthcawl Town Centre and is approximately centred on National Grid Reference 282032, 176903.*	
Site Area	*The site is currently undeveloped, soft landscaping dominates the site. Hardsurfaced car parking areas are situated in the south eastern area of the site.*	
Preliminary Risk Assessment		
History	*The site was previously occupied by a smithy, shipbuilding yard, dock, railway land and railway sidings. In addition, ground workings and an unspecified pit have been located onsite.*	
Geology/Hydrogeology	*Geological maps indicate that the site is underlain Blown Sand Deposits (Secondary A Aquifer) and the bedrock is the Oxwich Head Limestone (Principal Aquifer).*	
Mining	*The site is not affected by a legacy of historic coal mining.*	
Environmental Setting	*Former landfill c.44m north.* *Site is in an area requiring basic radon precautions.* *Nearest watercourse is the Bristol Channel approximately 93m south east.*	
Pollution Linkage (PL) Assessment	Human Health	*Moderate to Low as Made Ground is likely to be present beneath the site associated with the historical land uses.*
	Controlled Waters	*Moderate as potential sources of mobile contamination have been identified.*
	Permanent Ground Gas	*Moderate to high as significant sources of ground gas have been identified. Radon precautions are required.*
Ground Model		
Made Ground Soils	*Made Ground was encountered across the site to depths of between 0.2m and 4.0m bgl and consisted of topsoil, sandy fine gravel subbase, clayey sand and gravel and very sandy ashy gravel.*	
Natural Soils	*The natural strata beneath the site generally consists of loose to medium dense sand and gravel to 11.6m bgl however these deposits became dense to very dense between depths of 3.5m and 9.0m beneath the footprint of the proposed store. In addition, firm and firm to stiff Clay was present between 5.9m and 12.7m bgl in BH2 to BH4.*	
Bedrock	*Weak limestone bedrock was encountered during the investigation in BH2 to BH4 at depths of between 10.5m to 13.5m bgl.*	
Groundwater	*Groundwater was encountered in BH2 to BH4 and WS01 between depths of 4.5m and 7.5m bgl.*	

Ground Engineering Assessment	
Foundations	*The most appropriate foundation solution is considered to be driven piles transferring loads through the Sand and Clay end bearing in the underlying Limestone bedrock which has been encountered at depths of between 10.5m and 13.5m bgl. By using a displacement pile, this will minimise the amount of potentially contaminated spoil brought to the surface that will need to be removed as Hazardous waste.*
Highways	*CBR values of greater than 5% are likely to be achieved in undisturbed natural sand soils deposits for pavement design purposes. Untreated Made Ground should be assumed to have a CBR value of less than 2.5%.*
SuDS	*SuDS testing indicates that good drainage conditions are prevalent within the natural Sand deposits across the site, therefore the use of SuDS is considered to be feasible.*
Constraints	*It is proposed to construct a new Aldi store in the eastern half of the site. Historically, a dock wall was present in the south eastern part of the site and this has been proven in Trench 1 and Trench 2 at depths of 5.536m AOD to 5.555m AOD. The proposed position of the south eastern corner of the Aldi store lies across the position of the dock wall. In order to mitigate this, foundations will need to be designed to cantilever over the dock wall or the proposed position of the store will need to be moved by circa 2m to the north.*
GQRA Assessment and Revised (PL) Assessment	
Human Health	*Based on the site being developed commercially, no elevated Contaminants of Concern have been recorded, however asbestos has been detected in six samples of Made Ground at a maximum concentration of 0.41 mass %. As the proposed development will be covered by hardsurfacing, the risk to human health is Low.* *However, based on the concentrations of asbestos that have been recorded the risk to construction workers is high.*
Controlled Waters	*Groundwater testing has been carried and no elevated concentrations have been recorded therefore the risk to controlled waters is Low.*
Permanent Ground Gas	*Initial gas monitoring results place the site in CS1 and gas protection measures are not required. This will be confirmed on completion of the gas monitoring.* *The site is however located in an area requiring basic radon precautions.*
Final Appraisal	

The following further work is considered necessary to progress the site to construction phase:

- *Completion of gas monitoring programme.*
- *Issue gas assessment.*
- *Design of Remedial Specification.*
- *Detailed foundation design.*
- *Confirmation of the recommendations made within this report with regulators.*

TABLE OF CONTENTS

Plans		
Plan Reference	*Revision*	*Title*
GRO-21015-P01	-	*Project Location Plan*
GRO-21015-P02	-	*Preliminary Development Constraints Plan*
GRO-21015-P03	-	*Illustrative Preliminary CSM*
GRO-21015-P04	-	*Exploratory Hole Location Plan*
GRO-21015-P05	-	*Illustrative Revised CSM*

1.0 INTRODUCTION

1.1 Project Objectives

Groundtech Consulting Limited have been instructed by Craddys on behalf of Aldi Stores Limited to undertake a Preliminary Risk Assessment and Geo-Environmental Appraisal for a site at Eastern Promenade in Porthcawl.

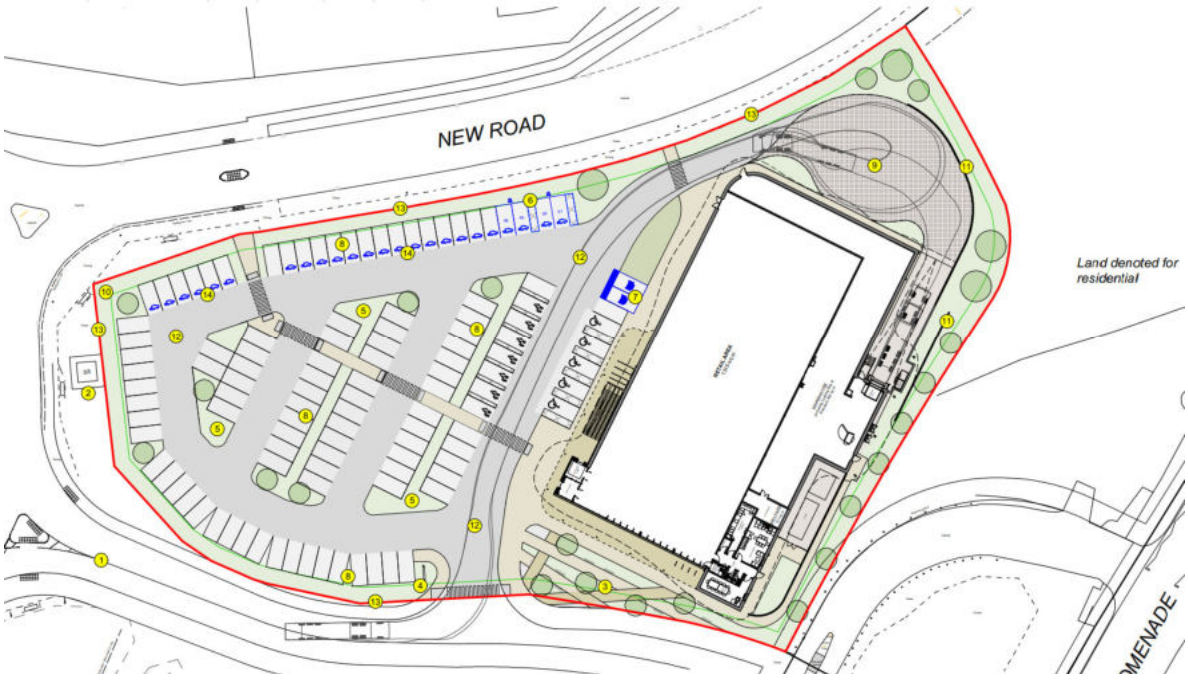
The objectives of the Preliminary Risk Assessment were to establish the sites environmental and geotechnical background in order to generate a Conceptual Site Model to identify any potential constraints and linkages which may affect the redevelopment of the site.

A main investigation was undertaken in accordance with BS 5930:2015, BS 10175:2017, BS 8576:2013 and BS 22475 to revise the CSM and quantify the level of risk identified in the PRA. The Appraisal has been prepared in accordance with current UK Legislation and to discharge Land Quality pre-commencement planning conditions.

The report has been undertaken to fulfil the requirements of a preliminary risk assessment in accordance with CLR11 "Model Procedures for the Management of Land Contamination".

1.2 Proposed Development

The proposed development is commercial end use comprising the construction of an Aldi store with associated car parking areas and a service yard.



Proposed Development

1.3 Limitations

This Preliminary Risk Assessment is based on information obtained from a number of sources and the information is assumed to be correct.

Other conditions may exist on the site that have not been taken into account in this assessment as they are outside the scope of works. Groundtech Consulting are not responsible for these circumstances that are not outlined in the report.

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2.0 SITE SETTING

2.1 Location

The site is located in Porthcawl Town Centre, as shown on the Project Location Plan *GRO-21015-P01* and is approximately centred on National Grid Reference 282032, 176903.

Project Location

Access to the site is gained off Eastern Promenade to the east.

2.2 Site Description

The site is irregular in shape and covers an area of circa 0.98 hectares. The topography of the site generally slopes gently down from west to east.

The site is currently undeveloped, soft landscaping dominates the surface of the site. Hardsurfaced car parking areas are situated in the south western area of the site.

Anecdotal evidence suggests that the site was occupied by a compound in the west, in use by Alun Griffiths (Contractors) Ltd (AG). A fuel tank within the AG compound was identified used for refuelling plant and machinery during their works.

Boundaries and Surrounding Uses
The northern, western and eastern boundaries are formed by a wooden post and rail fence with shrubs and vegetation. No delineating feature forms the southern boundary.

The site is surrounded by following features/land uses:

- *North - Eastern Promenade Road and a community centre with a fire station beyond.*
- *East - Eastern Promenade Road, a restaurant, fair ground and Sandy Bay Beach.*
- *South - Undeveloped soft landscaping.*
- *West - Portway Roundabout with residential and commercial properties beyond.*

Site photographs are presented in *Appendix 2* and relevant features are recorded on the Preliminary Development Constraints Plan *GR0-21015-P02.*

3.0 SUMMARY OF PREVIOUS INFORMATION

ESP produced a Geo-Environmental and Geotechnical Assessment in August 2020 and a summary of the relevant information is summarised below.

Preliminary Risk Assessment

The site was occupied by a compound in the west, in use by Alun Griffiths (Contractors) Ltd (AG). No visual or olfactory evidence was identified at the site surface during the inspection. A fuel tank within the AG compound was identified, used for refuelling plant and machinery during their works.

The nearest major surface water feature to the site is the seawater within Sandy Bay, with the mean high-water mark approximately 60m south west at its closest point. A small harbour is also located approximately 300m south. No rivers are identified within 500m of the site.

The site is underlain by Blown Sand overlying bedrock of the Carboniferous Oxwich Head Limestone. A large area of Made Ground is also indicated to the south east, associated with the infilled dock and the reclamation of the sea front, and this is indicated to marginally encroach on the site in the south east corner. The superficial deposits beneath the site (Blown Sands) are classed as a Secondary A aquifer, whilst the bedrock (Oxwich Head Limestone) is classed as Principal Aquifer.

Tidal influence on groundwater levels was considered to be limited.

Smithy, shipbuilding yard, dock, railway land, railway sidings, ground workings, unspecified pit, cuttings were identified.

The presence of slag within the shallow Made Ground was expected, and the risk from volumetrically unstable slag was considered Moderate.

No further UXO assessment is considered necessary.

The Preliminary Risk Assessment identified a very high risk from ground gas/vapours and also to groundwater from dock materials. Generally, a moderate risk was identified from identified sources of contamination.

Scope and Ground Conditions

Cable percussive boreholes were drilled to a maximum depth of 11.75m bgl. Chiselling at the base of the borehole was undertaken between 9.85m and 10.0m depth in order to prove the presence of the Oxwich Head Limestone bedrock. A rotary percussive borehole was drilled to 18.1m.

General Made Ground was encountered to a maximum depth of 1.7m generally as dark brown, occasionally light brown, with patches of black, sandy to very sandy, sandstone gravel. The Made Ground also contained several man-made objects such as glass and brick and probable fine-medium gravel sized slag fragments. Deeper Made Ground could be present at the site.

Made Ground in the backfilled dock was encountered to a maximum depth of 6.5m bgl as a black and dark grey, occasionally brownish black, very sandy angular gravel and cobbles. The gravel and cobbles largely comprised whole and crushed bricks, concrete and slag with occasional metal, timber and glass. Lenses of fine soils were also identified intermittently throughout the strata.

Blown Sand Deposits were encountered beneath the Made Ground generally from depths of between 0.15 and 1.7m bgl. SPT N-values within the Blown Sands varied between 2 and 34, with an average of 16 indicating a generally medium dense state.

Grade E/D Oxwich Head Limestone Bedrock was identified from depths of between 6.95m and 10.5m depth as a brownish red, sandy, gravelly clay.

Grade C Oxwich Head Limestone Bedrock was identified in all of the boreholes between 8m and 13.2m bgl as a light grey and occasionally reddish brown limestone, recovered as angular gravel and cobbles within the cable percussion boreholes following chiselling of the rock.

Grade B Oxwich Head Limestone Bedrock was encountered in the rotary borehole from a depth of 12.7m bgl as a light grey and occasionally dark grey thinly to medium bedded calcitic limestone. Fractures within the bedrock were generally very closely to closely spaced with localised weathering and fine-medium gravel infilling. A band of limestone conglomerate was identified between 15m and 15.35m depth.

Geo-Environmental Testing

No elevated Contaminants of Concern, however asbestos fibres detected in the Made Ground.

Elevated metal and speciated PAH concentrations were recorded in the groundwater samples.

Ground Gas

The site was classified as Characteristic Situation CS-2 for a commercial development (CIRIA C665:2007). The risk from radon is moderate and basic radon protection measures are required for development.

Revised Pollution Linkage Assessment

The revised pollution linkage assessment has generally identified a moderate risk.

Foundation Recommendations

Piled foundations were considered suitable taken down to the competent Oxwich Head Limestone bedrock at depths of approximately 10m bgl.

Soil Percolation Testing

The testing indicated that the infiltration capacity of the Blown Sands was identified to be good and both tests completed three fills, in line with the published guidance (BRE365, 2016).

4.0 ENVIRONMENTAL SETTING

4.1 Site History

Available historical maps have been obtained, a list of dates and scale are listed in the table below:

Scale	Date
1:1,250	*2003.*
1:2,500	*1880, 1899, 1919, 1943, 1962, 1965, 1965/68, 1966/69, 1976/79, 1976/77, 1977/78, 1987/91, 1992/93, 1992/95, 1993/95, 1995.*
1:10,000/10,560	*1884, 1900, 1914, 1947, 1948, 1969, 1980, 1991, 2001, 2010, 2021.*

The plans were examined and potential issues have been identified and summarised in the table below:

Date	Site	Surrounding Area
1880	***Ship building yard*** *with a* ***smithy*** *in the south eastern area of the site.* *Dock wall feature running through the south eastern part of the site.* ***Railway lines*** *running north west to east and south west to east through the site.* ***Sand pit*** *like features indicated across the central and western areas.*	*Generally surrounded by undeveloped land however* ***sand pits*** *appear to be present to the immediate north, north east and south west.* ***Railway lines*** *extend from the site to the east, south west and north west.* ***Dock*** *immediately south of the site.* ***Railway sidings*** *and a* ***tank*** *c.80m west.* ***Saw mill*** *c.175m south west.* ***Gas Works*** *and* ***Gasometer*** *c.240m north west.*
1899	*Buildings associated with the smithy and the ship building yard* ***demolished****.* *Additional* ***railway lines*** *shown.*	*Increased* ***railway*** *development c.25m west.* *Three* ***coal tips*** *within 250m of the site to the south west, the nearest being c.70m away.* ***Allotment gardens*** *c.100m north.* *Saw mill to the south west no longer present.*
1919	*Small* ***sand pit*** *in north eastern area.* *Sand pits on central and western area no longer shown, possibly* ***infilled****.*	*Coal tips to the south west no longer shown.*
1943	*Sand pit in north eastern possibly* ***infilled*** *as no longer indicated.* *Alignment of dock wall changed and shown as dashed line, i.e. potential underground feature.*	*Generally surrounded by undeveloped fields where the form pits have been* ***infilled****.* *Residential housing c.90m north and an amusement park c.80m north east.* *Dock has been* ***infilled****.* *Two* ***tanks*** *are located c.75m west and north west adjacent to the railway lines.* *Construction on allotment gardens to the north.*
1965	*Position of dock wall no longer shown.* *Southern area depicted as part of a car park.*	*Previous dock area now a car park.* *Gas Works no longer shown however gas holder remains in-situ c.270m north east.*
1969	*Railway tracks dismantled.*	*Railway lines in the vicinity of the site dismantled.*
1976	*No significant change.*	***Electric substation*** *c.160m north.*
1980	*Entire site shown as a car park.*	*Roundabout constructed to the immediate west and an Ambulance Station and Fire Station shown c.25m north.*
2021	*No significant change.*	*No significant change.*

The historical plans and satellite imagery are presented in *Appendix 3*.

4.2 Geology

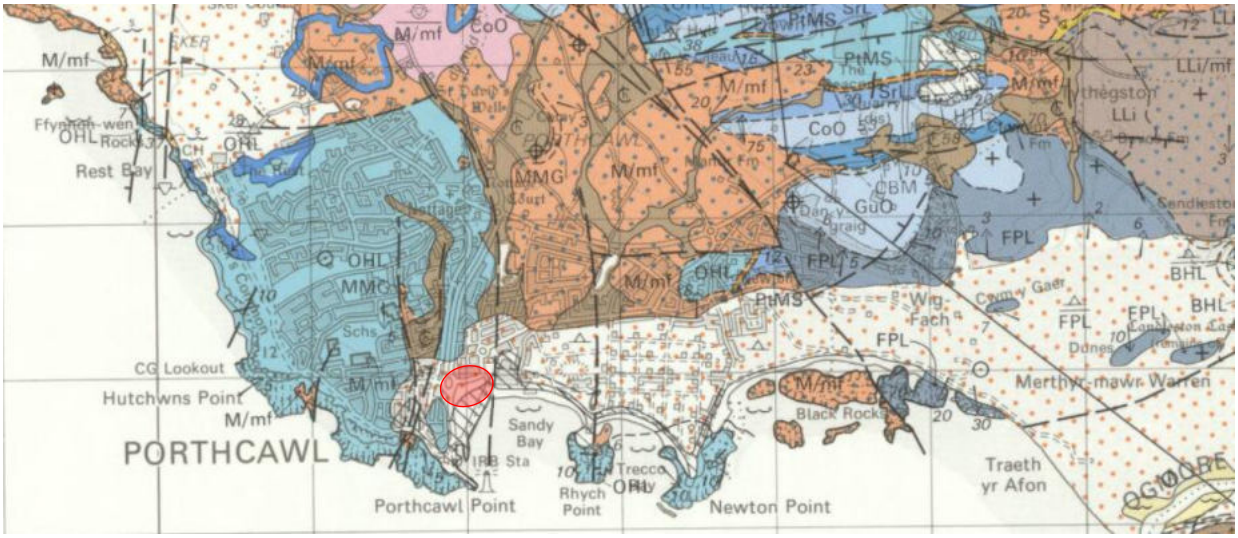
The following British Geological Survey (BGS) records and other available information were inspected to accurately determine the geology underlying the site:

- *1:50,000 Scale Geological Sheet 262, Bridgend (including part of sheet 261 Sker Point), – Solid and Drift Edition.*
- *BGS Records.*

Made Ground
A large area of Made Ground is indicated in the southern corner of the site and extends to the south, this is likely to be associated with the infilling of the dock.

Superficial Deposits
The site is indicated to be underlain by Blown Sand.

Solid Geology
The solid geology underlying the site comprises the Carboniferous Oxwich Head Limestone Formation which consists of interbedded Limestone and Mudstone.



Geological Map – Superficial and Bedrock Deposits

Geological Faults
No geological faults are shown on or within an influencing distance of the site.

BGS Records
Eight BGS records are indicated on site and are presented in *Appendix 4.*

In summary, Made Ground was present to depths of between 0.4m and 3.75m and was underlain by medium dense to dense Sand and Gravel. Soft to firm Clay was present in a number of the boreholes at depths of 7.25m to 7.8m bgl. Limestone bedrock was encountered in one of the boreholes at 9.6m bgl.

The shallowest groundwater strike was at 3.5m bgl.

4.3 Hydrogeology

The superficial Wind Blown sand deposits in this area are classified by the Environment Agency as a Secondary A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

The Oxwich Head Limestone Formation bedrock is classified as a Principal Aquifer which is geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale. Generally, principal aquifers were previously major aquifers.

The soils beneath the site are indicated to be of high leaching potential, these are areas able to easily transmit pollution to groundwater.

The site is not within 500m of a Source Protection Zone and there are no active groundwater or potable water abstraction licences within 2000m of the site.

4.4 Hydrology

The nearest watercourse is the Bristol Channel approximately 93m south east of the site. there are no other surface water features within 250m.

There are no active surface water features within 2000m.

Environment Agency information indicates that the Risk of Flooding from Rivers and Sea (RoFRaS) is *Low*.

4.5 Environmental Consultations

A request has been submitted to the Contaminated Land Officer at Porthcawl Community Council for information pertaining to the site, this information will be forwarded on receipt.

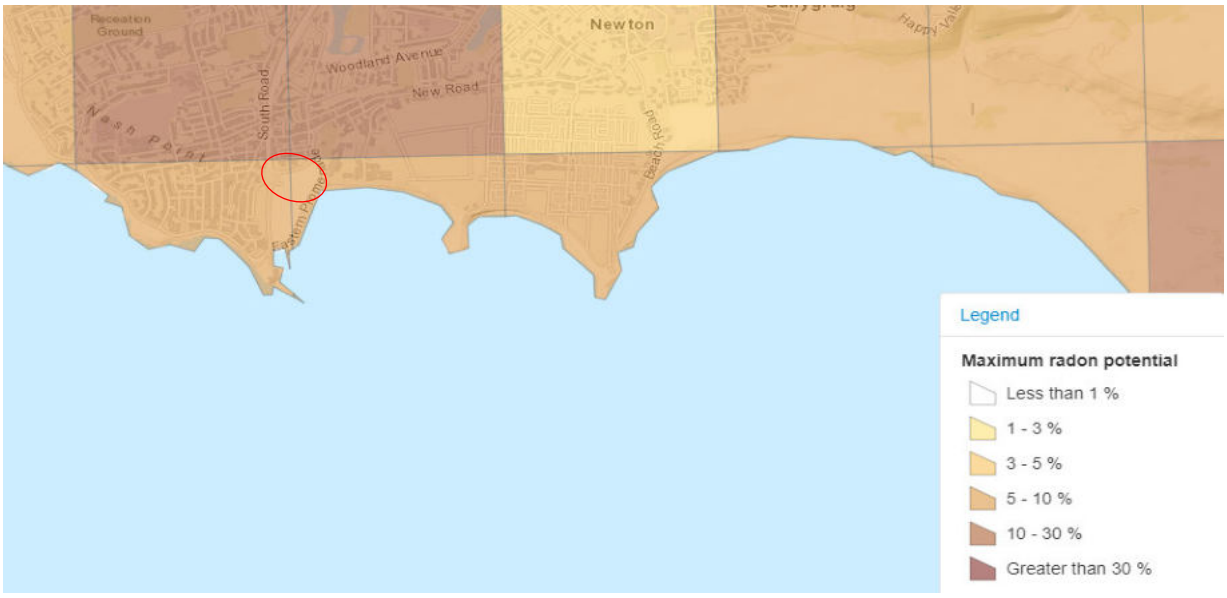
An environmental consultation has been conducted through Groundsure, which accesses British Geological Survey and Environment Agency databases. The complete Groundsure Report can be found in *Appendix 5* and a summary of the more relevant points are presented in the table below.

Record	<250m	250 – 500m	Description
Authorised Processes	*1*	*-*	*160m north and is a Part B permit for dry cleaning.*
Pollution Incidents	*-*	*7*	*The nearest was 276m south associated with contaminated soil material causing a minor impact to air and no impact to land.*
Landfill and Waste Treatment	*-*	*1*	*This was 44m north at Sandy Bay where inert, industrial, commercial and household waste was accepted. This was last recorded in 1974.*
Discharge Consents	*-*	*1*	*318m south at Eastern Promenade, this was revoked in 2002.*
Petrol Filling Stations	*-*	*-*	*-*
Current industrial Uses	*18*	*-*	*Ambulance Station 45m north.*

Record	<250m	250 – 500m	Description
			Fire Station 61m north. *Electricity substation 161m north.* *Station Hill Garage 205m north.*

4.6 Radon

Map 11 'Dorset, Southwest Wales' from BRE 211 and HPA were examined which defines areas which require radon protective measures. The probability is between 5% and 10% and is an area requiring basic radon precautions in foundations in accordance with BRE Report 211 'Radon – Guidance on protective measures for new dwellings' 2015 Edition.



Radon Map

The radon data in the Groundsure report is supplied by the BGS/Public Health England and is the definitive map of Radon Affected Areas in Great Britain and Northern Ireland, the Groundsure report confirms the classification being between 5% and 10% on the radon maps. The dataset was created using long-term radon measurements in over 479,000 homes across Great Britain and 23,000 homes across Northern Ireland, combined with geological data. The dataset is considered accurate to 50m to allow for the margin of error in geological lines, and the findings of this report supersede any answer given in the less accurate Indicative Atlas of Radon in Great Britain, which simplifies the data to give the highest risk within any given 1km grid square.

4.7 Coal Authority Consultation

The site is outside the area of a designated coalfield, the Law Society and Coal Authority state a mining search is not required.

5.0 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

5.1 Introduction

The potential level of risk posed by contaminants in soil and/or groundwater will be influenced by the type and concentration of the contamination at source, the likelihood of exposure occurring, the potential pollution linkages and the likely chronic or acute effects on the receptors.

A contaminant is defined as a substance that has the potential to cause harm, a risk is considered to exist if such a substance is present at sufficient concentrations to cause harm and if a pathway is present a receptor could be exposed to the contaminant.

Section 4.0 compiles the information from the previous sections to assemble a Conceptual Site Model to inform the risk assessment process. The potential sources identified on the site and off the site that are within influencing distance are assessed to determine if pollution linkages exist and an unacceptable risk is posed to human health and controlled waters. The assessment has been carried out on a qualitative basis and aims to produce a complete and comprehensive Preliminary Conceptual Site Model. The potential pollution linkages are displayed on *GRO-21015-P03* Illustrative Preliminary CSM.

Three potential types of impacts exist for a site and all three need to be considered in the qualitative preliminary risk assessment:

- *Impacts from sources on the subject site.*
- *Impacts to the surrounding area from the subject site.*
- *Impacts to the subject site from the surrounding area.*

5.2 Potential Contamination Sources

Onsite Sources and Associated Contaminants of Concern (CoC)
From the information obtained during the Preliminary Risk Assessment, a number of potential sources of contamination have been identified onsite which may affect the redevelopment of the site for commercial end use and include the following:

- *Former smithy and ship building yard*
- *Demolished buildings*
- *Railway land*
- *Former sand pits*
- *Infilled dock*
- *General Made Ground*
- *Former fuel tank in works compound*
- *Possible leaks from vehicles in the car park*

Associated Contaminants of Concern highlighted by relevant DoE Industry Profiles are presented in the table below:

Industry Profile	Associated Contaminants of Concern	Required Testing
Railway Land	*Fuel derived hydrocarbons, lubricating oils, creosote, polycyclic aromatic hydrocarbons, asbestos and ash.*	*Metals, speciated Polycyclic Aromatic Hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPH CWG) and asbestos.*

Engineering Works - shipbuilding	*Metals, fuels, oils, organic compounds, asbestos, anti-corrosives.*	*Metals, PAHs, TPH CWG and asbestos.*

A smithy was located in the south eastern area of the site and potential Contaminants of Concern (CoC) may include metals and speciated PAHs.

Made Ground is present beneath the site associated with previously demolished buildings, the infilling of the dock on the southern area, possible former sand pits and general development of the site. No elevated concentrations were recorded for a commercial end use by the previous investigation, however asbestos fibres were detected in the Made Ground beneath the site. The previous investigation also detected permanent ground gases and the site is located in an area requiring basic radon precautions.

A former above ground fuel storage tank was onsite in the western area in a works compound. In addition, there is the minor potential for fuel/oil to have leaked from cars parked onsite. These could be a potential source of fuel derived hydrocarbons.

Off-Site Sources and Associated Contaminants of Concern (CoC)
Several potential offsite sources of contamination have been identified through the PRA and include the following:

- *Former railway land surrounding the site.*
- *Former sand pits surround the site and an infilled dock to the south.*
- *Former dock to the south.*
- *Former landfill 44m north.*
- *Former coal tips, nearest being 75m south west.*
- *Tanks within 75m.*
- *Former allotment gardens 100m north.*
- *Electricity substation 160m north of the site.*
- *Saw mill 175m south west.*
- *Repair garage 205m north.*
- *Former gas works 240m north west of the site.*

Associated Contaminants of Concern highlighted by the DoE Industry Profiles are presented in the table below:

Industry Profile	Associated Contaminants of Concern	Required Testing
Railway Land	*Fuel derived hydrocarbons, lubricating oils, creosote, polycyclic aromatic hydrocarbons, asbestos and ash.*	*Metals, speciated PAHs, Total Petroleum Hydrocarbons (TPH CWG) and asbestos.*
Saw Mill	*Solvents, preservatives, Pesticides, creosols, phenols, fuels and oils*	*Metals, TPH CWG, Pesticides, Volatile Organic Compounds (VOCs), Semi Volatile Organic Compounds (SVOCs).*
Garages	*Lubricating oils, paint, fuels, solvents, anti-freeze, brake fluid*	*Metals, speciated PAHs, TPH CWG, VOCs, SVOCs.*
Gas Works	*Metals, tars, speciated PAHs, hydrocarbons*	*Metals, sulphate, cyanide, VOCs, SVOCs, speciated PAHs, TPH CWG.*

A dock was present to the south of the site and is potentially a source of fuel derived hydrocarbons, oils and paints associated with shipping vessels.

Coal tips were present to the south west of the site and could be a source of speciated PAHs and permanent ground gases.

Allotment gardens were to the north and potential CoC may include speciated PAHs and pesticides.

PolyChlorinated Biphenyls (PCBs) are commonly found in electricity substations. Historically, they were used in coolants and insulating fluids of electrical components in power generation and transmission equipment.

Tanks were present within 80m of the site, it is unknown what they stored however they could be a source of fuel derived hydrocarbons.

Former sand pits surround the site and an infilled dock is to the south. In addition, a former landfill was 44m north. These features could all be sources of permanent ground gases.

5.3 Pollution Linkages

The definition of a pollution linkage is a medium which allows a contaminant to impact a receptor. Potential pollution linkages have been recognised for the commercial development from the identified contamination sources that exist.

At this stage, the potential contaminants identified above are considered to pose an unacceptable risk to human health and controlled waters through the following pollution linkages:

- *Direct soil and dust ingestion.*
- *Dermal contact with soil both indoors and outdoors.*
- *Indoor air inhalation from soil and vapour.*
- *Outdoor inhalation of soil and vapour.*
- *Migration and accumulation of ground gas into internal spaces.*
- *Impaction of groundwater from soil contamination (diffuse and point).*
- *Impaction of groundwater from groundwater plume.*
- *Migration of soil and groundwater contamination impacting surface waters.*

5.4 Receptors

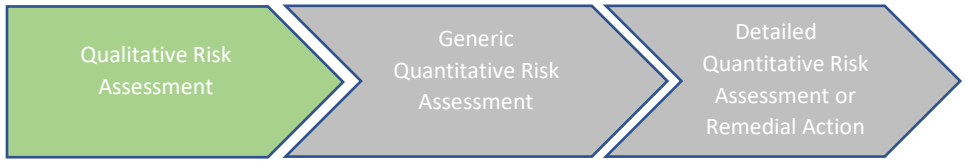
Receptors generally fall into the categories of human health or controlled waters within the river basin system. The recognised receptors are listed below:

- *Future site users of the Aldi store.*
- *Underlying superficial Secondary A Aquifer and bedrock Principal Aquifer.*
- *Coastal waters.*
- *Clean potable water supply pipe.*

5.5 Preliminary Conceptual Site Model (CSM)

The factual information obtained from the searches and summarised in Section 2.0 to 4.0 has been used to compile a Preliminary CSM. Using Source-Pathway-Receptor assessment criteria that is applicable in the UK, a risk assessment has been completed to determine if a plausible pollution linkage exists between the identified contaminants and receptors. The risk classification has been estimated in accordance with the CIRIA C552 assessment criteria outlined in *Appendix 6.*

Human Health Pollution Linkage Assessment



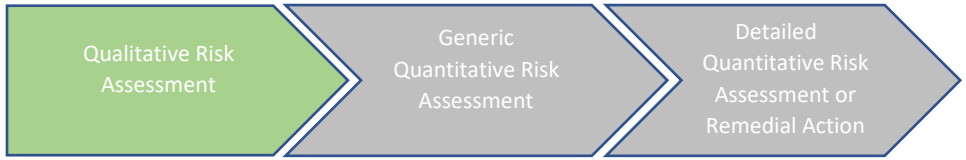
- The table below represents the first stage in the land quality risk assessment process - **the Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Qualitative Risk Assessment*	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Unlikely	Medium	Low	*Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site.* *The site is currently an undeveloped field with a large area of hardsurfacing used for car parking. Historically the site was a shipyard and a smithy with railway lines running through. The southern area was part of a dock which has now been infilled. In addition, it appears that a number of old sand pits were present on site which have been infilled. More recently, a works compound was in the western area which included an above ground fuel tank. Based on the history of the site, general Made Ground beneath the site may be a potential source of metals, PAHs, hydrocarbons and asbestos. The previous investigation did not record any elevated concentrations, however asbestos fibres were widespread in the Made Ground.* *Several potential offsite sources of contamination have been identified however, significant mobile contamination is unlikely to have migrated onto site.* *The proposed development is for a new Aldi store with associated car parking and a service yard. The site will therefore be predominantly covered with hardsurfacing*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
						which will break the pathway to potential site end users. As a result, a viable pollution linkage is not considered to exist.
PL2	Contaminated Soils	Inhalation of vapour.	Low Likelihood	Medium to Severe	Moderate	*This pollution linkage refers to volatile vapours migrating into confined spaces within the proposed development. The site was a former ship building yard, railway land and an above ground tank was in the western area. Potential sources of hydrocarbons have been identified therefore a plausible pollution linkage is considered to exist.*
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	*This pollution linkage relates to contamination on the subject site affecting adjacent site users. No significant sources of mobile contamination have been identified onsite therefore no pollution linkage is considered to exist.*
PL4	Contaminated Soils	Attacking potable water supply pipe.	Low Likelihood	Medium	Moderate	*Pollution Linkage 4 refers to the possible contaminants permeating potable water pipes and consumption by the future site end users of the tainted water supply. Made Ground is likely to be present at installation depth which may be contaminated with a range of organic contaminants such as hydrocarbons and VOCs/SVOCs.* *New potable water supply pipes will be included as part of the commercial development therefore, a pollution linkage is considered to exist. A local water company risk assessment will be required prior to construction to advise on the level of protection required for any potable water supply pipes.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Likely	Medium to Severe	Moderate to High	*Deep Made Ground is likely to be present beneath the site due to the sites historical uses and the infilling of a dock and sand pits.* *In addition, the infilled dock extends to the south offsite. Former sand pits and coal pits are also present in close proximity to the site which could have been infilled. A former landfill is 44m north which accepted industrial, commercial and household waste.* *Potential onsite and offsite sources of ground gas have been identified. The Blown Sands in the general area form a potential pathway for gases to migrate onto site.* *The risk will be quantified by the intrusive investigation including the installation and monitoring of ground gas wells.* *The site is within an area requiring basic radon precautions within foundations.*

Controlled Waters Pollution Linkage Assessment



- The table below represents the first stage in the land quality risk assessment process – **Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Qualitative Risk Assessment*	
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Likely	Medium	Moderate	*Deep and potentially contaminated Made Ground is likely to be present across the site associated with a former ship building yard, dock and railway land. In addition, an above ground fuel storage tank was present on the western area. As a result, mobile contamination may be present beneath the site.* *Geological maps indicate that the site is underlain by the Blown Sand (Secondary A Aquifer) and the Oxwich Head Limestone (Principal Aquifer). Therefore, a pathway is considered to exist to the underlying Aquifers.* *The site is not within 500m of a SPZ and is not considered a sensitive resource. There are no groundwater or potable water abstractions within 2km.* *The proposed development will be completely covered with hardsurfacing and a new drainage system installed. This will considerably reduce infiltration and leaching of potential contaminants.*

Conceptual Site Model						*Qualitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
						Given the history of the site, a pollution linkage is considered to exist and further investigation is required.
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	*Pollution Linkage 7 refers to the impaction of the Bristol Channel c.93m to the south east from contaminated soils and groundwater. No other surface water features are within 250m.* *Significant mobile contamination is not anticipated beneath the site, impaction of the Bristol Channel is unlikely given the attenuation distance involved.* *A viable pollution linkage is not considered to exist.*

6.0 SCOPE OF INVESTIGATION AND RATIONALE

6.1 Project Objectives

The aim of the fieldwork was to:

Determine the stratification beneath the site.
Maintain a watching brief for visual and olfactory evidence of contamination.
Obtain samples using methodology in current guidance for contamination analysis.
Identify realistic pollution linkages to groundwater.
Obtain relevant geotechnical parameters for preliminary foundation design to address both ULS and SLS conditions.
Determine if targeted supplementary investigation in areas of concern is required and for remedial design.
Install monitoring standpipes for gas and groundwater monitoring.
Assess the identified pollution linkages in the CSM.
Calculate soil infiltration rates to inform SuDS design.
Identify location of dock wall with respect to proposed Aldi store.

6.2 Scope of Works

The following scope of works was completed between the dates of 1st February and 8th February 2021.

- *Seven window sample boreholes (WS01 to WS07) were drilled to depths between 4.0m and 5.45m bgl using an Archway Dart tracked window sample rig.*
- *Eight trial pits (TP01 to TP08) were excavated to a maximum depth of 2.5m bgl using a JCB 3CX excavator.*
- *Two trial trench pits were excavated to 2.0m bgl to delineate the buried dock wall.*
- *Two soil percolation tests (SuDS1 and SuDS2) were conducted at 1.5m and 1.7m bgl respectively.*
- *Four cable percussive boreholes (BH1 to BH4) were drilled to depths between 4.0m and 13.7m bgl.*

The surveyed exploratory hole locations are presented on *GRO-21015-P02* and the exploratory hole logs are presented in *Appendix 7*.

The exploratory holes were positioned to establish the stratification beneath the site and target areas of concern as summarised in the table below:

Location	Target Rationale
BH1 to BH4	*Proposed store footprint*
WS01 to WS06	*Proposed store footprint / General site coverage*
SuDS1 and SuDS2	*Areas of proposed SuDS drainage*
TP01 to TP08	*General site coverage*
WS07, Trenches 1 and 2	*Former dock wall in the south east corner*

The exploratory holes were logged by a suitably experienced geo-environmental engineer in general accordance with the following current guidance:

- *BS 5930 'Code of Practice for Site Investigations' 2015.*
- *BS EN 14688-1:2002 'Geotechnical Investigation and Testing – Identification and classification of soil'.*
- *BS EN ISO 14689:2002 'Geotechnical investigation and testing – Identification and classification of rock'.*

6.3 Soil Sampling

During the intrusive investigation, representative samples were taken at regular intervals, changes of strata and where evidence of contamination existed. Laboratory testing was scheduled on the samples obtained.

The samples obtained are summarised in the table below:

Soil Sample	Number
Environmental Sample	*52*
Disturbed Sample	*76*
Bulk Sample	*44*

The samples have been obtained in accordance with current environmental and geotechnical guidance. The sampling plan has been designed to obtain samples from all required strata using the correct methodology.

Disturbed samples of soil for geo-environmental testing were placed in the correct sampling containers as required by the laboratory in accordance with their MCERTS and UKAS Accreditation. Transportation was arranged in a timely manner and the samples were at the correct temperature.

The sample locations and depths are recorded on the exploratory logs.

6.4 Geo-Environmental Testing

To inform the Generic Quantitative Risk Assessment, the following geo-environmental testing was scheduled to assess the risk from contamination on the site. The testing is based on the potential sources identified in the PRA and observations during the ground investigation.

Contaminants of Concern	Matrix	Number
Arsenic, cadmium, chromium (total and hexavalent), copper, lead, mercury, nickel, selenium, zinc and pH.	*Soil*	*15*
TPH CWG	*Soil*	*5*
VOCs and SVOCs	*Soil*	*5*
Waste Acceptance Criteria (WAC)	*Soil and Eluate*	*3*
Asbestos screening	*Soil*	*15*
Asbestos Quantification	*Soil*	*6*
Arsenic, cadmium, chromium (total and hexavalent), copper, lead, mercury, nickel, selenium, zinc and pH.	*Groundwater*	*3*
TPH CWG	*Groundwater*	*3*
Dissolved Organic Carbon	*Groundwater*	*3*
Hardness	*Groundwater*	*3*
VOCs	*Groundwater*	*3*

The Geo-Environmental Laboratory Soil Testing Results are presented in *Appendix 8* and the Groundwater Testing Results in *Appendix 9.*

Representative disturbed samples were obtained for all soil types encountered. Selected samples were scheduled for testing at an approved laboratory in accordance with BS 1377 'Method of Test for Soils for Civil Engineering Purposes' 1990. The following tests were scheduled:

British Standard	Test Method	Number
Part 2	*Particle Size Distribution*	*5*
Part 3	*pH Value*	*5*
Part 3	*Water Soluble Sulphate Content*	*5*

The Geotechnical Laboratory Testing Results are presented in *Appendix 10.*

6.5 Gas and Groundwater Monitoring

Gas and groundwater monitoring installations were constructed in the boreholes. The standpipes consisted of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) pipe - a bentonite seal was placed around the plain pipe and a clean gravel pack was placed around the slotted pipe. A summary of the installation construction is presented in the table below:

Location	Depth (m bgl)	Response Zone (m bgl)	Targeted Strata	Reason
WS01	*3.00*	*1.00 - 3.00*	*Sand*	*Ground Gas*
WS02	*4.00*	*1.00 - 4.00*	*Sand*	*Ground Gas*
WS03	*3.00*	*1.00 - 2.00*	*Sand*	*Ground Gas*
WS04	*4.00*	*1.00 - 4.00*	*Sand*	*Ground Gas*
WS05	*3.00*	*1.00 - 3.00*	*Sand*	*Ground Gas*
BH1	*3.50*	*1.00 - 3.50*	*Made Ground*	*Ground Gas*
BH2	*9.00*	*6.00 – 9.00*	*Sand and Gravel/Clay*	*Groundwater*
BH3	*9.00*	*6.00 – 9.00*	*Sand and Gravel/Clay*	*Groundwater*
BH4	*9.00*	*6.00 – 9.00*	*Sand and Gravel/Clay*	*Groundwater*

Permanent gas and flow rate monitoring was carried out using a GFM 436 infrared gas monitor with integral electronic flow analyser. The measurements taken are listed below:

- *Oxygen (O_2), carbon dioxide (CO_2) and methane (CH_4) as the percentage volume in air (%v/v).*
- *Hydrogen sulphide (H_2S) and carbon monoxide (CO) as the percentage volume in air (%v/v).*
- *Lower Explosive Limit (%LEL) of methane.*
- *Atmospheric and borehole pressure, including pressure trend.*
- *Flow measurements (l/hr).*
- *Weather and ground surface conditions.*

Both peak and steady state conditions were monitored to understand the behaviour of the permanent ground gas, the steady state conditions were recorded by allowing the gas monitor to run for a minimum of 3 minutes.

Interim permanent gas and groundwater monitoring results are presented in *Appendix 11.*

6.6 Groundwater Sampling

Well development was carried out to ensure no cross contamination from the drilling activities remained in the water column in the well. The method of sampling selected was using low flow pump due to the contamination identified during the PRA and Ground Investigation.

A water meter was used to test the pH, temperature and conductivity before sampling until equilibrium conditions were met, as per BS 10175 guidelines.

No groundwater was encountered within WS01 to WS07 and BH1 during the sampling visit.

Samples were sent to the UKAS Accredited laboratory the same day sampling was carried out in general accordance with BS 5930:2015 and BS 5667.

6.7 Vapour Survey - Photo Ionisation Detector

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation. The onsite monitoring was carried out in line CIRIA C6658 to aid targeting samples for VOC laboratory analysis.

Soil was collected for onsite testing, a plastic bag was half filled with soil allowing a suitably sized headspace. The bag was sealed and stored for at least 20 minutes before being tested for Total Volatile Organic Compounds (TVOCs) using a Photo Ionisation Detector (PID).

All of the results from the PID testing were 0ppm.

7.0 GROUND MODEL

7.1 Made Ground

Made Ground was encountered across the entire site to depths of between 0.2m and 4.0m bgl.

The surfacing of the site comprised the following:

- *Gravel surfacing in WS01, WS07, BH1 and TP01.*
- *Dark brown slightly sandy clayey topsoil was encountered in all of the remaining locations to a maximum depth of 0.4m bgl.*

Three main populations of Made Ground were encountered during the investigation and are described below:

1. *Sandy fine to coarse gravel between 0.1m to 0.2m bgl in WS01, WS07, BH1 and TP01.*
2. *Dark brown clayey sand and gravel of mixed lithologies including brick between 0.2m and 1.8m bgl in BH2, BH3, TP02 to TP06, TP08 and SuDS2.*
3. *Black very sandy ashy gravel between 0.3m and 4.0m bgl encountered in TP01 and BH1.*

Across the majority of the site, the Made Ground was 0.2m to 1.8m in thickness. Deeper Made Ground was encountered in the western area in TP05 and TP06 to depths of up to 2.2m however, the base of the Made Ground was not determined in either of these trial pits. This could be associated with the former railway lines which crossed the site.

The deepest Made Ground was encountered in BH1 in the south eastern part of the site to at least 4.0m bgl. This borehole was drilled in the area of the infilled dock. The top of the dock wall was potentially encountered in BH1 at c.3.5m bgl where a refusal was recorded.

In addition, Made Ground was encountered in Trench 1 and Trench 2 to 2.1m bgl and generally comprised light brown slightly clayey sand and gravel overlying black very sandy ashy gravel. These two trenches were excavated in the south eastern area of the site in the vicinity of the former dock wall which was encountered at a depth of 2.1m bgl (5.536m AOD to 5.555m AOD).

Exploratory Hole Locations

7.2 Natural Ground

The natural strata encountered generally confirmed the published geological records and are described below:

- *Loose to medium dense light brown Sand and Gravel / gravelly Sand was observed to depths of 11.6m bgl across the site. Locally, these deposits became dense to very dense in BH3 (3.5m to 5.9m bgl and at 9.0m bgl) and BH4 (4.0m to 6.1m bgl). WS2, WS3, WS4 and WS6 were terminated at depths of between 4.0m and 5.0m bgl due to a refusal on dense to very dense Sand.*

- *Firm and firm to stiff red brown slightly sandy gravelly Clay between depths of 5.9m and 12.7m bgl in BH2 to BH4.*

7.3 Bedrock

Weak Limestone bedrock was present in BH2 to BH4 at depths of between 10.5m to 13.5m bgl.

7.4 Groundwater

Groundwater strikes were observed in BH2 to BH4 and WS01 between depths of 4.5m bgl and 7.5m bgl.

Groundwater was not encountered in the remaining exploratory holes.

7.5 Watching Brief

A watching brief was maintained during the Ground Investigation for visual and olfactory evidence of contamination.

Potential contamination of black ashy Made Ground was noted in BH1, TP01, Trench 1 and Trench 2 between depths of 0.2m and 4.0m bgl.

7.6 Excavation Stability

Collapse was noted during excavation within all of the trial pits.

7.7 Excavation Progress

Slow progress while excavating the trial pits was generally not experienced. Trench 1 and Trench 2 was terminated on the top of the dock wall at c.2.1m bgl (c.5.536 to 5.555mAOD) and BH1 was terminated at 4.0m bgl (3.70m AOD). BH1 was terminated at 4.0m due to limestone cobbles and a boulder obstruction which is likely associated with the infilled dock.

Slow progress while during the cable percussive drilling was experienced within BH3 and BH4 between depths of 3.5m to 6.1m bgl where dense to very dense Sand and Gravel was encountered.

8.0 GROUND ENGINEERING

8.1 Assessment Background

The ground engineering investigation has been undertaken to formulate an accurate ground model in order to undertake preliminary foundation design. The ground model has been constructed with a moderate to high level of confidence and has evolved from the information obtained by the PRA.

Across the majority of the site, the Made Ground was 0.2m to 1.8m in thickness. Deeper Made Ground was encountered in the western area in TP05 and TP06 to depths of in excess of 2.2m bgl.

The deepest Made Ground was encountered in BH1 in the south eastern part of the site to at least 4.0m bgl where an infilled dock was located. The top of the former dock wall was encountered in Trench 1 and Trench at a depth of 2.1m bgl (5.536m AOD to 5.555m AOD).

The natural strata beneath the site generally consists of loose to medium dense sand and gravel to 11.6m bgl, these deposits became dense to very dense between depths of 3.5m and 9.0m beneath the footprint of the proposed store. In addition, firm and firm to stiff Clay was present between 5.9m and 12.7m bgl in BH2 to BH4.

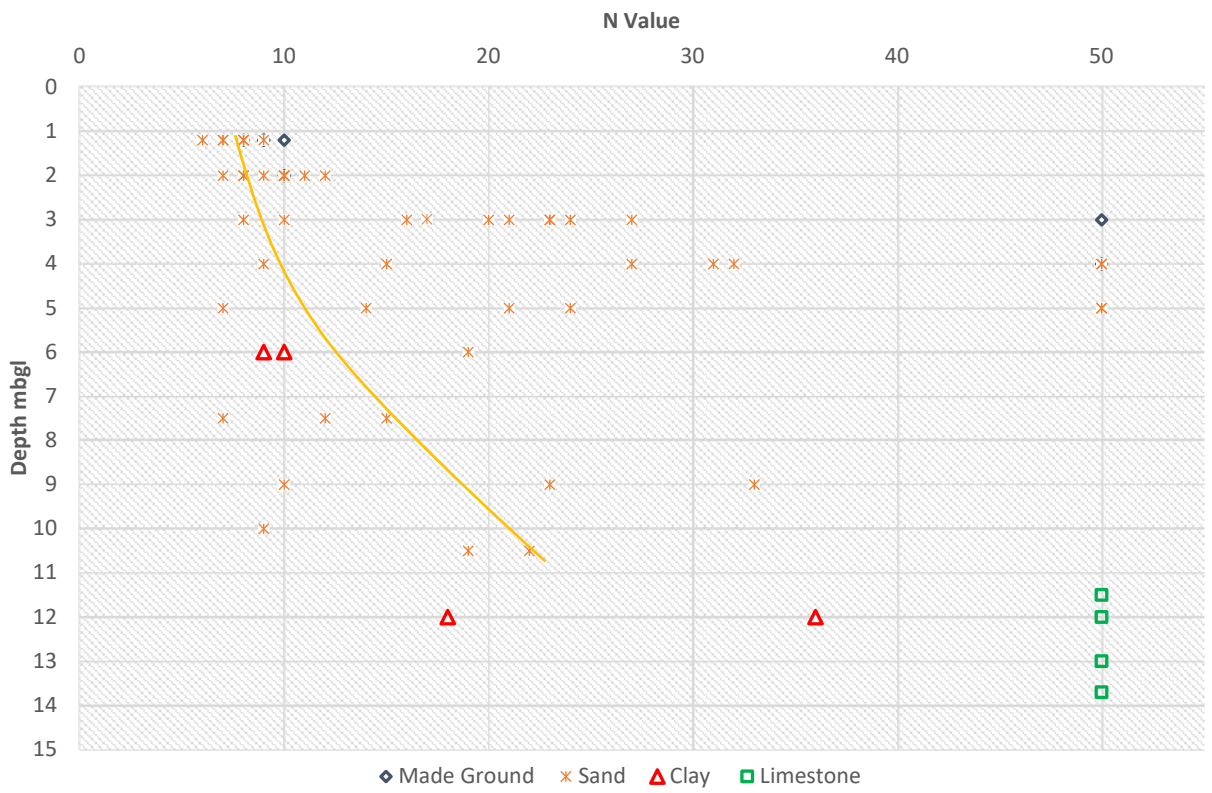
Weak Limestone bedrock was encountered during the investigation in BH2 to BH4 at depths of between 10.5m and 13.5m bgl.

Groundwater was encountered in BH2 to BH4 and WS01 between depths of 4.5m and 7.5m bgl.

It is proposed to construct a new Aldi store in the eastern half of the site. Historically, a dock wall was present in the south eastern part of the site and this has been proven in Trench 1 and Trench 2. The position of the exposed dock wall is shown on Plan *GRO-21015-P04* and a section showing the strata in the holes in the vicinity of the former dock wall is in *Appendix 7*. The proposed position of the south eastern corner of the Aldi store lies across the position of the dock wall and requires consideration in the development layout and foundation design.

8.2 Geotechnical Parameters

The geotechnical test results have been evaluated to derive geotechnical parameters for the soils underlying the site. A 'depth to SPT N value' graph is presented below to provide a generalised ground model for the site.



Depth v SPT Chart

Characterisation of the geotechnical parameters above has been undertaken to select a characteristic value, which is a cautious estimate of the value affecting the occurrence of the limit state.

The characteristic values of the underlying strata have been selected based on correlation with SPT values and where possible, published values. The characteristic values for Ultimate Limit State (ULS) selected are presented in the table below:

Stratum	Parameter	Selected Characteristic Value
Loose to medium dense Sand	*Drained angle of friction (ϕ')*	*30°*
Dense to very dense Sand	*Drained angle of friction (ϕ')*	*38°*
Firm Clay	*Undrained Shear strength (Cu)*	*50kPa*
Weak Limestone	*Drained angle of friction (ϕ')*	*36°*

8.3 Preliminary Foundation Design

The site is underlain by loose to medium dense sand and gravel to depths of up to 11.6m bgl and deep Made Ground has been encountered beneath the south eastern corner of the site in the vicinity of the infilled dock. Therefore, a shallow foundation solution is not considered to be viable option.

Significant asbestos contamination has been encountered across the eastern half of the site in the vicinity of the proposed Aldi store. After discussions with a vibro contractor, in order for vibro ground improvement to be used, the site would need to be remediated prior to undertaking works in order to mitigate the risk of

asbestos fibres becoming air-borne and affecting the construction workers. As a result, vibro improvement techniques are not considered to be a viable option.

The most suitable foundation solution is considered to be driven piles transferring loads through the Sand and Clay end bearing within the underlying Limestone bedrock which has been encountered at depths of between 10.5m and 13.5m bgl. A reinforced ring beam should be constructed to span between each pile cap and support loadings from the walls of the proposed store. A sacrificial piling matt should be installed and by using a displacement pile, asbestos fibres in the Made Ground will not become airborne. Asbestos control measures will still be required during groundworks when foundation and drainage excavations are being undertaken.

The former dock wall is situated beneath the south eastern corner of the proposed Aldi store. In the first instance, consideration should be given to moving the position of the store or orientating it such that the corner does not overlay the wall. Or alternatively, if the building has to remain in the proposed position, the south eastern corner should be designed to cantilever over the dock wall.

Preliminary design by calculation has been carried out applying due skill and care using the global factor of safety method.

Design by Calculation
The preliminary design by calculation is based on the following ground model:

- *MG to 0.55m*
- *Loose to medium dense Sand to 6.2m*
- *Firm Clay to 7.5m*
- *Loose to medium dense Sand to 10.5m*
- *Limestone to 11.0m*

For a single pre-cast concrete pile 225mm in diameter and 11m in length end bearing in the Limestone, an allowable load of 230kN is provided. If greater loads are associated with the proposed development, consideration should be given to larger diameter piles or pile groups. This design should be confirmed with the preferred piling contractor. The type of pile material to be used should be discussed with the piling contractor to ensure lateral stability is achieved.

Detailed pile design should be undertaken by an experienced piling contractor and should take into account finished levels.

An appropriate working platform should be constructed in accordance with BR470 guidance.

If the ground conditions encountered during the construction phase differ significantly to the conditions encountered during the Ground Investigation, work should cease and Groundtech Consulting contacted for further advice.

During the construction phase supervision should be on a continuous basis to check the design assumptions are correct and construction conforms to design. Supervision should include inspections, Control Ground Investigations and monitoring.

Design Validation
Static load testing on working piles is recommended as a minimum to validate the design for ULS and SLS conditions in accordance with Eurocode 7. Due to the size of the development and the associated loadings, static load testing is not economical and an appropriate Factor of Safety should be used in the design. The piles are likely to be driven to sett using pile driving formulae.

The piling type, length, depth of reinforcement and design should be discussed with a specialist piling contractor. They can then undertake the detailed design including drawings and specifications to provide fitness for purpose design.

All piling work should be carried out in accordance with BS EN 12699:2015 'Execution of special geotechnical works. Displacement piles'.

8.4 Floor Slabs

A suspended floor slab will be required for the proposed store supported by the reinforced ring beam.

8.5 Construction

The trial pits indicate that instability of excavations is anticipated. Instability of the Made Ground is also a possibility and should be considered in the groundwork's method statements.

Tracked high specification plant is recommended to maintain the build programme. Breaking equipment may also be required locally to penetrate obstructions identified by the Ground Investigation.

If any slag is encountered within the infill materials, consideration should be given to their expansive properties.

Asbestos is widespread within the Made Ground materials across the central and eastern areas of the site. Controlled excavation including dust suppression should be implemented so not to disturb these soils and release asbestos fibres.

Groundwater has been encountered at depths of between 4.5m and 7.5m during the Ground Investigation and is not considered to be a constraint.

8.6 Concrete Classification

Made Ground
Water soluble sulphate testing was undertaken on fifteen samples of the Made Ground. The range of soluble sulphate (SO_4) recorded is less than 10mgl/l to 190mg/l and associated pH values ranged between 6.7 and 9.8 indicating slightly acidic to slightly alkaline conditions.

In a dataset where there are greater than nine samples, the average of the highest 20% of the water soluble sulphate concentrations should be taken as the characteristic value together with the average of the lowest 20% of the pH results. The characteristic water soluble value is 15mg/kg and the pH value is 7.16.

Natural Strata
Water soluble sulphate testing was undertaken on three samples of the natural Sand. The range of soluble sulphate (SO4) recorded is 23mgl/l to 86mg/l and associated pH values ranged between 7.8 and 8.6 indicating slightly alkaline conditions.

In a dataset where there are less than five samples, the highest water soluble sulphate concentration and lowest pH result are taken as the characteristic value. The characteristic water soluble value is 86mg/kg and the pH value is 7.8.

Granular deposits are present beneath the site therefore the groundwater is considered to be mobile.

The results of laboratory pH and sulphate content indicate that ACEC Class AC-1 and sulphate class DS-1 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005. The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site-specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

8.7 Highway Design

CBR values of greater than 5% are likely to be achieved in undisturbed natural Sand deposits for pavement design purposes, unless proven otherwise by in-situ testing at sub-base level by a specialist geotechnical engineer. As a minimum, the subgrade should be proof rolled prior to construction.

Untreated Made Ground should be assumed to have a CBR value of less than 2.5%, unless proven otherwise. Highways Agency document HD25 'Interim Advice Note 73/06 Revision 1' (2009) states that where a subgrade has a CBR value lower than 2.5%, it is considered unsuitable support for a pavement foundation since it would tend to deform under construction traffic and must be improved.

Where highways are proposed in areas underlain by Made Ground, it is recommended that Made Ground to a depth of 1.0m below subgrade level is excavated, sorted, and classified in accordance with Series 600 (Earthworks) of the Highways Agency "Specification for Highways Works". Following the above, any suitable material which can be used as part of highway construction shall be compacted in accordance with the earthwork's specification.

The soils are considered to be frost susceptible due to the fines content and highway construction should be a minimum thickness of 450mm to mitigate the risk.

8.8 Sustainable Urban Drainage System (SuDS)

SuDS testing was undertaken in two locations across the site in full accordance with BRE Digest 365 'Soakaways' (2016). A summary of the soil percolation test results is given below, and the full results are presented in *Appendix 12.*

Location	Depth (m bgl)	Test No.	Infiltration Rate m/s	BRE Compliant (Y/N)
SuDS1	*1.20*	*1*	*1.19×10^{-4}*	*Y*
SuDS1	*1.20*	*2*	*9.16×10^{-5}*	*Y*
SuDS1	*1.20*	*3*	*7.87×10^{-5}*	*Y*
SuDS2	*1.60*	*1*	*1.35×10^{-4}*	*Y*
SuDS2	*1.60*	*2*	*2.14×10^{-4}*	*Y*
SuDS2	*1.60*	*3*	*1.30×10^{-4}*	*Y*

Based on the results of the soil infiltration testing carried out within natural Sand, good drainage conditions have been proven at the positions and depths that were tested and the use of a SuDS drainage system is

considered to be a feasible option for the proposed commercial development. Deep Made Ground is present locally and SuDS design should take this into consideration.

9.0 LAND QUALITY

9.1 Geo-Environmental Testing Results - Soils

Samples of Made Ground have been tested for a range of relevant Contaminants of Concern. In accordance with CLR11 (DEFRA & EA, 2004), a Generic Quantitative Risk Assessment (GQRA) has been undertaken to determine the significance of the concentrations as derived through Geo-Environmental analysis.

The GQRA process comprises the comparison of the actual concentrations measured on site with Generic Assessment Criteria (GACs) for the protection of human health.

The GACs used for the assessment of soil concentrations have been derived using the CLEA model. The GACs used and their ranking of importance are listed below:

- *Soil Guideline Values (SGVs) which demonstrate minimal risk.*
- *LQM/CIEH S4ULs which use the same toxicological data as the SGVs but different exposure criteria.*
- *C4SLs which demonstrate low risk.*

In deriving the GACs for use on Brownfield sites, we have assumed a 1% Soil Organic Matter unless the results indicate otherwise.

The proposed end-use for the site is a commercial development comprising an Aldi store with associated hardsurfaced areas. We have therefore undertaken the GQRA on the basis that the proposed development site falls under the commercial land-use scenario as defined in SR3 (EA, 2009b).

The strata or sources of contamination targeted by the laboratory testing scheduled is summarised in the table below:

Strata	Number of Samples Tested	Locations
Reworked Topsoil (Population 1)	*6*	*SuDS1, TP02, TP03, TP07, WS02 and WS03.*
Granular Made Ground (Population 2)	*9*	*SuDS2, BH1, BH2, BH3, WS01, TP01, TP04, TP06 and TP08.*

A summary of the Geo-Environmental Testing results is presented below and the GQRA screening values are presented in *Appendix 13*:

Metals				
Contaminant	Range (mg/kg)	Screening Value (mg/kg)	Number	Exceedances
Arsenic	*8.8 - 62*	*640*	*0*	-
Boron	*0.2 – 1.9*	*240000*	*0*	-
Cadmium	*0.1 – 2.0*	*230*	*0*	-
Chromium	*4.0 - 180*	*8600*	*0*	-
Hexavalent Chromium	*<1.0*	*49*	*0*	-
Copper	*12 – 130*	*68000*	*0*	-
Lead	*15 - 1300*	*2300*	*0*	-
Mercury	*<0.05 – 4.3*	*26*	*0*	-
Nickel	*4.1 - 34*	*1800*	*0*	-

Selenium	*<0.5 – 5.9*	*13000*	*0*	-
Zinc	*41 – 2500*	*730000*	*0*	-
Polycyclic Aromatic Hydrocarbons (PAHs)				
Contaminant	Range (mg/kg)	Screening Value (mg/kg)	Number	Locations
Naphthalene	*<0.03 – 0.25*	*190*	*0*	-
Acenaphthylene	*<0.03 – 0.10*	*83000*	*0*	-
Acenaphthene	*<0.03 – 0.25*	*84000*	*0*	-
Fluorene	*<0.03 – 0.34*	*63000*	*0*	-
Phenanthrene	*<0.03 – 4.1*	*22000*	*0*	-
Anthracene	*<0.03 – 3.7*	*520000*	*0*	-
Fluoranthene	*0.05 – 20*	*23000*	*0*	-
Pyrene	*0.03 – 16*	*54000*	*0*	-
Benzo(a)anthracene	*<0.03 – 6.5*	*170*	*0*	-
Chrysene	*0.03 – 5.2*	*350*	*0*	-
Benzo(b)fluoranthene	*<0.03 – 4.6*	*44*	*0*	-
Benzo (k)fluoranthene	*<0.03 – 1.8*	*1200*	*0*	-
Benzo(a)pyrene	*<0.03 – 4.00*	*35*	*0*	-
Indeno(123cd)pyrene	*<0.03 – 1.60*	*500*	*0*	-
Dibenzo(ah)anthracene	*<0.03 – 0.41*	*3.5*	*0*	-
Benzo(ghi)perylene	*<0.03 – 1.8*	*3900*	*0*	-
TPH CWG - Aliphatics				
Contaminant	Range (mg/kg)	Screening Value (mg/kg)	Number	Locations
>C5-C6	*<0.01*	*3200*	*0*	-
>C6-C8	*<0.01*	*7800*	*0*	-
>C8-C10	*<0.01*	*2000*	*0*	-
>C10-C12	*<1.5 – 2.6*	*9700*	*0*	-
>C12-C16	*<1.2 – 4.0*	*59000*	*0*	-
>C16-C35	*<3.4 – 128.3*	*1600000*	*0*	-
TPH CWG - Aromatics				
Contaminant	Range (mg/kg)	Screening Value (mg/kg)	Number	Locations
>C5-EC7	*<0.01*	*26000*	*0*	-
>EC7-EC8	*<0.01*	*56000*	*0*	-
>EC8-EC10	*<0.01*	*3500*	*0*	-
>EC10-EC12	*<0.9 – 4.1*	*16000*	*0*	-
>EC12-EC16	*<0.5 - 11*	*36000*	*0*	-
>EC16-EC21	*<0.6 - 26*	*28000*	*0*	-
>EC21-EC35	*<1.4 - 450*	*28000*	*0*	-
Total aliphatics and aromatics(C5-35)	*<10 - 630*	-	-	-
MTBE	*<0.01*	*7900*	*0*	-
Benzene	*<0.01*	*95*	*0*	-
Toluene	*<0.01*	*4400*	*0*	-

Ethylbenzene	*<0.01*	*2800*	*0*	*-*
m/p-Xylene	*<0.01*	*6700*	*0*	*-*
o-Xylene	*<0.01*	*2600*	*0*	*-*
Others				
Organic Matter (%)		*0.4 – 2.6*		
Asbestos Screen				
Position	Depth (m bgl)	Asbestos Type	Asbestos Quantity (mass %)	
TP01	*0.50*	*Crocidolite, Chrysotile*	*0.41 mass %*	
TP02	*0.30*	*None Detected*		
TP03	*0.10*	*None Detected*		
TP04	*0.40*	*None Detected*		
TP06	*1.00*	*None Detected*		
TP07	*0.10*	*None Detected*		
TP08	*0.40*	*Chrysotile ACM recorded as visible paper fragments*	*(awaiting quantification results)*	
WS01	*0.80*	*Crocidolite, Chrysotile*	*0.31 mass %*	
WS02	*0.20*	*Chrysotile*	*0.016 mass %*	
WS03	*0.20*	*None Detected*		
BH1	*1.00*	*None Detected*		
BH2	*0.50*	*Chrysotile*	*(awaiting quantification results)*	
BH3	*0.50*	*None Detected*		
SuDS1	*0.20*	*None Detected*		
SuDS2	*0.40*	*Chrysotile*	*(awaiting quantification results)*	

Generally, the VOCs and SVOCs were recorded at concentrations below the laboratory limits of detection. However, the following were above the limits of detection:

- *Dibenzofuran in TP08 (0.4m) and SuDS2 (0.4m) at concentration of 0.2mg/kg and 0.5mg/kg respectively.*
- *Carbazole in TP08 (0.4m), SuDS2 (0.4m), BH1 (1.0m) and WS01 (0.8m) at concentrations of between 0.2mg/kg and 1.5mg/kg.*
- *2-Methylnaphthalen in SuDS2 (0.4m) and BH1 (1.0m) at concentrations of 0.1mg/kg to 0.2mg/kg.*

The risk from the COC listed above will be addressed using speciated PAHs S4ULs as they are from the same source and the CoC are of similar composition.

9.2 Generic Quantitative Risk Assessment - Soils

Made Ground was encountered across the entire site to a maximum depth of 4.0m bgl, visual evidence of potential contamination was observed in the form of black ash as a minor constituent in the Made Ground in BH1, TP01, Trench 1 and Trench 2 between depths of 0.2m and 4.0m bgl. These were all in the area of the backfilled dock.

Metals, PAHs and Hydrocarbons

Geo-environmental testing indicates that there are no elevated concentrations of heavy metals, speciated Polycyclic Aromatic Hydrocarbons (PAHs) and hydrocarbons based on the site having a commercial end use.

A total TPH concentration of 630mg/kg was recorded in a sample of Made Ground from WS01 at 0.8m in the southern part of the site in the area of the former ship building yard. Interpretation by the laboratory indicates it is a trace that is unidentifiable. This concentration is not elevated above commercial screening values.

Based on the geo-environmental results, the former use of the site as railway land does not appear to have impacted the soils that were recovered as part of this investigation.

VOCs and SVOCs

Volatile Organic Compound (VOC) and Semi-Volatile Organic Compound (SVOC) testing was carried out on five samples of the Made Ground from across the site. Generally, all of the VOC compounds were recorded at concentrations below the limits of detection (LoD). Dibenzofuran, Carbazole and 2-Methylnaphthalene were recorded slightly above laboratory detection limits locally. These compounds are generally associated with coal tar and fuel and the risk can be assessed using speciated PAH S4ULs.

The VOC testing results are in keeping with the PID results measured in the field on environmental samples which were recorded as 0ppm in the soils.

Asbestos

Crocidolite and Chrysotile asbestos fibres were detected at concentrations levels between 0.016 mass% and 0.41 mass% in TP01 at 0.5m, TP08 at 0.4m, WS01 at 0.8m, WS02 at 0.2m, BH2 at 0.5m and SuDS2 at 0.4m within the Made Ground consisting of reworked topsoil, ashy gravelly sand, gravelly sand and clayey sand and gravel. These exploratory holes were all in the eastern half of the site in the vicinity of the proposed store.

The likely sources of the widespread asbestos are the former railway land and the ship building yard. In addition, it could also be related to materials used to infill any sand pits that were present onsite.

During the previous ESP Ground Investigation, asbestos was also detected as being widespread across the site.

9.3 Groundwater Testing

Three samples of groundwater were taken from BH2 to BH4 and were tested for a similar suite of Contaminants of Concern as the soils and the results compared with reference to a selection of guidance documents as detailed at the rear of this report.

The implementation of the Water Framework Directive (WFD) is to protect and enhance the quality of groundwater and groundwater-dependent ecosystems. The objective of the WFD requires all groundwater bodies (GWBs) are of 'good' status in terms of water quality. This status is based on thresholds for the chemical constituents of groundwater and their impact on ecosystems. Preventing pollution is by far the most sustainable and cost-effective way of maintaining good groundwater quality. National Resource Wales (NRW) are committed to the 'prevent or limit' approach reflected in EU and domestic legislation.

Priority is under the Water Framework Directive to protect water supplies intended for human consumption and ensure protection of groundwater quality that supplies dependent ecosystems. After first guidance in 1992 the following significant guidance has been introduced:

- *Water Framework Directive (2000/60/EC) and the Water Act 2003.*
- *The State of Groundwater in England and Wales 2006.*
- *Second phase of the environmental permitting regime in 2010 replacing the Groundwater Regulations (1999, 2009).*
- *Groundwater Daughter Directive.*

Pollutants can be divided into those that break down easily (degradable pollutants) and those that do not (non-degradable pollutants). The Water Framework Directive introduced the concept of 'hazardous substances' and 'non-hazardous pollutants', which replaced the previous List I and List II of substances considered to pose the greatest threat to the environment.

- *Hazardous substances are the most toxic and must be prevented from entering groundwater. Substances in this list may be disposed of to the ground, under a permit, but must not reach groundwater. They include pesticides, sheep dip, solvents, hydrocarbons, mercury, cadmium and cyanide.*

- *Non-hazardous pollutants are less dangerous and can be discharged to groundwater under a permit but must not cause pollution. Examples include sewage, trade effluent and most wastes. Non-hazardous pollutants include any substance capable of causing pollution and the list is much wider than the previous List II of substances. For example, nitrate is now a non-hazardous pollutant whereas before it was not a List II substance.*

Polluting substances in groundwater can occur as a gas (gaseous phase) or dissolved in water (aqueous phase), or as a non-aqueous phase liquid (NAPL). Some pollutants include substances that dissolve readily in water. These are said to have high solubility; an example is MTBE. Substances that have low solubility (such as oil) are referred to as non-aqueous phase liquids (NAPLs). NAPLs behave differently in groundwater depending on whether they are lighter or heavier than water. Light non-aqueous phase liquids (LNAPLs) may float on the water table whereas dense non-aqueous phase liquids (DNAPLs) may sink through the aquifer until they reach an impermeable layer. They may then generate plumes of contamination. In both cases, the slowly dissolving pollutant may form a plume of dissolved contamination which moves with the groundwater flow.

A table summarising the groundwater testing results is presented below:

Metals				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
Arsenic	*2.6 - 3.6*	*50*	*0*	-
Boron	*56 - 62*	*1000*	*0*	-
Cadmium	*<0.5*	*<0.08 - 0.25*	*0*	-
Chromium	*1.8 – 2.8*	*4.7*	*0*	-
Hexavalent Chromium	*<0.006*	*3.4*	*0*	-
Copper	*<7*	*1 - 28*	*0*	-
Cyanide	*<0.1*	*1*	*0*	-
Lead	*<5*	*1.2*	*0*	-
Mercury	*<1*	*1*	*0*	-
Nickel	*<2*	*4*	*0*	-
Zinc	*<3 - 4.0*	*8 - 125*	*0*	-

Polycyclic Aromatic Hydrocarbons (PAHs)				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
Benzo(a)pyrene	*<0.016*	*0.00017*	*0*	-
Indeno(123cd)pyrene	*<0.011*	*0.00017*	*0*	-
Benzo(ghi)perylene	*<0.011*	*0.00017*	*0*	-
Benzo(b)fluoranthene	*<0.01*	*0.00017*	*0*	-
Benzo(k)fluoranthene	*<0.01*	*0.00017*	*0*	-
TPH CWG – Aliphatics				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
>C5-C6	*<10*	*15,000*	*0*	-
>C6-C8	*<10*	*15,000*	*0*	-
>C8-C10	*<10*	*300*	*0*	-
>C10-C12	*<5*	*300*	*0*	-
>C12-C16	*<10*	*300*	*0*	-
>C16-C35	*<10*	-	-	-
Total aliphatics C5-35	*<10*	-	-	-
TPH CWG - Aromatics				
Contaminant		EQS (ug/l)	Exceedances	Locations
>C5-EC7	*<10*	-	-	-
>EC7-EC8	*<10*	-	-	-
>EC8-EC10	*<10*	-	-	-
>EC10-EC12	*<5*	*90*	*0*	-
>EC12-EC16	*<10*	*90*	*0*	-
>EC16-EC21	*<10*	*90*	*0*	-
>EC21-EC35	*<10*	*90*	*0*	-
Total aromatics C5-35	*<10*	-	-	-
Total aliphatics and aromatics(C5-35)	*<10*	-	-	-
MTBE	*<0.1*	*15*	*0*	-
Benzene	*<0.5*	*10*	*0*	-
Toluene	*<5*	*74*	*0*	-
Ethylbenzene	*<1*	*300*	*0*	-
m/p-Xylene	*<2*	*30*	*0*	-
o-Xylene	*<1*	*30*	*0*	-
Others				
Total Hardness		*185 – 264mg/l*		

All of the VOCs tested for were recorded at concentrations below the laboratory limits of detection.

The screening values used in the above table were obtained from Environmental Quality Standard or Best Equivalent (EQS) for freshwater, testing results for salinity have been used to determine if EQS for Transitional (estuaries) and Coastal Waters should be used instead are pending. All contaminants screened were below screening values for both freshwater and coastal waters.

The EQS for Transitional (estuaries) and Coastal Waters where the screening values are more stringent are presented in the table below:

Contaminant of Concern	EQS (ug/l) Transitional (estuaries) and Coastal Waters
Arsenic	*25*
Hexavalent Chromium	*0.6*
Benzene	*8*
Toluene	*40*

9.4 Generic Quantitative Risk Assessment - Groundwater

Strata underlying the majority of the site consists of Made Ground over natural granular sands and gravels with occasional bands of Clay which are then underlain by Limestone bedrock. The superficial Blown Sand deposits are classified as a Secondary A Aquifer and the Oxwich Head Limestone bedrock is classed as Principal Aquifer.

During the Ground Investigation, groundwater was encountered at depths of between levels of 4.5m bgl and 7.5m bgl which equates to 0.28m AOD and 3.326m AOD. Groundwater level monitoring will assist in determining whether there are any tidal water influences beneath the site.

The nearest watercourse to the site is the Bristol Channel and is 93m to the south east, the contaminants tested for have generally been compared to EQS screening levels. No gross contamination was observed in the soils and this has been supported by no elevated concentrations of Contaminants of Concern being detected in the groundwater by the laboratory testing.

The former use of the site as a ship building yard and the southern area forming part of a dock has not impacted the groundwater. The localised Clay strata appears to have restricted migration towards the Bristol Channel.

9.5 Permanent Ground Gases

One gas monitoring visit has been carried out to date on 16th February 2021. No concentrations of methane (CH_4) were recorded within any of the boreholes during the visit. However, carbon dioxide (CO_2) was detected within the standpipes at a maximum concentration of 2.4% v/v with associated depleted oxygen (O_2) levels of 17.5% v/v.

No positive gas flows were recorded within any of the boreholes during the visit.

The atmospheric pressure recorded was at 1003mb and monitoring was undertaken during a period of steady barometric pressure.

Groundwater was encountered in BH1 to BH4 at depths of between 3.32m and 4.21m bgl. No groundwater was recorded in the standpipes installed in the window sample boreholes.

Characterisation of the Gas Screening Value (GSV)

Based upon the results recorded, in accordance with CIRIA Report C665, the risk to the site from ground gases has been assessed by converting the results to gas screening values (GSVs), calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates. In addition,

individual "hazardous gas flow rates" (Qhg) have been derived for each monitoring point. As no levels of methane have been recorded, a GSV for carbon dioxide only has been calculated.

GSV (l/hr) = max borehole flow rate (l/hr) x max gas concentration (%)

For this assessment, the maximum recorded concentration of carbon dioxide of 2.4%v/v has been used to calculate the GSV together with a positive flow rate of 0.1l/hr (the limit of detection of the gas analyser).

Carbon Dioxide GSV = 0.024 (2.4%) x 0.1 = 0.0024 l/hr

In order to assess the ground gas regime beneath the site and the need to incorporate ground gas precautions, guidance was taken from CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings'. Based on the site being developed for a commercial end use, the Wilson and Card method has been used to carry out the assessment.

When considering the results in accordance with CIRIA C665 (Section A Development and Table 8.5 – Modified Wilson and Card Classification) it can be seen that the GSV value for carbon dioxide is below the assessment GSV of 0.07 l/hr and falls within Characteristic Situation 1.

Characteristic Situation 1

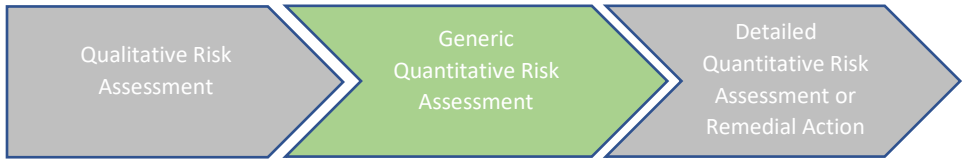
Based on the results to date, the proposed development classified as a Building Type C in accordance with BS 8485:2015 falls in CS1 in accordance with Table 2 of the above guidance and no gas protection measures are required. A full ground gas risk assessment will be carried out on completion of the monitoring.

Radon
The site is located in an area where basic radon precautions are required within the proposed development.

9.6 Revised Pollution Linkage Assessment

The pollution linkage assessment has been revised based on the Ground Investigation and testing to identify any realistic pollution linkages in order to quantify the risks to human health and controlled waters. An Illustrative CSM is presented on *GRO-21015-P05*.

Human Health Pollution Linkage Assessment



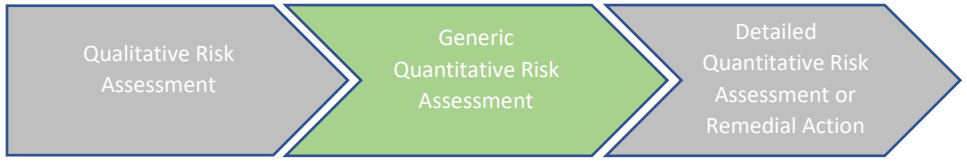
- The table below represents the second stage in the land quality risk assessment process - **the Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Generic Quantitative Risk Assessment*	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Unlikely	Medium	Low	*Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site.* *The site is currently an undeveloped field with a large area of hardsurfacing used for car parking. Historically the site was a shipyard and a smithy with railway lines running through. The southern area was part of a dock which has now been infilled. In addition, it appears that a number of old sand pits were present on site which have been infilled. More recently, a works compound was in the western area which included an above ground fuel tank.* *Geo-environmental testing indicates that there are no elevated Contaminants of Concern within the Made Ground based on the site being developed commercially. However, asbestos has been detected within six samples of Made Ground at a maximum concentration of 0.41 mass %. The Joint Industry Working Group combined hazard, exposure and receptor ranking is Medium.* *The proposed development is for a new Aldi store with associated car parking and a service yard. The site will therefore be covered with hardsurfacing which will break the*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
						pathway to potentially contaminated soils. As a result, a viable pollution linkage is not considered to exist.
PL2	Contaminated Soils	Inhalation of vapour.	Unlikely	Medium to Severe	Low	*This pollution linkage refers to volatile vapours migrating into confined spaces within the proposed development.* *During the Ground Investigation, no visual or olfactory evidence of hydrocarbon contamination was noted in the underlying soils. No TPH concentrations were recorded within the volatile range.* *In addition, the results of the PID testing were 0ppm indicating that no volatiles were present within the Made Ground soils.* *As no source has been identified, a plausible pollution linkage is not considered to exist.*
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	*This pollution linkage relates to contamination on the subject site affecting adjacent site users. No significant mobile contamination has been identified in the Ground Investigation and a viable pollution linkage is considered to exist.*
PL4	Contaminated Soils	Attacking potable water supply pipe.	Low Likelihood	Medium	Moderate	*Pollution Linkage 4 refers to the possible contaminants permeating potable water pipes and consumption by the future site end users of the tainted water supply. Made*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	*Rationale and Action*
						Ground has been encountered to a maximum depth of 4.0m bgl and organic contaminants have been identified in WS01 at 0.8m bgl. *New potable water supply pipes will be included as part of the commercial development therefore, a potential pollution linkage is considered to exist. A local water company risk assessment will be required prior to construction to advise on the level of protection required for any potable water supply pipes.*
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Likely	Medium to Severe	Moderate to High	*Made Ground has been identified up to 4.0m bgl associated with the infilling of a former dock. In addition, potential offsite sources of ground gas have been identified in the PRA.* *Initial monitoring places the site in CS1 and gas protection measures are not required. This will be confirmed on completion of the monitoring.* *However, the site is within an area requiring basic radon precautions within foundations.*

Controlled Waters Pollution Linkage Assessment



- The table below represents the second stage in the land quality risk assessment process – **Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					*Generic Quantitative Risk Assessment*	
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Unlikely	Medium	Low	*Deep Made Ground has been encountered beneath the site in the area of the former dock which has been infilled. However, no sources of mobile contamination were identified as part of the Ground Investigation.* *Groundwater testing indicates that no elevated CoC have been recorded within three samples that have been tested.* *The site is not within 500m of a SPZ and is not considered a sensitive resource. There are no groundwater or potable water abstractions within 2km.* *The proposed development will be completely covered with hardsurfacing and a new drainage system installed. This will considerably reduce infiltration and leaching of potential contaminants.* *Based on the results of testing, a pollution linkage is not considered to exist.*

Conceptual Site Model						*Generic Quantitative Risk Assessment*
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	*Rationale*
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	*Pollution Linkage 7 refers to the impaction of the Bristol Channel c.93m to the south east from contaminated soils and groundwater. No other surface water features are within 250m.* *No mobile contamination was encountered as part of the Ground Investigation and no elevated CoC were recorded in the groundwater samples that were tested.* *A viable pollution linkage is not considered to exist.*

9.7 Outline Remedial Strategy

Made Ground has been encountered across the entire site to a maximum depth of 4.0m bgl. No elevated concentrations of metals, speciated PAHs, VOCs and TPH CWG have been recorded in the Made Ground. However, asbestos has been detected in six locations in the eastern half of the site at a maximum concentration of 0.41 mass %.

Based on the site having a commercial end use, the site will be predominantly covered with hardsurfacing which will effectively act as a cover system. Where areas of soft landscaping are proposed, a clean cover system comprising 600mm of topsoil and subsoil will be required including a 100mm hard dig layer. The topsoil at the site is not considered to be appropriate to be used as part of the cover system as asbestos has been identified in it.

Based on the gas monitoring carried out to date, the site is within CS1 and gas protection measures will not be required. However, the site is in an area requiring basic radon precautions. A full ground gas risk assessment will be carried out on completion of the gas monitoring.

A watching brief should be maintained during the groundworks for any contamination previously unseen as part of this investigation. If any contamination is identified, work should cease, and Groundtech Consulting should be consulted immediately.

Approval from the regulators should be obtained prior to the development commencing to avoid any delays at the construction stage.

9.8 Asbestos in Soils

Asbestos fibres were detected within six samples of the granular and topsoil Made Ground soils that were screened from beneath the eastern part of the site to a maximum concentration of 0.41 mass %.

Based on the Joint Industry Working Group (JIWG) assessment, the work at the site will be non-licenced however following will be required during construction work:

- *RPE – EN140 with P3 filter half mask*
- *Localised mechanical dust suppression*
- *Localised and enhanced personal decontamination facilities*

The JIWG assessment tables are in *Appendix 14.*

9.9 Health and Safety - Construction and Ground Workers

During the reclamation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. The risk to construction and ground workers is assessed in the table below:

PL Ref	Potential Source	Pollution Linkage	Likelihood	Severity	Level of Risk
PL8	*Made Ground*	*Ingestion, direct contact, inhalation of dusts.*	*Unlikely*	*Medium*	***Low***
PL9	*Asbestos*	*Ingestion, direct contact, inhalation of dusts.*	*Likely*	*Medium*	***High***

Laboratory testing has confirmed that asbestos is generally present within the granular and topsoil Made Ground at concentrations between levels between 0.016 mass % and 0.41 mass %. The contractor should communicate the risks associated with asbestos with site personnel through a site induction and via information on noticeboards. The contractor should implement control measures to their satisfaction.

General guidance on these matters is given in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land". In summary, the following measures are suggested to provide a minimum level of protection:

- *All ground workers should be issued with the relevant protective clothing, footwear and gloves. These protective items should not be removed from the site and personnel should be instructed as to why and how they are to be used.*
- *Hand-washing and boot-washing facilities should be provided.*
- *Care should be taken to minimise the potential for off-site migration of contamination by the provision of dust suppression control and wheel cleaning equipment during the construction works.*
- *Good practices relating to personal hygiene should be adopted on the site.*
- *The contractor shall satisfy the Health and Safety Executive with regard to any other matters concerning the health, safety and welfare of persons on the site.*

9.10 Waste Classification by Assessment

We have reviewed the testing results and inputted them into the HazWasteOnline model which allows users to code and classify waste as defined in the EWC (European Waste Catalogue 2002) based on EC Regulation 1272/2008 on the Classification, labelling and packaging of substances and mixtures (CLP) and latest Environment Agency guidance (WM3 "Guidance on the classification and assessment of waste (1st edition 2015)-Technical Guidance").

This is a useful tool as waste producers have the legal responsibility to classify any waste they produce.

Three samples were tested to assess whether they contained any contaminants in the hazardous range when screened against assessment criteria within WM3. The results are in the Waste Classification Report presented in *Appendix 15* and are summarised in the table below.

Location	Depth (m bgl)	Material	Classification	Hazardous Properties
WS01	*0.80*	*MADE GROUND: gravelly sand.*	***Hazardous***	*Carcinogenic – zinc chromate and asbestos Ecotoxic -lead chromate and zinc chromate*
WS02	*0.20*	*MADE GROUND: sandy gravelly clayey topsoil.*	*Non-Hazardous*	-
WS03	*0.20*	*MADE GROUND: sandy gravelly clayey topsoil.*	*Non-Hazardous*	-
TP01	*0.50*	*MADE GROUND: ashy gravel.*	***Hazardous***	*Carcinogenic – zinc chromate and asbestos*
TP02	*0.30*	*MADE GROUND: clayey sand and gravel.*	*Non-Hazardous*	-
TP03	*0.10*	*MADE GROUND: sandy clayey topsoil.*	*Non-Hazardous*	-
BH1	*1.00*	*MADE GROUND: sandy ashy gravel.*	*Non-Hazardous*	-
BH2	*0.50*	*MADE GROUND: sandy clayey topsoil.*	*Non-Hazardous*	-
BH3	*0.50*	*MADE GROUND: clayey sand and gravel.*	*Non-Hazardous*	-
SuDS1	*0.20*	*MADE GROUND: gravelly sandy clayey topsoil.*	***Hazardous***	*Carcinogenic – zinc chromate*

Location	Depth (m bgl)	Material	Classification	Hazardous Properties
SuDS2	*0.40*	*MADE GROUND: clayey sand and gravel.*	***Hazardous***	*Carcinogenic – zinc chromate and EPH Mutagenic - EPH*
TP04	*0.40*	*MADE GROUND: clayey sand and gravel.*	*Non-Hazardous*	-
TP06	*1.00*	*MADE GROUND: clayey sand and gravel.*	*Non-Hazardous*	-
TP07	*0.10*	*MADE GROUND: gravelly sandy clayey topsoil.*	*Non-Hazardous*	-
TP08	*0.40*	*MADE GROUND: clayey sand and gravel.*	***Hazardous***	*Carcinogenic – zinc chromate*

Based on the HazWasteOnline assessment tool varying types of Made Ground have been classified as Hazardous including gravelly sand, ashy gravel and clayey sand and gravel. The materials classified as being hazardous are situated beneath the central and eastern parts and are generally associated with zinc chromate, lead chromate and asbestos. The zinc chromate and lead chromate is generally associated with paint and fuel which could have arisen from the site being used as a ship yard and dock.

However, all Made Ground should be assumed to be Hazardous and remain on site where possible which reinforces the use of displacement piles as the foundation solution.

In addition, asbestos is present across the site and where concentrations are greater than 0.1 mass % this material will also be classified as being hazardous.

Total testing was not undertaken on the natural soils and are assumed to be Non-hazardous.

9.11 Waste Acceptance Criteria (WAC) Results

The Landfill Directive (Directive 1999/31/EC on the landfilling of waste) led to the establishment of a methodology for classifying wastes. Wastes can only be accepted at a landfill if they meet the relevant Waste Acceptance Criteria (WAC) for that type of landfill. There are three different WAC, these are for:

- *Inert waste*
- *Non–hazardous waste*
- *Hazardous waste*

Wastes should first be classified based on their total concentrations as detailed in the previous section. WAC testing is then required if the end disposal route is a landfill.

Solid and eluate WAC analysis was undertaken on three samples, the findings of which are presented in the table below.

Reference	Depth (m)	Strata Type	Classification by Assessment	WAC Analysis	Landfill Disposal
TP01	*0.50*	*Made Ground*	*Hazardous*	*Stable Non-reactive*	*Hazardous*
BH1	*1.00*	*Made Ground*	*Non-Hazardous*	*Hazardous*	*Non-Hazardous*
SuDS2	*0.4*	*Made Ground*	*Hazardous*	*Stable Non-reactive*	*Hazardous*

The WAC testing has revealed that if the end disposal route of the Made Ground is landfill, two of the samples would be accepted at a Hazardous Landfill and one at a Non-Hazardous Landfill.

The possibility of automatic inert classification of the natural soils should be explored in accordance with Section 4.3 of the EA guidance document. The Council Decision includes a list of wastes in Section 2.1.1 of the document that are assumed to be inert and therefore acceptable at a landfill for inert waste without testing, this is the case if:

- *They are single stream waste of a single waste type (although different waste types from the list may be accepted together if they are from a single source)*
  and
- *There is no suspicion of material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify contamination and they do not contain other their disposal in other classes of landfill.*

If any organic contaminated material is encountered during the construction phase, it is possible that this may be classified as hazardous and testing should be undertaken at that time.

Materials should be segregated and where necessary sufficient time is allowed to further classify the material properly, including discussion with landfill sites and waste transfer stations to find the best disposal route. It is recommended that where possible, the soils could be recycled at a suitable local waste treatment plant or transfer station rather than a landfill disposal route.

The reuse of soils on the site this should be done in accordance with the CL:AIRE "Development Industry Code of Practice for the Definition of Waste" (CL:AIRE CoP). Any re-use scheme should be designed to minimise disposal costs.

After a cut and fill balance plan/volume calculation has been carried out, a U1 and T5 exemption could be registered. This will allow the use of the following soils without a waste permit or under Dow CoP MMP:

- *1,000 tonnes (c. 600m^3) of non-hazardous soil*
- *5,000 tonnes (c. 3,000m^3) of natural sand and gravels.*
- *50,000 tonnes (c. 25,000m^3) of bituminous material to be used in roadways.*
- *5,000 tonnes (c. 3,000m^3) of crushed concrete / stone.*

10.0 FINAL APPRAISAL

10.1 Land Quality

Historically the site formed a ship building yard, smithy and railway land. Part of a dock was on the south eastern area which has been infilled.

Across the majority of the site, the Made Ground was 0.2m to 1.8m in thickness. Deeper Made Ground was encountered in the western area in TP05 and TP06 to in excess of 2.2m bgl. The deepest Made Ground was encountered in BH1 in the south eastern part of the site to at least 4.0m bgl where an infilled dock was located.

Based on the site being developed commercially, no elevated Contaminants of Concern have been recorded, however asbestos has been detected in six samples of Made Ground at a maximum concentration of 0.41 mass %. As the proposed development will be covered by hardsurfacing, the risk to human health is *Low.*

Groundwater testing has been carried and no elevated concentrations have been recorded and the risk to controlled waters is *Low.*

Initial gas monitoring results place the site in CS1 and gas protection measures are not required. This will be confirmed on completion of the gas monitoring. The site is however located in an area requiring basic radon precautions.

Based on the results of geo-environmental testing, the Made Ground soils are likely to be classified as being Hazardous and should remain onsite where possible.

10.2 Ground Engineering

It is proposed to construct a new Aldi store in the eastern half of the site. Historically, a dock wall was present in the south eastern part of the site and this has been proven in Trench 1 and Trench 2 at depths of 5.536m AOD to 5.555m AOD. The proposed position of the south eastern corner of the Aldi store lies across the position of the dock wall as shown on Plan *GRO-21015-P04.* In order to mitigate this, foundations will need to be designed to cantilever over the dock wall or the proposed position of the store moved by circa 2m to the north.

The most appropriate foundation solution is considered to be driven piles transferring loads through the Sand and Clay end bearing in the underlying Limestone bedrock which has been encountered at depths of between 10.5m and 13.5m bgl. By using a displacement pile, this will minimise the amount of potentially contaminated spoil brought to the surface that will need to be removed as hazardous waste.

Based on the results of the soil infiltration testing carried out within natural sand, good drainage conditions have been proven at the positions and depths that were tested and the use of a SuDS drainage system is considered to be a feasible option for the proposed commercial development.

10.3 Required Further Work

The following further work is considered necessary to progress the site to construction phase:

Completion of gas monitoring programme.
Issue gas assessment.
Design of Remedial Specification.
Detailed foundation design.
Confirmation of the recommendations made within this report with the regulators.

11.0 RELEVANT INDUSTRY REFERENCES

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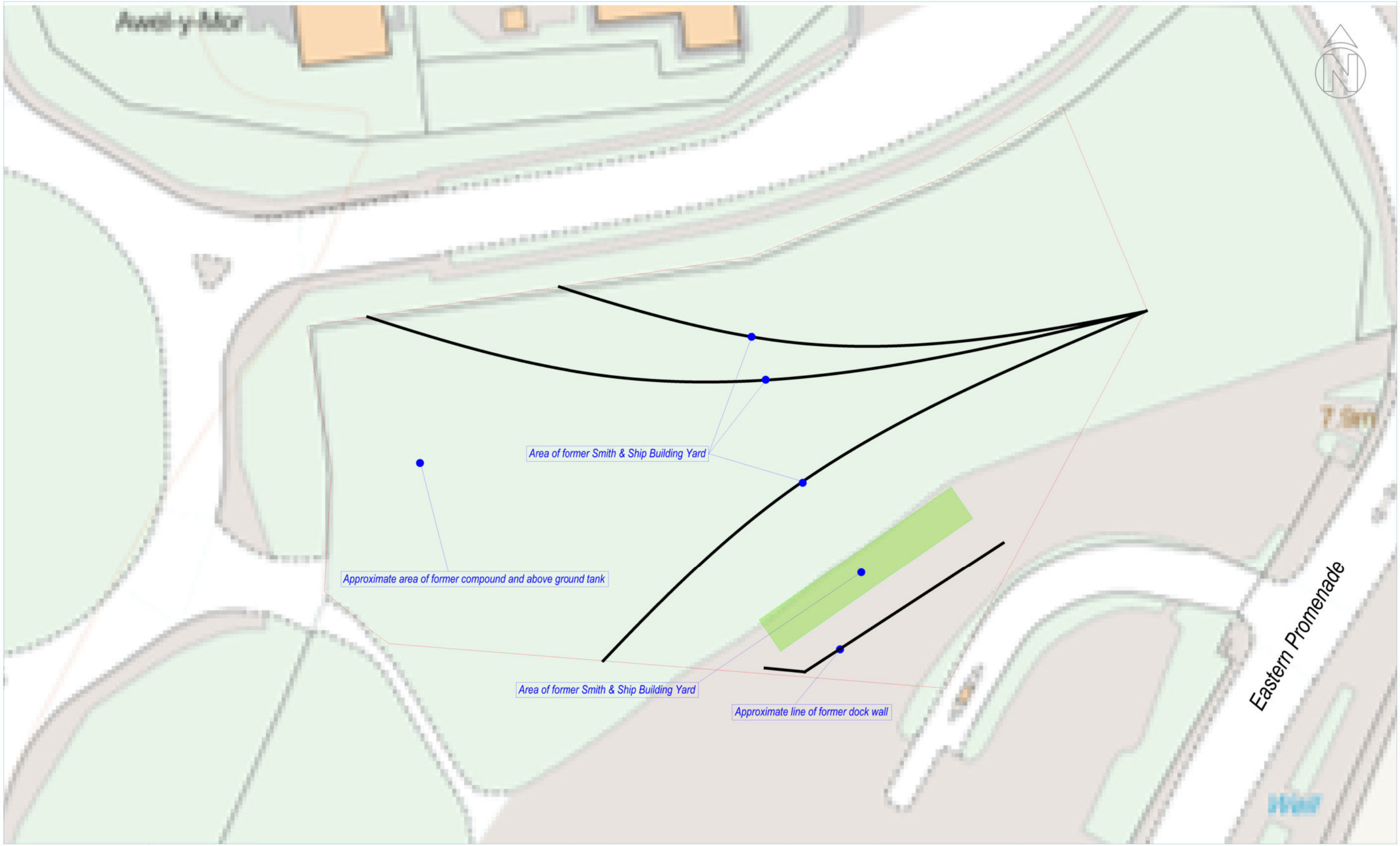
APPENDIX 1 - Plans

GROUNDTECH CONSULTING	CLIENT	DATE				Status
	ALDI STORES LIMITED	MARCH 2021				Preliminary
	PROJECT TITLE	SCALE				Draft
	ALDI PORTHCAWL	NTS				Issued ●
	PLAN TITLE	PLAN NUMBER				For Comment
	PROJECT LOCATION PLAN	GRO-21015-P01	Rev.	Details	Date	Approved

Notes

● Site Location



GROUNDTECH CONSULTING

CLIENT	ALDI STORES LIMTED
PROJECT TITLE	ALDI PORTHCAWL
PLAN TITLE	DEVELOPMENT CONSTRAINTS PLAN
DATE	MARCH 2021
SCALE	NTS
PLAN NUMBER	GRO-21015-P02

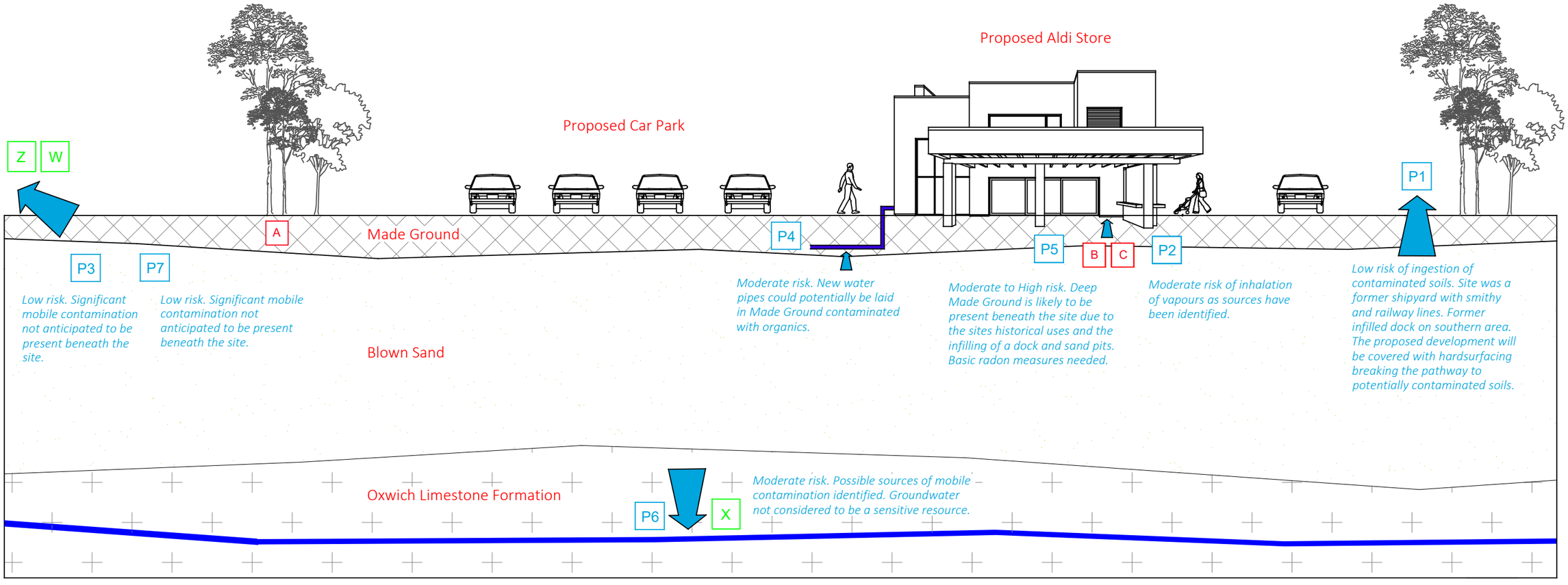
Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes

Approximate site boundary

SOURCES	POLLUTION LINKAGES	RECEPTORS
A. Contaminated Soils / Made Ground. B. Permanent Ground Gas.	P1. Ingestion of soil and dust. P2. Inhalation of vapour. P3. Inhalation of soil dust by adjacent site users. P4. Attacking of potable water supply pipe. P5. Migration and accumulation of ground gas in internal places. P6. Impaction of groundwater from soil contamination. P7. Migration of soil and groundwater contamination impacting surface waters.	W. Bristol Channel c.93m south east. X. Groundwater within the Secondary A Aquifer and Principal Aquifer. Y. Site end users. Z. Adjacent site users.



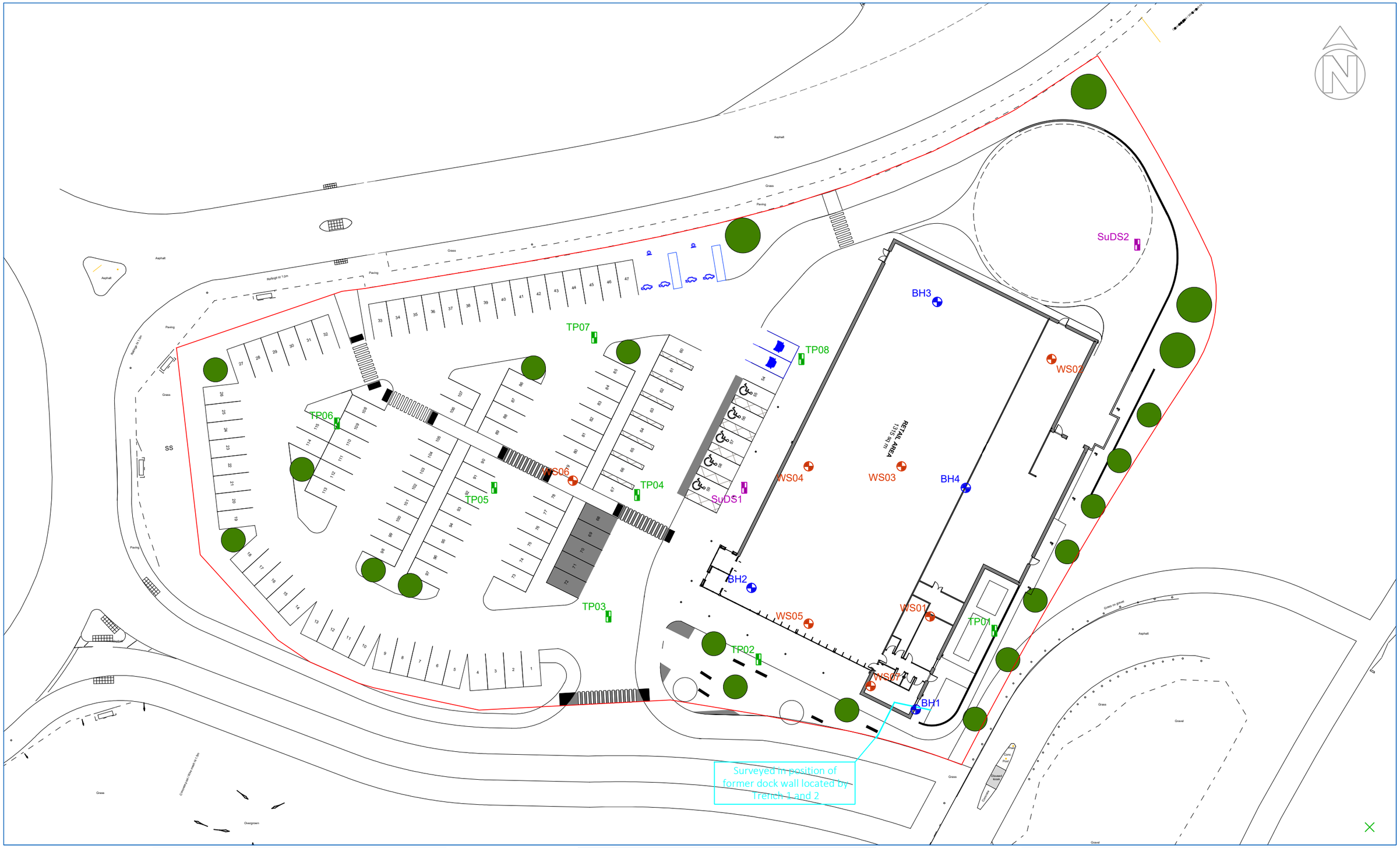
GROUNDTECH CONSULTING

CLIENT	ALDI STORES LTD
PROJECT TITLE	ALDI PORTHCAWL
PLAN TITLE	ILLUSTRATIVE PRELIMINARY CSM
DATE	MARCH 2021
SCALE	NTS
PLAN NUMBER	GRO-21015-P03

Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes



GROUNDTECH CONSULTING	CLIENT: ALDI STORES LTD	DATE: MARCH 2021
	PROJECT TITLE: ALDI PORTHCAWL	SCALE: 1:500 (A3)
	PLAN TITLE: SURVEYED EXPLORATORY HOLE LOCATION PLAN	PLAN NUMBER: GRO-21015-P04

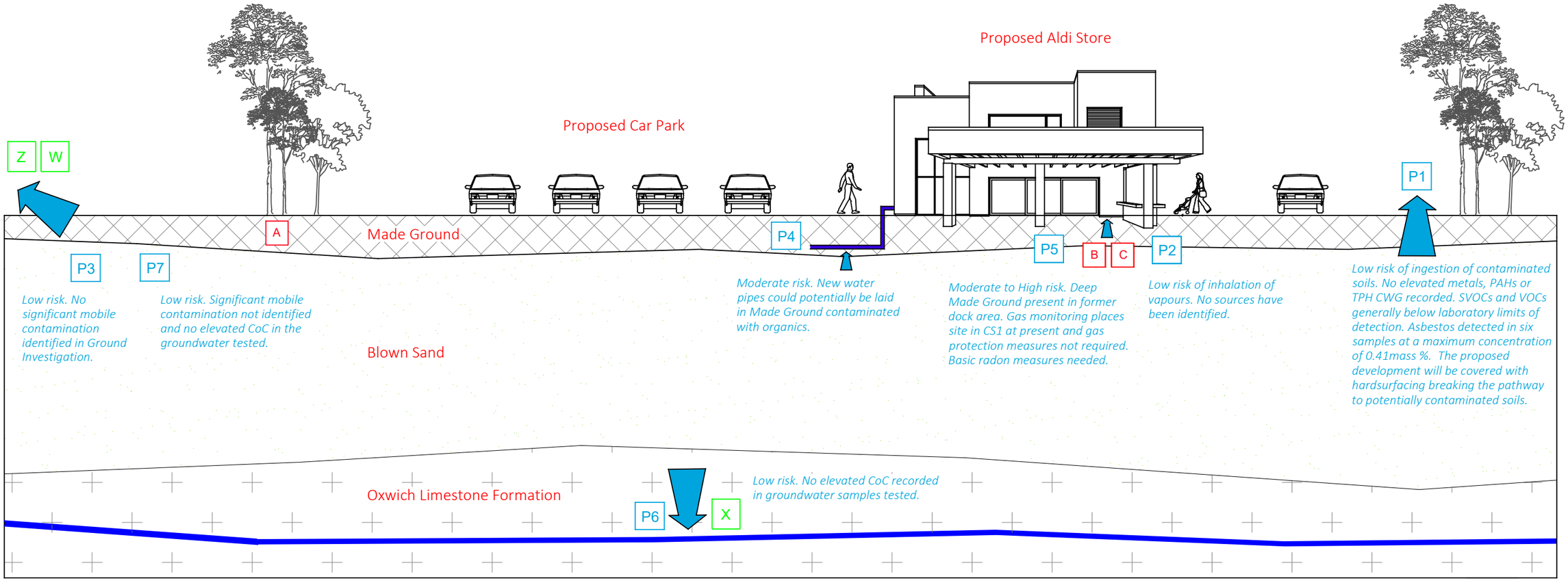
Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes

- *Cable percussive borehole location*
- *Window sample borehole location*
- *Trial Pit location*
- *Soil Percolation Test location*

SOURCES	POLLUTION LINKAGES	RECEPTORS
A. Contaminated Soils / Made Ground. B. Permanent Ground Gas.	P1. Ingestion of soil and dust. P2. Inhalation of vapour. P3. Inhalation of soil dust by adjacent site users. P4. Attacking of potable water supply pipe. P5. Migration and accumulation of ground gas in internal places. P6. Impaction of groundwater from soil contamination. P7. Migration of soil and groundwater contamination impacting surface waters.	W. Bristol Channel c.93m south east. X. Groundwater within the Secondary A Aquifer and Principal Aquifer. Y. Site end users. Z. Adjacent site users.



GROUNDTECH CONSULTING

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PROJECT TITLE	ALDI PORTHCAWL
PLAN TITLE	ILLUSTRATIVE REVISED CSM
DATE	MARCH 2021
SCALE	NTS
PLAN NUMBER	GRO-21015-P05

Rev.	Details	Date

Status	
Preliminary	
Draft	
Issued	●
For Comment	
Approved	

Notes

APPENDIX 2 - Site Photographs

Photograph 1 - General site area

Photograph 2 - Northern area of site.

Photograph 3 - SuDS1

Photograph 4 - SuDS2

Photograph 5 – TP01

Photograph 6 – TP02

Photograph 7 – TP03

Photograph 8 – TP04

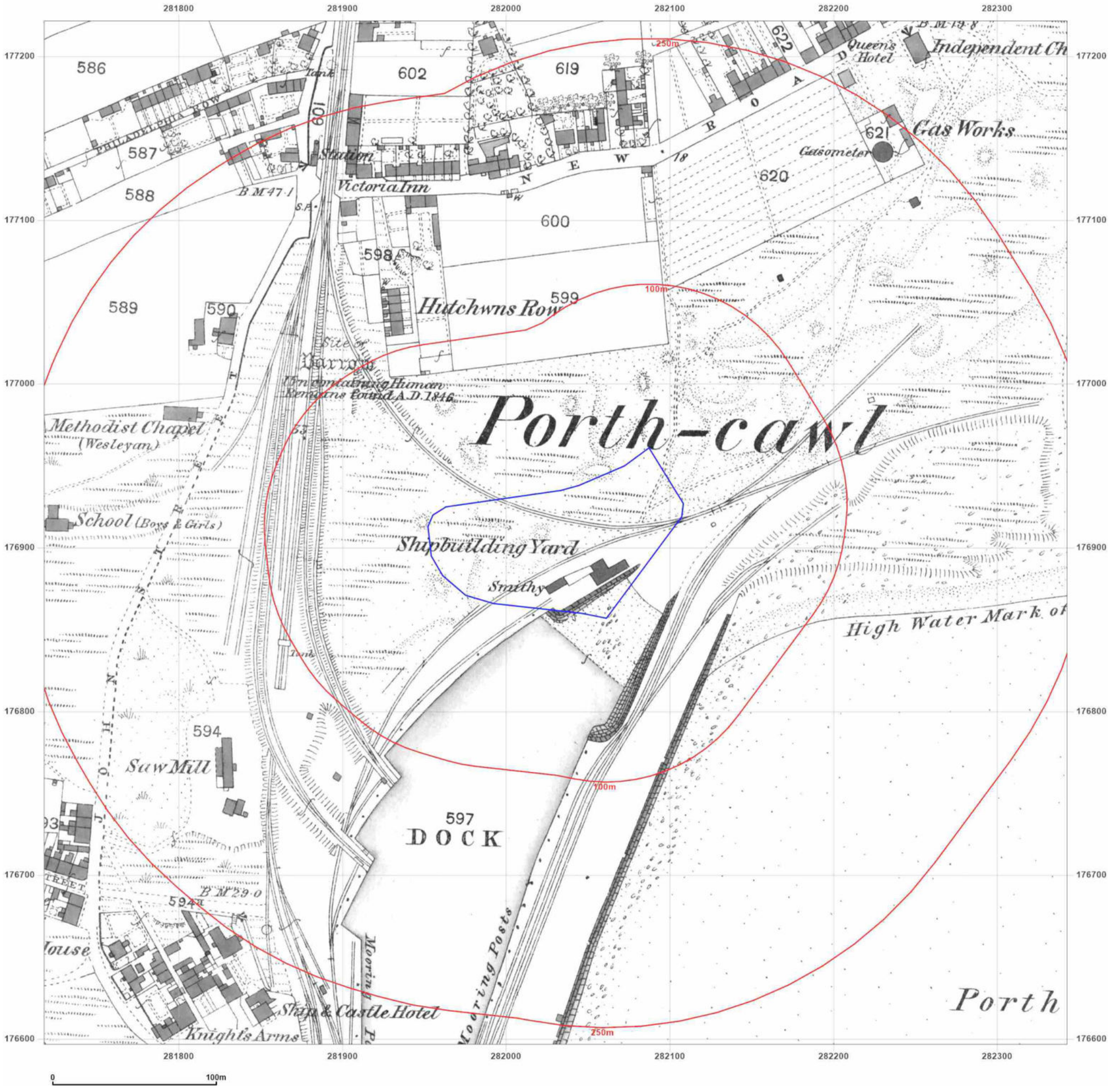
Photograph 9 – TP05

Photograph 10 – TP06

Photograph 11 – TP07

Photograph 12 – TP08

APPENDIX 3 - Historical Plans



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Porthcawl ,CF36 5TS

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Report Ref: EMS-663326_874858
Grid Ref: 282030, 176909

Map Name: County Series

Map date: **1880**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1880
Revised 1880
Edition N/A
Copyright N/A
Levelled N/A

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Production date: 21 January 2021

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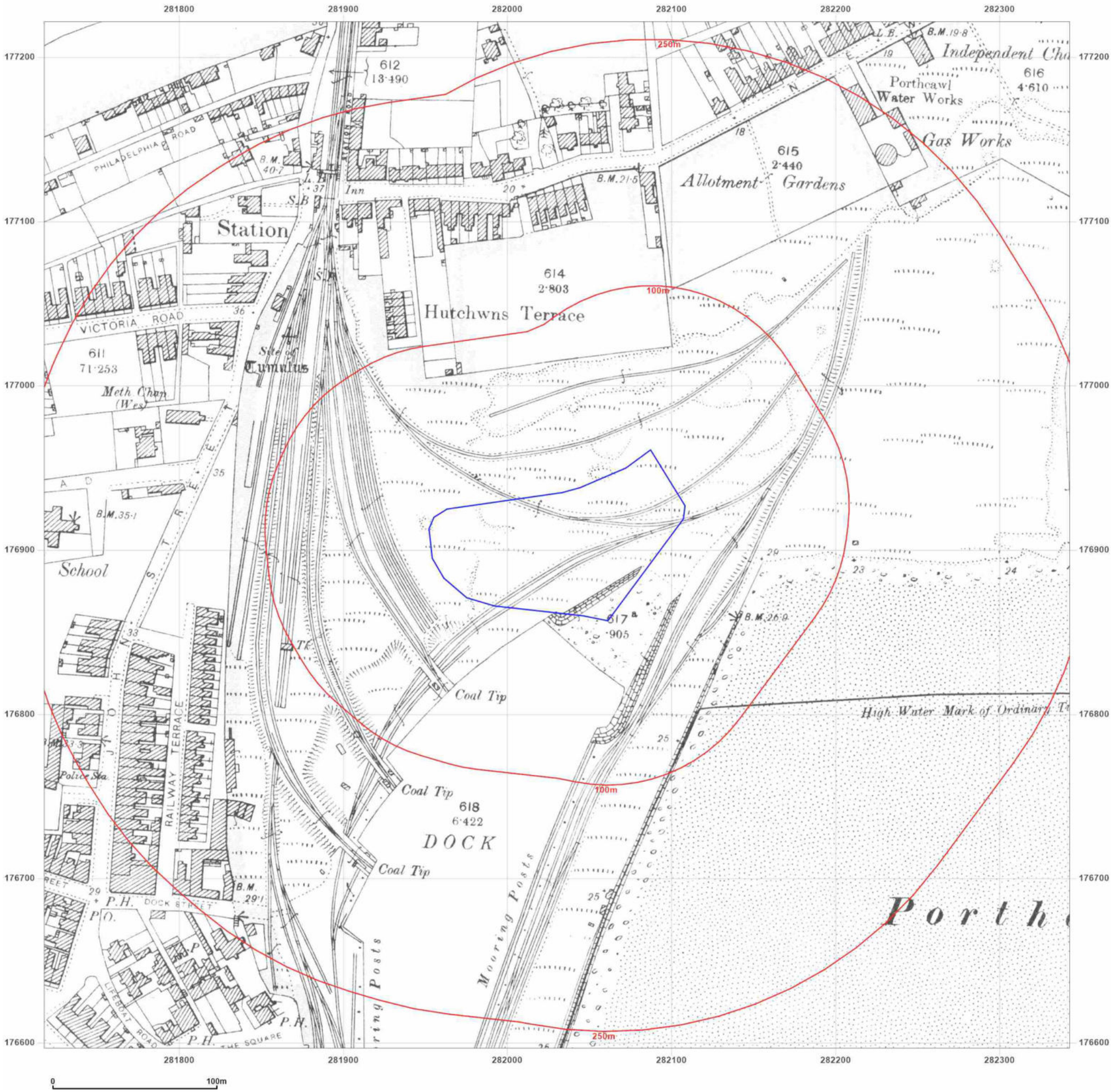

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Report Ref: EMS-663326_874858
Grid Ref: 282030, 176909

Map Name: County Series

Map date: **1899**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1899
Revised 1899
Edition N/A
Copyright N/A
Levelled N/A

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Client Ref: EMS_663326_874858
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Grid Ref: 282030, 176909

Map Name: County Series

Map date: **1919**

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Printed at: 1:2,500

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Surveyed 1919
Revised 1919
Edition N/A
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Levelled N/A

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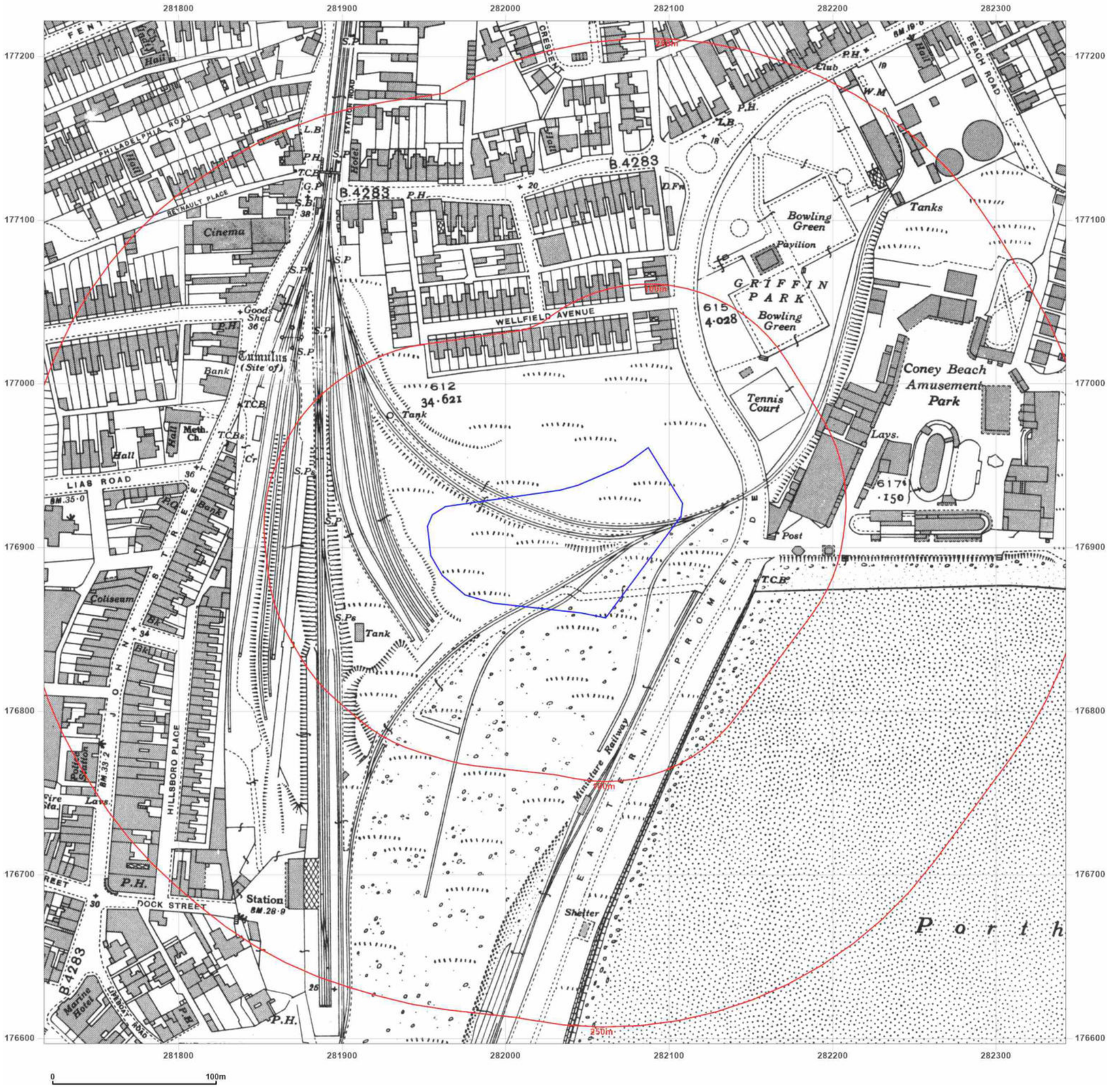

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Client Ref: EMS_663326_874858
Report Ref: EMS-663326_874858
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Map Name: County Series

Map date: **1943**

Scale: 1:2,500

Printed at: 1:2,500

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Surveyed 1943
Revised 1943
Edition N/A
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Levelled N/A

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Client Ref: EMS_663326_874858
Report Ref: EMS-663326_874858
Grid Ref: 282030, 176909

Map Name: National Grid

Map date: **1962**

Scale: 1:2,500

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Surveyed N/A
Revised N/A
Edition N/A
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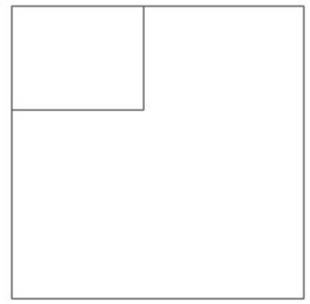

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Map Name: National Grid

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Surveyed 1965
Revised 1965
Edition N/A
Copyright 1966
Levelled 1962

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Surveyed 1968
Revised 1968
Edition N/A
Copyright 1969
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