

St. Johns, Manchester

Phase 2 Site Investigation

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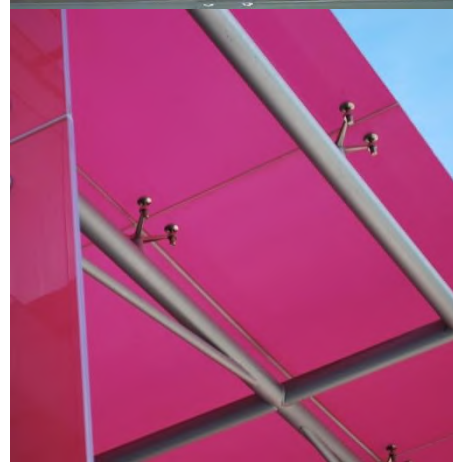
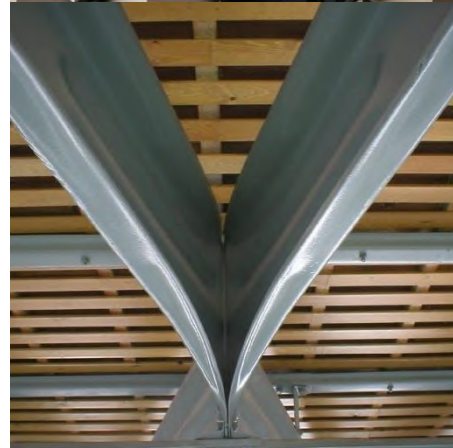
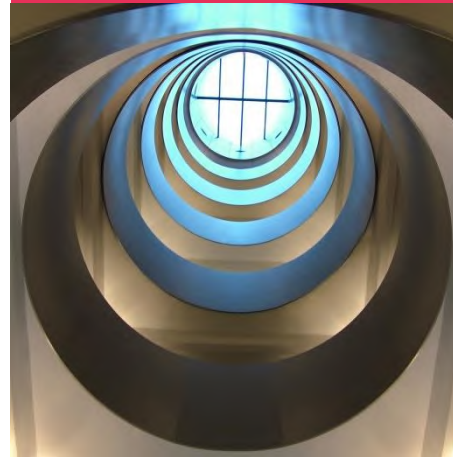
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Phase 2 Site Investigation

Rev	Description	Issued by	Checked	Date
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Executive Summary

Appointment	In February 2018, Curtins were instructed by Manchester Quays Ltd to undertake a Phase 2 Intrusive Investigation at the St. John's development site in Manchester city centre. The site is approximately centred on NGR 383110, 398029, and covers an area of approximately 5.4 ha. This investigation addresses recommendations as presented in previous Phase 1 reports, with the aim of the Phase 2 works to characterise geo-environmental conditions prior to redevelopment as generally high rise (up to 52-storeys) buildings comprising residential apartments with retail, leisure and commercial spaces, and dual storey basements.
Current Site Status	The development site is located in Manchester City Centre, in the Spinningfields area of the city. The site is currently occupied by the Old Granada Studios (central) with hardstanding external surfaces currently used for car parking. Beyond Quay Street at the north of the site, a small disused warehouse and hardstanding surfacing, is boarded by fencing, beyond which is a small area of soft landscaping directly south of New Quay Street. The south of the site is currently undergoing demolition.
Summary of Phase 1	The relatively flat and level site is currently occupied by the Old Granada Studios (Central) a disused warehouse (north) and recently demolished buildings (south) with hardstanding surfaces. The site was historically used for a range of commercial and industrial buildings and warehouses, with a former railway line in the south of the site. The site is underlain by Alluvium (west) and the Chester Pebble Beds Formation, with associated Secondary A and Principal Aquifer designations respectively. Two groundwater abstractions are located within 250m of the site, to the northeast, though neither are used for potable water supplies. The River Irwell is located approximately 60m west of the site, flowing from northeast to southwest. Seven discharge consents are located between the site and the River Irwell, all relating to storm water/storm sewage overflows. UXO Mitigation measures are required for all intrusive investigation works. Primary potential risks to be investigated during the Phase 2, as well as establishing ground conditions for geotechnical design, included; risks to human health and controlled waters, and potential for ground gas.
Fieldworks Undertaken	Fieldworks were carried out between 3rd April and 13th July 2018 and comprised eight window sample boreholes to maximum depth of 4.31m bgl, three cable percussive boreholes (4.00m - 4.70m) and five rotary open hole boreholes (4.20m - 5.00m), each with rotary cored follow on, to maximum depth of 55.00m bgl. Ground gas and groundwater monitoring standpipes or piezometers were installed in selected boreholes. Selected soil and rock samples were scheduled for chemical and geotechnical analysis. To date, three of six return ground gas monitoring visits have been undertaken. Groundwater samples have been scheduled to be obtained to allow for chemical assessment.
Encountered Ground Conditions	Made Ground deposits were encountered in all exploratory holes across the site, ranging in thicknesses between 0.60m to 6.25m, though typically reached a maximum thickness of 3.40m. Deposits comprise a thin layer of tarmacadam or concrete, underlain by loose brown, dark brown and blackish brown clayey gravelly fine to coarse sand, and soft to firm orangish brown, brown, grey or black slightly gravelly sandy clay, with various anthropogenic fragments. A hydrocarbon odour was recorded in WS03 at depths of between 0.10 – 1.20m bgl. A suspected infilled canal wall was identified in RBH02 from 0.40m – 6.25m bgl. These are underlain by up to 5.32m of superficial soils comprising firm dark brown slightly sandy slightly gravelly clay and loose to dense orangish and reddish brown gravelly fine to coarse sand. A limited thickness (0.20m) of black spongey peat was identified in RBH03 at 2.00m bgl. Bedrock (Chester Pebble Beds Formation) was encountered at depths between 3.05m to 7.45m bgl and comprised extremely weak to very strong thinly laminated to thickly bedded reddish brown fine and medium grained sandstone, with interbedded bands of mudstone and siltstone. The top of the bedrock is highly weathered, and often recovered as sand and gravel. Arisings from shallow exploratory holes were typically recovered as dry. Groundwater strike was unable to be recorded in deep cored boreholes due to the use of water flush drilling techniques.
Environmental Laboratory Testing and Ground Gas Monitoring Results	Soil chemical analysis results did not identify any exceedances when compared with Tier 1 screening thresholds for a 'Commercial' end use scenario. Asbestos boarding was identified in archaeological trenches undertaken at the same time as this investigation. No samples were scheduled for analysis. Groundwater chemical analysis identified exceedances of heavy metals and PAH concentrations when compared with EU DWS and WFD WQS thresholds. During ground gas monitoring, a maximum concentration of 4.0% v/v carbon dioxide (CO₂) was recorded in BH02 on the third visit. A maximum recorded steady state flow rate of 1.0l/hr was recorded in RBH02 on the third monitoring visit. Concentrations of methane (CH₄), carbon monoxide (CO) and hydrogen sulphide (H₂S) have been recorded below the instruments limit of detection. This maximum recorded level of CO₂ results in a calculated 'worst case' Gas Screening Value (GSV) of 0.0400 l/hr, if maximum flow is taken as 1.0 l/hr.

Phase 2 Site Investigation

Ground Contamination and Ground Gas Assessment	Risks to human health have been assessed as low on the basis that all Made Ground soils are to be removed from site to facilitate the construction of a dual storey basement. Risks to controlled waters (groundwater and surface water) have been assessed as low on the basis that all Made Ground soils are to be removed from site to facilitate the construction of a dual storey basement. Elevated concentrations identified in groundwater samples may be representative of background conditions. With reference to Situation A non-traditional construction as defined by the NHBC and the modified Wilson & Card classification as contained within CIRIA C665, the maximum methane and carbon dioxide concentrations and respective gas screening values indicate a Gas Characterisation Situation 1 (CS1) gas regime, requiring no gas protection measures for the proposed new development. Due to the proposed basement features, the advice of a specialist radon assessor should be obtained.
Preliminary Material Classification and Soils Reuse	If soil arisings are required to be disposed off-site, an initial assessment of shallow soils was carried out using a proprietary waste characterisation assessment tool. Results of nineteen Made Ground soil samples identified that seventeen samples indicated to be non-hazardous for off-site disposal. Two samples indicated to be hazardous owing to the concentrations of copper and copper (RBH06 at 0.40m) and benzo(a)anthracene, diesel, copper, lead and zinc (WS03 at 0.30m bgl). In addition, asbestos board was identified in archaeological trenches, which should be appropriately managed and disposed of by an appropriately licensed contractor. The initial assessment of the seven natural soil samples tested may be considered non-hazardous waste for off-site disposal. Where natural soils are being considered for off-site disposal as inert waste, Waste Acceptance Criteria (WAC) testing should first be undertaken with confirmation of acceptability from the receiving landfill. The Contractors should satisfy themselves regarding the classification of any waste arisings. Confirmation of acceptability should be sought from the receiving landfill or treatment facility via the issue of laboratory chemical testing results.
Geotechnical Assessment	The Made Ground and the superficial deposits are not considered to be suitable founding strata due to the likely significant loadings for a high-rise building and it is considered that a piled foundation solution is adopted designed as end bearing in the sandstone bedrock. However, pad foundations for the low-rise buildings may be suitable founding in the superficial deposits /completely weathered sandstone. Square pad foundations maybe suitable for the low-rise buildings with a presumed bearing resistance of approximately 400-600kN/m² founding at 4.5m bgl in the weathered Sandstone increasing to approximately 600 - 1000 kN/m² at 8.0m bgl founding in the partially weathered sandstone. For the high-rise buildings it is considered that a piled foundation be adopted to accommodate the significant loads. Initial estimates in accordance with Eurocode 7 (Ref.7) indicate that a bored pile of 750mm diameter and 16m length would provide a total design resistance of 11,025 kN for combination 1 and 6228 kN for combination 2. Increasing to 14,502 kN combination 1 and 8110 kN combination 2 for a 900mm diameter bored pile of 16m length. Due to the likely presence of groundwater into excavations once rockhead is penetrated a contiguous pile or secant piled foundation should be considered to reduce groundwater flow into excavations to enable basements to be constructed. It is recommended that all ground slabs should be suspended to account for the high structural loads and any potential hydrostatic uplift. Basement slabs should be developed to span between foundations to resist buoyancy. The potential risk of floatation should be considered in the temporary condition during construction. Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. An allowance should be made for breaking out and removing any encountered concrete obstructions associated with existing foundations. Temporary earthworks support is envisaged to allow the proposed construction within the Made Ground outside the permanent basement wall, which may be in the form of sheet piled walls, subject to design by a temporary works engineer.
Recommendations	Based on the findings of the ground investigation, the following recommendations are made: 1) It is anticipated that all Made Ground soils are to be removed from site to facilitate the construction of a dual storey basement. It is considered unlikely that a remediation strategy will be required for this development; 2) Further numerical analysis be undertaken to model the pile interaction with the sandstone in order to obtain a greater understanding of the pile carrying capacity and settlement; and 3) Notwithstanding, appropriate PPE should be supplied to and worn by all groundwork and construction personnel during the basement excavation, and other groundwork and construction activities, with reference to the environmental testing results presented herein and within Appendix C.

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1.0 Introduction

1.1 Project Background

In February 2018 Curtins were instructed by Manchester Quays Limited to undertake a Phase 2 Intrusive Investigation at the St. Johns site in Manchester city centre. The site is approximately centred on NGR 383110, 398029, and covers an area of approximately 5.4 ha. A site location plan is presented as *Figure 2.1*.

1.2 Scope of Services

This investigation addresses recommendations as presented in previous Curtins Phase 1 reports (refs. 1-4), with the aim of the Phase 2 works to characterise geo-environmental conditions prior to redevelopment as generally high rise (up to 52-storeys) buildings comprising residential apartments with retail, leisure and commercial spaces with a dual storey basement. The current development plans for which can be referred to within *Appendix A* of this report.

Specifically, the Phase 2 report is intended to determine:

- a) If there is a risk of the proposed end user being adversely impacted upon by potential contamination in shallow site soils that may be present on the site due to its known current, recent and historical use;
- b) If there is a risk of groundwater and/or surface water being adversely impacted upon by potential contamination that may be present on the site due to its known current, recent and historical use;
- c) If there is a risk to the end user from soil gases including methane, carbon dioxide, carbon monoxide and hydrogen sulphide;
- d) Preliminary recommendations for the design of basement walls and foundation design; and
- e) Recommendations for the specification of sub-structure concrete and water supply pipes.

Consideration of detailed flood risk, ecology and archaeological issues are outside of the scope of this report.

2.0 Phase 1 Preliminary Site Assessment Summary

This section presents a summary of the current site setting, history, geology and hydrogeology/hydrology, as presented in the following Phase 1 Reports:

- Curtins Phase 1 Preliminary Site Assessment for Bonded Warehouse and Energy Centre (Report ref. B049241/JJ/6744) dated 24th May 2018 (Ref. 1);
- Curtins Phase 1 Preliminary Site Assessment for St. John's Place, Manchester (Report ref. B049228/JJ/6743) dated 24th May 2018 (Ref. 2);
- Curtins Phase 1 Preliminary Site Assessment for Central Village, Manchester (Report ref. B061604.010)/JJ/6923) dated 12th July 2016 (Ref. 3); and
- Curtins Phase 1 Preliminary Site Assessment for Old Granada Studios, Manchester (Report ref. B049242/JJ/6736 Rev. A) dated 19th June 2017 (Ref. 4).

It is not the intention of this report to duplicate the information within the above documentation, rather the information below providing the background information to support the revised post Phase 2 siteworks Conceptual Site Model (CSM), as presented in *Section 8.0*.

2.1 Current Setting

The development site is located in Manchester City Centre, located off Quay Street in the Spinningfields area of the city. Figure 2.1, overleaf, outlines the location of the proposed development.

Surface cover across the site is predominantly tarmac roads and hardstanding surfaces, with concrete surfaces within existing buildings. The site is currently occupied by the following:

Table 2.1 – Summary of the Existing Land Use On-Site

Location	Description
North (New Quay Street to Quay Street)	Disused warehouse and low-rise office building Small area of soft landscaping directly south of New Quay Street.
Central Portion (South of Quay Street, East of Water Street)	Old Granada TV Film Studios and hardstanding surfaces for car parking. Studios comprise warehouses and office facilities
South (Grape Street)	Two existing buildings with hardstanding external surfaces. Demolition works currently being undertaken.
West (West of Water Street)	Vacant Land

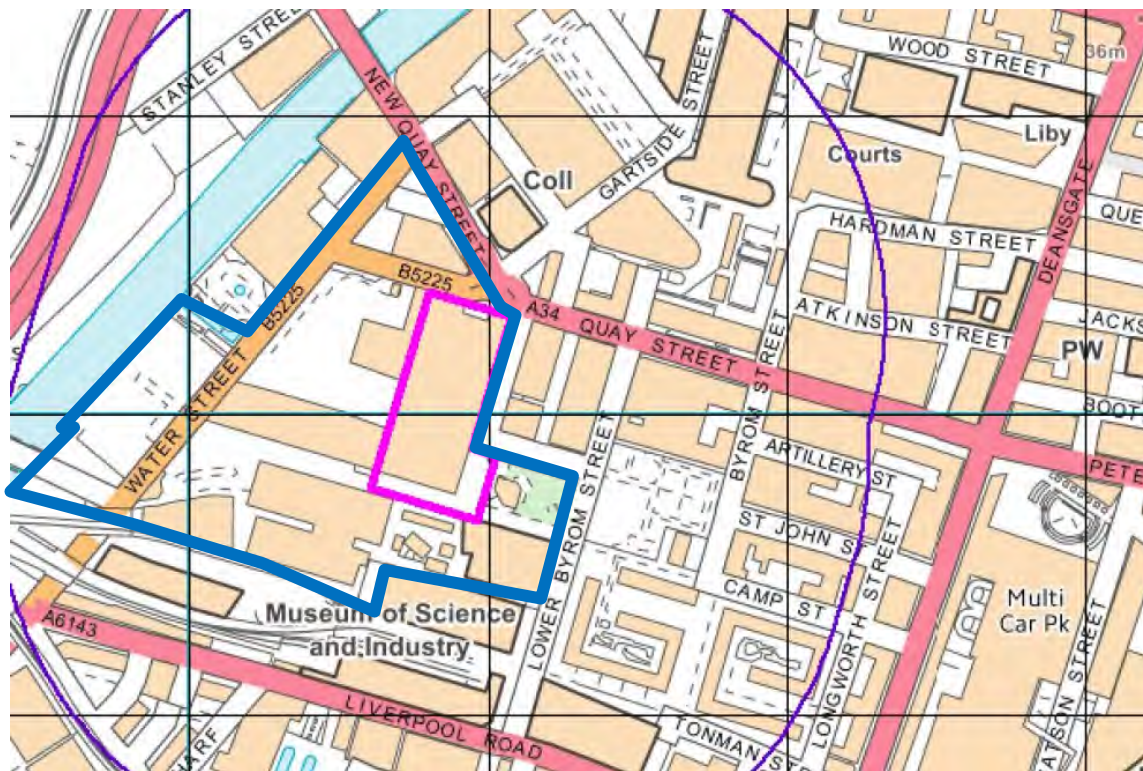


Figure 2.1 – Site Location Plan, approximate site boundary shown in blue
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2.2 Previous Site Use

A review of the available historical mapping information for the site as presented within the previous Curtins Phase 1 reports (Ref.1-4) has been undertaken with specific reference to potential sources of contamination. Table 2.2 summarises the findings.

Table 2.2 – Summary of on-site historical land use.

Date	Description
1848	North - The site was occupied by commercial/industrial land comprising multiple warehouses including dye house, cotton and wool mills and timber yards. Central - Mixed use residential and commercial including timber yard and gasometer. Site intersected by canal associated with dry dock. South - Commercial/industrial land use including timber yard, crane, cotton storage and railway sidings. Railway to the south of the site.
1891-1908	North/Central - Demolition of previous structures and construction of newer commercial/industrial South - Numerous railway lines build on site as part of the Liverpool Road & Salford Goods Station

1940s	Major construction across northern and central areas of the site following WWII. Potential for UXO from Luftwaffe bombing at this time. North - Construction of an automobile and electrical engineering workshop. Central - Construction of an engineering works in the west and eastern boundary of the site. Warehouses and compound works also identified.
1950s	Central Additional construction at west and central portion. Tank noted at the western boundary associated with engineering works.
1960s – 1970s	Central - Construction of the Granada Television Centre with associated car parking centrally within the site. South - Liverpool Road goods Depot railway line noted as being disused. Railway lines no longer shown on site by 1990.
1992	North Demolition of Albert Shed Warehouse and subsequent conversion to a car park (now disused)
1999	South New structure build at the south of the site in area previously occupied by railway lines.

2.3 Published Geology

A study of the Envirocheck, BGS borehole records and BGS 1:50,000 mapping (Solid and Superficial Editions) for Manchester (Sheet 085) indicates the following geological succession underlying the site:

- Alluvium of *Flandrian Age*; and
- Chester Pebble Beds Formation of *Early Triassic Age*.

2.3.1 Made Ground Deposits

Made Ground deposits are not indicated to be present on the site. However, given the substantial historical development that has occurred on the site, and suspected infilled canal in the west of the site, it is anticipated that Made Ground deposits, of unknown composition, may be encountered during the investigation.

2.3.2 Superficial Deposits

Alluvium deposits comprising clay, silt, sand and gravel are identified at the west of the site. Elsewhere on site, superficial deposits are not recorded to be present.

2.3.3 Bedrock Deposits

Bedrock deposits are present as Chester Pebble Beds Formation of *Early Triassic Age*, comprising sandstone.

There are three BGS fault lines located within 1 kilometre (km) of the site, with the closest being approximately 100m to the northwest, orientated northwest to southeast.

2.3.4 Mining and Quarrying

The previous reports did not identify evidence of historic mining activities in historic mapping within or in the area immediately adjacent to the site. The Coal Authority's online interactive mapping confirms that the site is located within a coal mining referral area.

It is considered unlikely that relic mining features are present on site and as such, have not been considered any further.

2.3.5 Other Pertinent Geological Existing Geological Records

The previous reports identified a low risk to no hazard from the following ground stability hazards on and around the site; running sands, collapsible ground, landslides, shrinking or swelling clay, compressible ground and ground dissolution.

UK Radon Mapping confirms the site is situated in an area where less than 1% of homes are above the radon action level. The new development incorporates a basement and so the advice of a specialist Radon assessor must be obtained.

2.4 Hydrogeology and Hydrology

Environment Agency data indicates that the site, corresponding with the underlying bedrock geology, overlies a Principal Aquifer. These are;

Layers of rock or drift deposits that have high intergranular and/or fracture permeability meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, Principal Aquifers are aquifers previously designated as Major Aquifers.

Where Alluvium superficial soils are recorded, it is identified 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 site is not situated within a designated Source Protection Zone (SPZ). The Groundwater Vulnerability Map presented in the Envirocheck Report indicates a highly permeable principal aquifer underlies the site, with high vulnerability.

There are two groundwater abstractions within 250m of the site, both at Gartside Street, Manchester, and are operated by Bovis Lend Lease Ltd. The Envirocheck Report identifies the groundwater abstraction for non-evaporative cooling purposes.

The nearest surface water feature is the River Irwell directly west of site, which flows from N to S. No water quality data is available for this feature. There are no surface water abstractions within 1000 m of the site.

There are seven discharge consents directly west of the site into the River Irwell, all relating to storm water/storm sewage overflows.

2.5 Landfill

There are no licensed landfills located within 250 m of the site.

The nearest identified historical landfill (Wilburn Street) is located approximately 200m west of the site.

2.6 Unexploded Ordnance (UXO) Risk Assessment

The site of interest is in Manchester City Centre. Risk mapping for UXOs has placed the site within a High-risk area. High-risk regions are those that show a bomb density of >50 bombs per 1000 acres and abundant potential WWII targets.

A review of historical maps (Ref. 5) indicate bomb ruins within the south-eastern corner of the site, with damaged and demolished buildings in the vicinity to the east, north and south. Several fire bombs and high explosives were dropped in the vicinity of the site. *Figure 2.6* overleaf shows the impacted land during WWII.



Figure 2.6 – Historic Records showing bombing incidents during WWII. Site boundary marked in **Blue**. **Red** circles indicate fire bombs, **Blue** circles indicate high explosives, **Pink** shading indicates damaged buildings, **Red** shading indicates demolished buildings, **Green** marks indicate line mines.

An Explosive Ordnance Threat Assessment (Ref. 6) was undertaken by Planit in March 2016 (for the larger overall St. John's development area) and concluded the threat level with portions of the Site are at Medium threat levels and therefore a UXO Threat Mitigation Strategy is required prior to intrusive engineering works. Details of the mitigation strategy can be found within the assessment.

2.7 Summary of Phase 1 PCSM

A summary of potential pollutant linkages at the development site identified in the previous Phase 1 reports referenced in *Section 2.0* is presented in *Table 2.8*, overleaf, were identified as requiring further investigation to enable the safe redevelopment of the site.

Table 2.7 – Preliminary Conceptual Site Model

Source	Pathway	Receptor	Risk
Made Ground of unknown composition from: • Historic development on, and near the site; • Leaks and spills of petrol and diesel from plant/engineering activities, car parking and depot vehicles, and warehouse/factory processes; • Potential use of asbestos containing materials in historic buildings; • Adjacent railway tracks and stations near historic engineering works; • Manufacturing/Treatment processes associated with historic timber yard; • Dock and motor repair works and electrical substation adjacent to the site;	Direct contact/ ingestion and inhalation	Future site-users (Commercial Development)	Moderate
	Horizontal and vertical migration of contaminants through superficial soils	Groundwater (Principal Aquifer)	Low
		Groundwater (Secondary A Aquifer)	Low
		Surface Water (River Irwell)	Low
Production of ground generating gases from: • Made Ground deposits containing organic/ putrescible content; • Infilling of canal basin directly beneath the site; • Historic St. Johns Church Graveyard.	Vertical and horizontal migration through existing service corridors and the underlying superficial deposits	Future site-users	High

Potential contaminants of concern associated with any Made Ground present include, amongst others; broad range aliphatic and aromatic hydrocarbons present within any fuel oils; semi-volatile and volatile organic contamination; polycyclic aromatic hydrocarbons (PAHs); inorganic compounds including heavy metals; and asbestos present in discarded building materials.

The qualitative risk assessment determined the above risks associated with the proposed development of the site warrant further investigation.

It was recommended that a ground investigation is conducted to both confirm this assessment and provide data in support of the structural and civil engineering design. The scope of the investigation undertaken is detailed in *Section 3.0*.

3.0 Phase 2 Investigation Scope of Works

Site investigation works were undertaken between the 3rd April and 13th July 2018.

The scope of the ground investigation was designed in general accordance with current UK guidance including CLR11 (Ref. 7), British Standard (BS) 10175 (Ref. 8), BS5930:2015 (Ref. 9), and BSEN1997: Part 2:2007 Eurocode 7 (Ref. 10). A summary of the scope and rationale are summarised in *Table 3.0* below.

Table 3.0 – Scope and Rationale of Fieldwork Undertaken

Exploratory Hole Type	Exploratory Hole Reference	Exploratory Hole Depth (m bgl)	Rationale
Window Sample Boreholes	WS01	-	Confirm ground conditions. Collect soil and water samples for chemical and geotechnical analysis. Undertake in-situ testing Gas and groundwater monitoring Determine geotechnical parameters
	WS02	0.80	
	WS03	1.20	
	WS04	3.39	
	WS05	3.30	
	WS06	3.41	
	WS07	-	
	WS08	3.38	
	WS09	-	
	WS10	4.31	
	WS11	4.30	
	WS12	-	
	WS13	-	
Cable Percussive Boreholes	BH02	4.70	Confirm ground conditions. Collect soil and water samples for chemical and geotechnical analysis. Undertake in-situ testing Gas and groundwater monitoring Determine geotechnical parameters Facilitate subsequent rotary cored boreholes
	BH03	4.70	
	BH04	4.00	
Rotary Open Hole Boreholes	RBH01	-	Confirm shallow ground conditions Undertake in-situ testing Gas and groundwater monitoring Facilitate subsequent rotary cored boreholes
	RBH02	5.00	
	RBH03	4.20	
	RBH04	4.30	
	RBH05	5.00	
	RBH06	4.50	
Rotary Cored Boreholes	BH02	25.20	Confirm deep ground conditions including presence of voids. Collect rock samples for geotechnical analysis. Undertake in-situ testing Gas and groundwater monitoring Determine geotechnical parameters
	BH03	25.20	
	BH04	25.10	
	RBH01	-	
	RBH02	40.00	
	RBH03	40.30	
	RBH04/A/B	40.50	
	RBH05	40.00	
	RBH06	55.00	

* Exploratory boreholes marked in red are yet to be undertaken.

Several exploratory boreholes, at the time of writing, have not been undertaken. These are outlined below:

- WS01 – Located over basement of existing building;
- WS07 – Located within a demolition exclusion zone;

- WS09 – Located within a demolition exclusion zone;
- BH06 – Located within a demolition exclusion zone; and
- Slip Trenches – Located within a demolition exclusion zone.

Exploratory hole locations were surveyed on completion.

Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20059-A records the locations of the exploratory holes, a copy of which is contained within *Appendix A*.

3.1 Soil Logging and Sampling

Exploratory window sample hole, rotary hole and manually excavated hand pit arisings were logged on site by a qualified Engineer. All exploratory holes were logged in accordance with the requirements of BS5930 (Ref. 9), including recording observed visual and olfactory indications of contamination. Exploratory hole logs are provided in *Appendix B*.

3.2 Monitoring Well Installations

Ground gas and groundwater monitoring installations (50mm diameter) were installed within six window sample borehole locations and four rotary cored borehole locations. A bentonite seal was placed above and below the screened section of the borehole to minimise the potential for downward migration of contaminants, and the creation of a preferential migratory pathway. A gravel surround was installed in the annulus between the sides of the borehole and the slotted sections of pipe.

The 50 mm diameter monitoring wells were primarily designed to assess the potential for ground gas and strata likely to have the highest permeability and as such the screened section focussed on granular superficial strata, or the underlying bedrock.

Piezometers (19mm) were installed within four rotary cored borehole locations. A gravel and sand surround was installed in the annulus between the sides of the borehole, and approximately +/- 1m above and below the resting point of the piezometer. A bentonite seal was placed above and below the screened section of the borehole to minimise the potential for downward migration of contaminants, and the creation of a preferential migratory pathway.

These were installed at 2.00m below the vertical extent of the proposed basement floor to assess the potential ingress of water from fractures below the basement.

A summary of the response zones is presented in *Table 3.2* overleaf.

Table 3.2 – Monitoring Well Response Zones

Borehole Reference	Response Zone(s) (m bgl)	Standpipe/ Piezometer	Strata Description(s)
WS04	2.00 – 3.00	Standpipe (50mm)	CLAY and SAND
WS05	2.00 – 3.00	Standpipe (50mm)	SAND
WS06	2.00 – 3.00	Standpipe (50mm)	SAND
WS08	2.00 – 3.00	Standpipe (50mm)	SAND
WS10	2.00 – 4.00	Standpipe (50mm)	SAND
WS11	1.50 – 3.50	Standpipe (50mm)	SAND
BH02	5.00 – 20.00	Standpipe (50mm)	SANDSTONE (Bands of mudstone and siltstone)
BH03	8.80 – 10.00	Piezometer (19mm)	SANDSTONE
BH04B	5.00 – 20.00	Standpipe (50mm)	SANDSTONE
RBH02	6.30 – 20.00	Standpipe (50mm)	SANDSTONE (Bands of mudstone)
RBH03	14.50 – 16.50	Piezometer (19mm)	SANDSTONE
RBH04	9.20 – 10.20	Piezometer (19mm)	SANDSTONE
RBH05	5.00 – 20.00	Standpipe (50mm)	SANDSTONE
RBH06	10.20 – 10.50	Piezometer (19mm)	SANDSTONE

Copies of borehole logs can be referred to in *Appendix B* of this report.

3.3 Post-Investigation Monitoring

3.3.1 Ground Gas Monitoring

An initial programme of six gas monitoring visits over three months was proposed to assess ground gas conditions as identified in the Preliminary Conceptual Site Model. Three visits have been undertaken to date.

3.3.2 Groundwater Sampling

Groundwater samples from rotary boreholes RBH02, BH02 and BH04, and window sample borehole WS10.

4.0 Laboratory Analysis

Representative soil samples were selected for laboratory chemical analysis, based on field observations and to provide a characterisation of the Made Ground and natural strata encountered. Selected soil samples were placed in laboratory provided containers and stored in cool boxes prior to being transported to the nominated laboratory under the laboratory's chain of custody documentation. The laboratory selected by Curtins for chemical analysis of soil and groundwater samples was Envirolab, a UKAS and MCERTS accredited laboratory.

Given the potential site wide source of contamination (Made Ground) the sampling positions (boreholes) were generally located in a non-targeted, systematic array to give adequate and representative coverage of the site accounting for the historical site use, proposed end use and the immediate environmental setting.

4.1 Soil Analysis

The contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), heavy metals, volatile and semi-volatile organic compounds and asbestos, the extent of which is captured by the broad environmental testing suite listed in *Table 4.1* below.

Table 4.1 – Environmental Chemistry Analysis Suite: Soils

Suite Ref.	Analyte	LOD
Soils Suite A	Asbestos Screen, pH and Soil Organic Matter (SOM)	-
	Arsenic, Chromium, Chromium VI, Copper, Lead, Selenium, Zinc, Nickel	1 - 5 mg/kg
	Boron (water soluble)	1 mg/kg
	Cadmium	0.5 mg/kg
	Mercury	0.17 mg/kg
	Cyanide (total)	1 mg/kg
	Phenols (screen)	0.2 mg/kg
	PAHs (USEPA 16)	0.1 mg/kg
	TPH (Aro/Alk Split)	0.01 to 0.1 mg/kg
SVOCs	SVOC Suite (Excluding PAH-16)	100 – 500 µg/kg
VOCs	VOC Suite	1 – 10 µg/kg

Nineteen soil samples were taken from Made Ground soils across the site and tested for Soils Suite A. Additionally, seven soil samples were taken from within natural soils and tested for Soils Suite A.

Nine Made Ground soil samples and a single natural soil sample were tested for SVOCs, and one Made Ground soil sample was tested for VOCs.

Copies of the environmental chemistry testing certificates are presented in *Appendix C*.

4.2 Groundwater Analysis

The contaminants of concern potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), volatile organic compounds, and heavy metals the extent of which is captured by the broad environmental testing suite listed in *Table 4.2* below.

Table 4.2 – Environmental Chemistry Analysis Suite: Waters

Suite Ref.	Analyte	LOD
Water Suite A	pH	-
	Total Hardness	2 mg/l
	Arsenic, Lead, Nickel, Selenium, Zinc	1 µg/l
	Boron (water soluble), Chromium, Copper, Mercury, Phenols (screen)	0.01 - 10 µg/l
	Cadmium	0.2 µg/l
	Cyanide, Sulphide	0.005 – 0.1 mg/l
	Sulphate	1 mg/l
	PAHs (USEPA16)	0.01 µg/l
	TPH (Aro/Alk Split)	1 – 5 µg/l
VOCs	VOC Suite (Excluding PAH-16)	1 – 10 µg/l
SVOCs	SVOC Suite	1 – 10 µg/l

Water samples were taken from rotary boreholes RBH02, BH02 and BH04, and window sample borehole WS10.

Copies of the environmental chemistry testing certificates are presented in *Appendix C*.

4.3 QA/QC

The Envirolab Deviating Samples Reports (1802606, 1805180, 185337, 1805734 and 1805735) did not record any deviations.

All analysis reports are enclosed within *Appendix C*.

4.4 Geotechnical Analysis

Rock samples for geotechnical testing were prepared and tested in accordance with ISRM Suggested Methods. The following tests were carried out:

- 119 No. Point Load Index Test (PLT) – Axial Plane;
- 100 No. PLT – Diametral Plane;

- 80 No. Uniaxial Compressive Strength (UCS);
- 50 No. Natural Rock Water Content;
- 40 No. Rock Porosity Density;
- 10 No. Brazilian Tests;
- 13 No. Sound Velocity Tests (P and S Wave)
- 8 No. Hoek Triaxial Compression Tests
- 10 No. Hoek Shear Box Tests;

Copies of the geotechnical testing certificates are presented in *Appendix D*.

5.0 Encountered Ground Conditions

5.1 General

A summary of the ground conditions encountered during the site investigation works is presented below, with detailed information presented in the exploratory hole logs included in *Appendix B* and a summary of each strata presented in subsequent sections.

Table 5.1 – Summary of Ground Conditions Encountered

Stratum	Depth to top of strata m bgl (mAOD)	Thickness (m)		Description
		Min	Max	
Made Ground	0.00 (27.27)	0.60	6.25	MADE GROUND of Tarmacadam and concrete/limestone sub-base, or concrete, underlain by loose brown, dark brown blackish-brown clayey, gravelly fine to coarse SAND, and soft to firm orangish brown, brown, grey or black sandy slightly gravelly CLAY. Possible canal wall identified in RBH02 between 0.40m – 6.25m bgl.
Superficial Soils¹	0.60 (26.67)	0.25*	5.32	Firm dark brown slightly sandy slightly gravelly CLAY. Loose to dense orangish and reddish-brown gravelly fine to coarse SAND. RBH03 recorded spongy peat at 2.00 – 2.20m bgl.
Chester Pebble Beds Formation	3.05 (23.07)	>20.70**	>50.35**	Extremely weak to strong reddish-brown SANDSTONE. Top of strata weathered. Bands of sandy coarse gravel at the surface. Rare interbedded mudstone and siltstone.

1 BGS geological mapping does not record the presence of superficial soils beneath the site

* Where encountered

** Thickness not proved

5.2 Made Ground

Made Ground deposits were encountered in all exploratory holes, to depths of between 0.60m bgl and 6.25m bgl. The deepest Made Ground was encountered in RBH02, where deposits comprise a red brick wall, underlain by well bonded brick and concrete. It is likely that the wall is associated with a historic canal which historically underlies the site. Elsewhere, a maximum thickness of 3.40m was recorded in BH04B.

Deposits typically comprise a surface cover of a limited thickness of tarmacadam, often with concrete subbase, or concrete. BH02 and RBH05 recorded up to 0.30m of topsoil, with frequent rootlets.

The surface cover is typically underlain by granular deposits comprising brown, orangish brown, and reddish brown gravelly sand with occasional cobbles. Dark brown and brownish black, slightly clayey

gravelly sand, with occasional cobbles, was also encountered. Anthropogenic fragments within these soils included: brick, concrete, slag, slate, tile, glass, asphalt, plastic, porcelain and wood fragments, in addition to mixed lithologies of sandstone, mudstone and limestone. Thicknesses of the upper granular Made Ground strata are variable across the site, ranging between 0.17m (RBH06) – 3.05m (BH04). A strong diesel odour was noted within WS03.

The granular deposits are underlain by cohesive soils in WS03, WS04, WS05, WS06, WS08, WS10, WS11 and RBH06, to a maximum depth of 3.10m bgl (RBH06), though typically to between 1.20m -0 1.70m bgl). Deposits within WS04, WS05, WS10, WS11, RBH06 comprised very soft to firm orangish brown, with black mottling (WS05 and WS10) slightly sandy to sandy gravelly clay. Soft black sandy clay was encountered in WS06 between 0.80m – 1.30m, and WS03 recorded very soft greenish grey sandy, gravelly clay with low cobble content, where a hydrocarbon odour was noted. Anthropogenic fragments included: concrete, sandstone, brick, slag, tile, mudstone and limestone.

5.3 Superficial Deposits

BGS geological mapping does not record the presence of superficial soils beneath the development area. This investigation encountered superficial soils all exploratory holes, except for RBH02 which recorded extensive Made Ground soils to 6.25m bgl, and generally comprised granular soils, though limited thicknesses of cohesive soil were also encountered.

5.3.1 Granular Soils

Granular superficial soils were encountered in all exploratory holes except for RBH02, with a maximum recorded thickness of 5.32m.

Deposits typically comprised light, yellowish, reddish or orangish brown medium dense to very dense slightly gravelly fine to coarse sand. Gravels are fine to coarse, sub angular to rounded of mixed lithologies of sandstone, mudstone, limestone, quartzite and rare coal. Rarely, deposits are slightly clayey, and clay bands are identified within shallow sand deposits.

Nineteen SPT 'N' Values were recorded to full penetration with values ranging between 8 – 41, generally increasing with depth, illustrated in Figure 5.3.1 overleaf

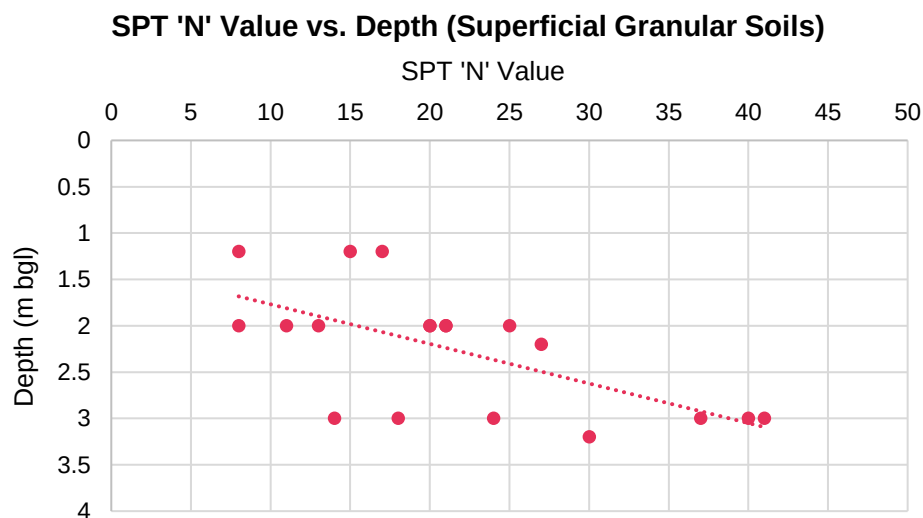
With exception of WS04 which progressed to bedrock, all window samples were terminated within the granular soils within very dense sand due to SPT refusal.

An organic odour was recorded in BH04B at 3.40m – 3.65m bgl, within grey sandy gravel deposits.

Table 5.3.1 and Figure 5.3.1 overleaf summaries the geotechnical properties of the soils.

Table 5.3.1 – Summary of geotechnical test results – granular superficial deposits

Parameter	No. of tests	Minimum	Maximum	Average
pH	6	7.27	7.91	7.50
Water Soluble Sulphate (mg/l)	6	0.02	0.07	38
SPT 'N' Value (Full Penetration)	19	8	41	22
Organic Content (%)	6	0.2	1.5	0.82

Figure 5.3.1 – Granular SPT 'N' Values Plotted Vs. Depth

5.3.2 Cohesive Soils

Cohesive soils were encountered in four exploratory holes (WS04, WS06, WS08 and RBH04), ranging in thicknesses between 0.10m – 0.70m.

The shallow bands of clay recorded in WS04, WS06 and WS08 comprise firm light and dark brown, with occasional mottling, slightly gravelly sandy clay, with gravels of fine to medium sub angular to rounded sandstone and limestone. The deeper clay identified in RBH04 (5.70 – 5.80m bgl) recorded reddish brown slightly sandy very gravelly clay, with gravels of sub rounded to rounded granite and sandstone.

RBH03 recorded 0.20m of black, spongy peat at 2.00m bgl.

Table 5.3.2 – Summary of geotechnical test results – cohesive superficial deposits

Parameter	No. of tests	Minimum	Maximum	Average
pH	1	4.46		
Water Soluble Sulphate (mg/l)	1	200		
SPT 'N' Value (Full Penetration)	3	6	21	11
Organic Content (%)	1	0.3		

5.4 Bedrock Deposits

Bedrock was encountered in all exploratory holes each of the progressed cable percussive and rotary open hole boreholes, in addition to WS04, from depths of 3.05m bgl (WS04) to 7.45m bgl (RBH02), to a maximum recorded depth of >55.00m bgl.

Generally, deposits comprise extremely weak to very strong thinly laminated to thickly bedded reddish brown fine and medium grained, occasionally coarse grained, sandstone, with interbedded and small bands of mudstone and siltstone within. The base of the sandstone strata was not encountered during this investigation. The boreholes were terminated at depths of between 25.00m – 55.00m bgl.

The top of the strata is generally highly weathered and was recovered as sand and gravel in several locations, occasionally with clay lenses. Material recovered as rock was heavily fractured with very closely spaced, undulating and rough sand and gravel infilled fractures. The total core recovery (TCR) in the top 5m of rock (<10m bgl) was 62%, approximately 30% lower than the TCR between 10m – 15m bgl (91%), with corresponding average Rock Quality Designations (RQD) of 18 at depths <10m bgl and 43 between 10m – 15m bgl. The average TCR and RQD for rock at depths >15m were calculated to be 96 and 62 respectively. The above indicates that the rock at depths <10m bgl is of poor to very poor rock mass quality, increasing to poor to fair between 10m – 15m bgl. Rock at depths >15m bgl is generally of good rock mass quality. Generally, the RQD increases with depth, as shown in Figure 5.4.1 overleaf.

Full details of the lithologies, rock properties, and fracture notes are presented within exploratory borehole logs, attached within *Appendix B*.

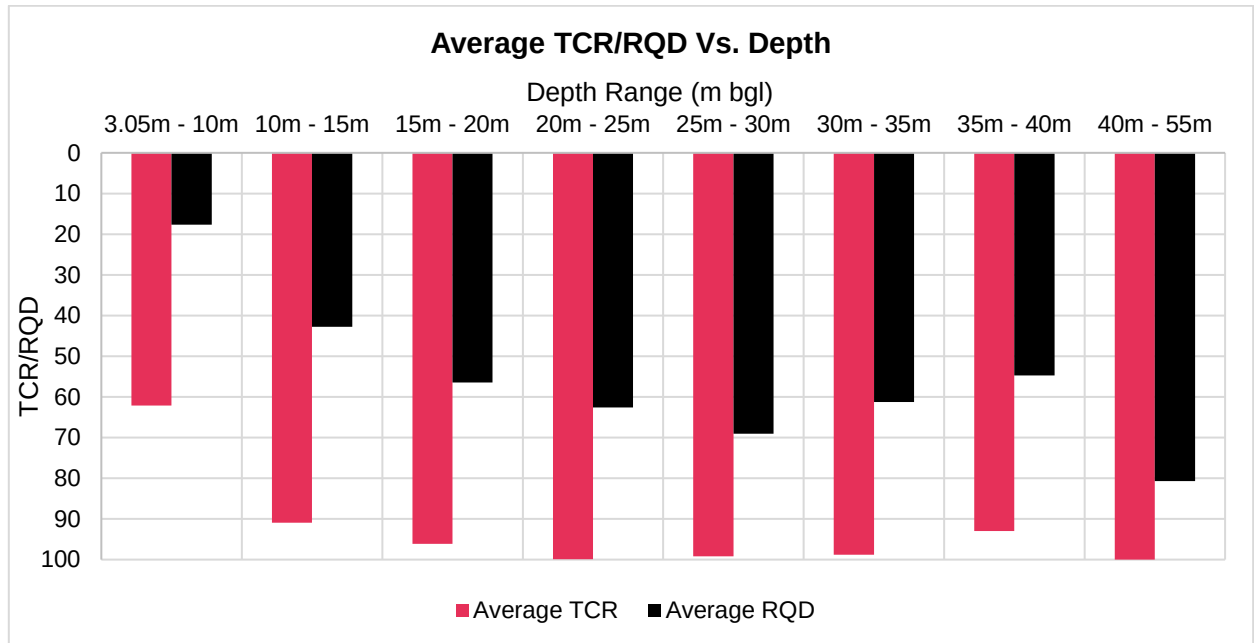


Figure 5.4.1 – Average TCR and RQD Plotted Against Rock Depth

A summary of the geotechnical test results recorded within the bedrock is presented in Table 5.4, below. Full details of the geotechnical test results recorded are presented in the exploratory borehole logs, in *Appendix B*, and test result certificates in *Appendix D*.

Table 5.4 – Summary of Rock Testing Results, Bedrock

Parameter		No. of tests	Minimum	Maximum	Average
Point Load Test (PLT) Is50 (MPa)	Axial	119	0.01	0.58	0.18
	Diametral	100	0.01	0.40	0.10
	All Tests	219	0.01	0.58	0.14
Estimated Unconfined Compressive Strength from PLT Is(50) Results (MPa)	Axial	119	0.20	11.60	3.59
	Diametral	100	0.20	8.00	1.93
	All Tests	219	0.20	11.60	2.83
Unconfined Compressive Strength (UCS) (MPa)		80	0.9	35.6	10.7
Bulk Density of Sandstone (Mg/m ³)		151	0.22	2.44	2.21
Dry Density of Sandstone (Mg/m ³)		50	1.87	2.22	2.03
Natural Water Content (%)		50	5.3	13.6	6.3
Porosity (%)		40	17	30.6	24.5
Tensile Strength by Brazilian Test (MPa)		10	0.370	1.100	0.639

Parameter		No. of tests	Minimum	Maximum	Average
Hoek Shear Box Test Angle of shearing resistance ϕ' (°) peak/residual Apparent cohesion c' (MPa) peak/residual		10	8.5/4.5 18/8	45/40 533/354	25/18.5 235/167
Hoek Triaxial Compression Test Internal friction angle ϕ (°) Apparent cohesion c' (MPa)		8	20.5 3	40.9 7	33.6 5
Sound Velocity Test	P Wave Travel Time (μ s)	13	48.5	126.5	76.3
	P Wave Compression (m/s)		1161	1994	1640
	S Wave Travel Time (μ s)		82.5	219.4	136.0
	S Wave Compression (m/s)		642	1149	918

Overall 219 Point Load Tests (PLT) were carried out on samples of sandstone bedrock from rotary cores. PLT $Is(50)$ values ranged between 0.01 MPa to 0.58 MPa. Comparison between the axial and diametral PLT tests indicates that, generally, the rock strength is greater when pressures are applied axially than diametrically, with maximum PLT $Is(50)$ values of 0.58 MPa and 0.40 MPa recorded for axial and diametral tests respectively. The average PLT $Is(50)$ value for axial and diametral tests identifies a similar trend, with values of 0.18 MPa and 0.10 MPa respectively.

An approximation of the unconfined compressive strength (UCS) of the rock may be derived from the following relationship:

$$PLT\ Is(50) \times 20 = UCS.$$

In principle the correlation between point load test indices and UCS should be developed on a site-specific basis. Published literature indicates that a factor between 10 and 60 is possible; although a value of 20 – 25 is typical. The available dataset is not suitable to support a site-specific correlation because of the overall quantity of samples, and because of the unavoidable preferential sample selection across the available core. Consequently, a general factor of 20 has been applied (Hoek and Bray, 1981).

Using the above relationship, estimated UCS values with an overall range of between 0.20 MPa to 11.60 MPa may be derived, indicating the rock tested is Very Weak to Weak.

UCS testing was undertaken on 80 No. Rock samples, with UCS values ranging between 0.9 MPa to 35.6 MPa, indicating the sandstone samples are very weak to medium strong.

Estimates of characteristic compressive strength from PLT $Is(50)$ values are significantly weaker than those recorded by direct UCS testing. This is likely to be due to the preferential selection of samples for the UCS testing, which given their more intact nature, are inherently stronger than those selected for point load tests. The combined dataset should provide a reasonable characterisation of the range of rock strengths encountered within the undertaken boreholes. Some variation beyond the findings of this investigation should be anticipated.

Figure 5.4.2, below, indicates that, generally, the UCS, and estimated UCS, of the sandstone bedrock increases with depth.

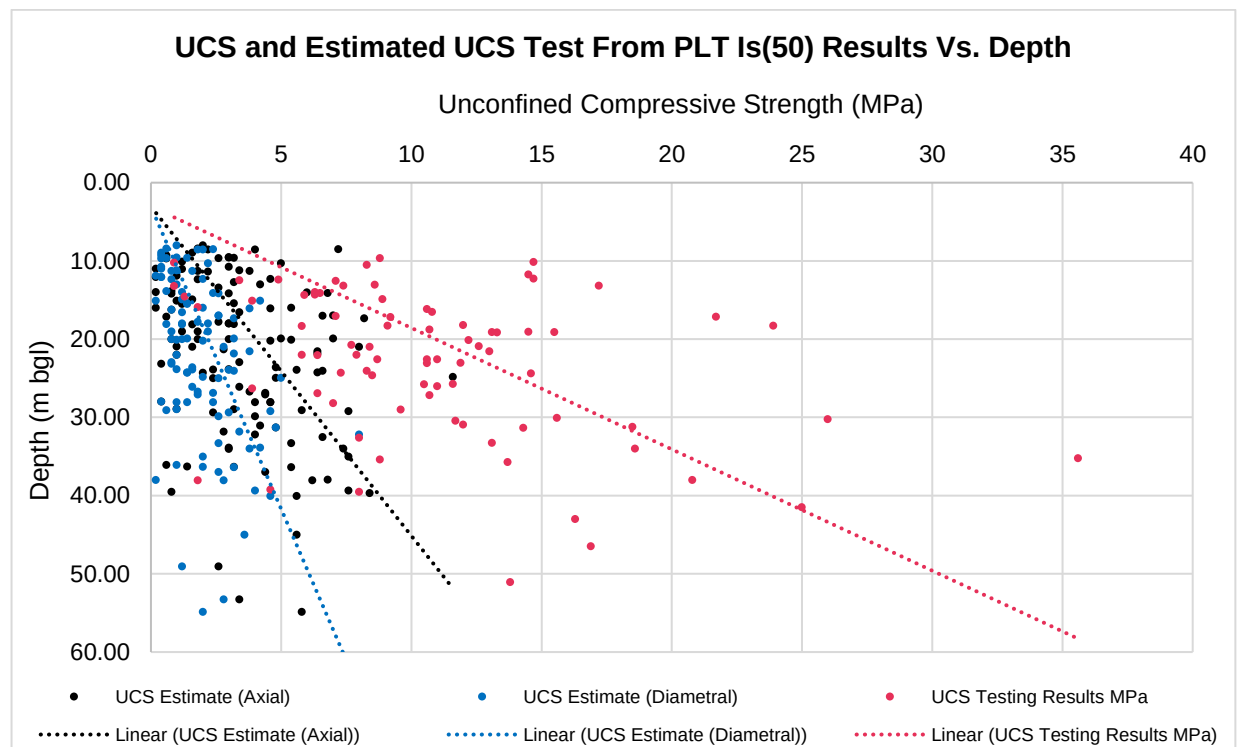


Figure 5.4.2 – Variation of UCS Test and Estimated UCS Results with Depth

Eight Hoek Triaxial Compression Tests were undertaken in sandstone bedrock at depths between 11.00m – 21.86m bgl. Test results indicate an internal angle of friction of between 20.5° -40.9° with an apparent cohesion of between 3 and 7 MPa.

It should be noted that the in-situ strength characteristics of the rock will be affected by the aperture and spacing of discontinuities, in addition to the strength of the rock itself, particularly where the discontinuities are very closely spaced.

The indirect tensile strength of sandstone bedrock was assessed by undertaking ten Brazil tests. The tensile strength of the rock was recorded at values between 0.370 MPa to 1.100 MPa, accounting for rock samples obtained at depths of between 9.82m to 21.89m bgl. The average tensile strength of sandstone within this depth range was 0.639 MPa. Seven samples failed by axial split, two samples failed by curved split, and one sample fractured by wedge fracture.

5.5 Observed Potential Contamination

A hydrocarbon odour was identified in WS03 at depths of between 0.10m – 1.20m bgl. This was also identified in the chemical testing results. The source of the odour was not identified in this investigation.

An organic odour was identified in BH04B between 3.40m – 3.65m bgl within dark grey sandy gravel deposits.

5.6 Obstructions Encountered

Table 5.6 below summarises the obstructions encountered during this investigation.

Table 5.6 – Obstructions Identified

Exploratory Hole Ref.	Depth (m bgl)	Obstructions Encountered
WS02	0.80	Dense soils. Could not be penetrated further using hand excavation methods.
BH04/A	0.45	Concrete slab.

5.7 Groundwater

Groundwater strikes were not recorded in shallow window sample or cable percussive boreholes. Due to the use of water flush in rotary cored boreholes, it was not possible to determine water strikes within bedrock during the investigation.

Table 5.7, below, summarises the groundwater levels recorded during post investigation monitoring. Full details of the response zones within window sample borehole locations and rotary cored borehole locations are included in Appendix B. Full details of the recorded water levels during post investigation monitoring visits are presented in *Appendix E*.

Table 5.7 – Groundwater Noted During Site Investigation

Exploratory Hole Location Ref.	Monitored Water Levels			
	Installation Strata	Response Zone (m bgl)	Depth (m bgl)	Depth (mAOD)
WS04	CLAY and SAND	2.00 – 3.00	Dry	-
WS05	SAND	2.00 – 3.00	Dry	-
WS06	SAND	2.00 – 3.00	Dry	-
WS08	SAND	2.00 – 3.00	Dry	-
WS10	SAND	2.00 – 4.00	3.44 - 3.45	-
WS11	SAND	1.50 – 3.50	Dry	-
BH02	SANDSTONE (Bands of mudstone and siltstone)	5.00 – 20.00	4.25 - 4.26	23.01 - 23.02
BH03	SANDSTONE	8.80 – 10.00	1.97- 3.93	22.66 - 24.62

BH04B	SANDSTONE	5.00 – 20.00	3.12 - 3.18	23.37 - 23.43
RBH02	SANDSTONE (Bands of mudstone)	6.30 – 20.00	3.38 - 3.63	22.79 - 23.04
RBH03	SANDSTONE	14.50 – 16.50	-	-
RBH04	SANDSTONE	9.20 – 10.20	4.06 - 4.44	22.06 - 22.44
RBH05	SANDSTONE	5.00 – 20.00	4.18	23.09
RBH06	SANDSTONE	10.20 – 10.50	3.90	-

Groundwater was encountered within superficial deposits in WS10 only, within granular soils. Each of the remaining installations within the window sample boreholes were recorded as dry during post investigation monitoring visits.

Groundwater levels within the bedrock deposits typically rose above the monitoring installation response zone, to depths of between 1.97m – 4.44m bgl.

5.8 Aggressive Ground Conditions

The classification of the site in terms of concrete in aggressive ground is based on the guidance provided in Table C2 of the Building Research Establishment (BRE) Special Digest 1, third edition of 2005. *Table 5.8* details the classification.

It is anticipated that Made Ground and superficial soils are to be removed from site as part of the development plans. As such, the Design Sulphate and AC classifications have not been assigned for these strata.

The Chester Pebble Beds Formation is not recorded in Box C6 of the Building Research Establishment (BRE) Special Digest 1, third edition of 2005, which describes the UK Geological Formations known to contain Pyrite. The ground investigation identified ground conditions which are unlikely to present a significant risk of degradation of concrete from chemical attack. Although no samples were obtained from the rock, an absence of evidence to show the site will be impacted by the presence of elevated sulphate concentrations, or low pH values, would suggest a Design Sulphate Classification, and ACEC classification of DS-1 and AC1 respectively. Considering the mobile groundwater condition for the scheme area.

Pile designers should satisfy themselves that the concrete used within the adopted piled foundation solution, and basement construction, is suitable for the ground conditions identified on site.

6.0 Ground and Groundwater Contamination Assessment

This section of the report includes the assessment of the potential contamination, solid, liquid and gas, identified on the subject site which may present a risk to the proposed end users, associated utilities and the wider environment.

In guidance published by the Environment Agency, the risk to human health or controlled waters is determined through an assessment of pollutant linkages between a source of contamination (within the ground or groundwater either on or off site) and a sensitive receptor such as end users of the site, building materials, edible plants grown in gardens or groundwater abstracted for drinking. This is termed a source-pathway-receptor relationship. The same model is applied to the assessment of risk arising from ground gases as detailed within BS8576:2013 (Ref. 11).

These models have a common approach, which is one of a tiered assessment. At each stage of the assessment further detail can be applied to the conceptual site model to provide a detailed interpretation on a site by site basis. As part of the planning process this approach is adopted to establish either if the site is 'suitable for use' or whether additional work or else remedial work is required for the site to be deemed so.

The sub-sections hereafter therefore incorporate the first tier (Tier 1) of this approach otherwise referred to as the Generic Quantitative Risk Assessment (GQRA). The GQRA builds on the qualitative risk assessment presented in the Phase 1 Desk Study in conjunction with observations made during the ground investigation and is based solely on the results of the chemical and other testing data obtained as part of Curtins ground investigation. The GQRA is used to build/refine the Conceptual Site Model (CSM) for the site as detailed and presented in *Section 8.0* of this report.

The following sections present more detail on the risk assessment methodology rationale for the main receptors.

6.1 Human Health GQRA

Detailed guidance on human health risk assessment is available within several documents, published by both the Environment Agency and Defra. Guidance includes Contaminated Land Exposure Assessment (CLEA) v1.071 model (Ref. 12), Science Report 2 (Ref. 13) and Science Report 3 (Ref. 14).

A generic quantitative risk assessment (GQRA) has been carried out for the Potential Contaminant Linkages (PCLs) investigated by screening of soil contamination data against relevant Generic Assessment Criteria (GAC) where available, including:

- i) **Soil Guideline Values (SGVs):** These have been published by the Environment Agency and are trigger values for screening out low risk areas of land contamination. SGV's give an indication of representative average concentrations of chemicals in soil, below which long-term health risks are likely to be minimal. SGVs have been published for several contaminants

- including arsenic, cadmium, mercury, nickel, selenium, BTEX, phenols and dioxins, furans and dioxin-like PCB substances for land uses including residential, allotments and commercial. The SGVs have been developed for a sandy loam soil with 6% soil organic matter (SOM) content;
- ii) **Supplementary Screening Values (SSVs):** In addition to the SGVs developed by the EA, other third party organisations have derived SSVs for a wider range of contaminants and land uses using the CLEA Model. Curtins have adopted these numbers where applicable, including those developed by Atkins AtriskSoil™, the LQM/CIEH Suitable for Use Levels (S4UL) and EIC/AGS/CL:AIRE published thresholds;
 - iii) **Category 4 Screening Levels (C4SLs):** In March 2014 Defra published C4SLs for arsenic, benzene, benzo(a)pyrene, cadmium, hexavalent chromium and lead. These values were derived to support the revised Part 2A Statutory Guidance issued in 2012 (Ref.15) in which four categories of contaminated land are included, ranging from Category 1 (significant/high risk) to Category 4 (low risk). C4SLs are not representative of significant possibility of significant harm (SPoSH) and are low risk levels which, and therefore where the C4SLs are not exceeded, land can be demonstrated to be in Category 4 and cannot be determined as contaminated land.

6.1.1 Adopted Soil Human Health GACs Screening Methodology

The use of the site, noted as generally high rise (up to 52-storeys) buildings comprising residential apartments with retail, leisure and commercial spaces with single and dual storey basements; is most analogous with a *commercial* end-use scenario and so assessment has been undertaken against the following GACs, in order of preference:

1. Environment Agency Soil Guideline Values,
2. CL:AIRE, AGS, EIC. Soil Generic Assessment Criteria for Human Health Risk Assessments,
3. LQM/CIEH 2015 S4ULs for Human Health Risk Assessment, and
4. DEFRA Category 4 Screening Levels.

The soil organic matter (SOM) content has an influence on the volatilisation of organic contaminants (i.e. the higher the SOM, the lower the volatilisation rate and therefore inhalation exposure risk). Soil organic matter (SOM) values for the site soils ranged significantly from 0.2% w/w to 21.4% w/w. the greatest concentrations of soil organic matter were encountered in WS02 at 0.20m, WS03 at 0.30m, WS05 at 0.80m and WS10 at 0.50m (21.4%, 14.9%, 11.2% and 17.5% w/w respectively). Soils where, or directly above where, these samples were obtained from, with the exception of WS02 recorded the presence of slag, and or wood fragments, and the high concentrations are attributed to these features. A strong diesel odour was recorded in WS03.

With consideration for a calculated geometric average, Made Ground features determine an SOM of 4.94% w/w while natural soils maintain a lower valuation of 0.56% w/w. As such, a

comparison against Tier 1 thresholds for a conservative SOM of 2.5% for Commercial end use has been adopted for Made Ground, and a SOM of 1.0% for natural soil features.

The adopted GAC's are listed in *Appendix F*.

6.1.2 Generic Assessment Criteria Screening of Soil Laboratory Results

The results of the environmental testing can be referred to in *Appendix C*.

With respect to the proposed end use of the site, no exceedances are noted within recovered soil samples.

Concentrations of SVOCs above the limit of detection of the laboratory testing methodology were identified in four soil samples. These are outlined in Table 6.1.2 below.

Table 6.1.2 – SVOC Concentrations Identified Above the LOD of the Testing Methodology in Tested Soil Samples.

Exploratory Hole ID	Depth (m bgl)	Stratum	Determinant	Concentration (µg/kg)
RBH06	0.40	Made Ground	Perylene	276
WS03	0.30	Made Ground	Dibenzofuran Carbazole* 2,4-Dinitrotoluene 1,4-Dichlorobenzene 1,2-Dichlorobenzene 2-Methylnaphthalene Perylene	6150 3680 1190 1400 9190 2280 4490
WS03	1.00	Made Ground	Dibenzofuran Carbazole* 2,4-Dinitrotoluene 2,4-dimethylphenol 1,4-Dichlorobenzene 1,2-Dichlorobenzene 2-Methylnaphthalene Perylene	2710 1110 1230 1320 1350 7440 3460 2760
WS02	0.30	Made Ground	Dibenzofuran Carbazole* 2-Methylnaphthalene Perylene	644 683 751 1120

Selected soil samples were screened for asbestos. No suspected asbestos containing materials (ACMs) were identified in the exploratory hole logs and laboratory screening confirmed that asbestos was absent in the soil samples tested.

On 17th July 2018, asbestos boarding was identified during trial trenches undertaken as part of an archaeological investigation, running simultaneously with this intrusive investigation. A sample was not obtained for screening.

6.2 Controlled Waters GQRA

A model for assessing the potential for pollution of controlled waters and for deriving a safe concentration in ground and groundwater is the Environment Agency's publication 'Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination' (Ref. 16)

In relation to the standards for controlled waters, there are currently no generic groundwater standards or surface water standards that are necessarily applicable to all sites.

However, dependant on the receptor identified as being at risk, see *Section 6.2.1*, the UK Drinking Water Standards (Ref. 17), Surface Water (Abstraction for Drinking Water and/or Water Framework Directive Water Quality Standards (WFD WQS) (Ref. 18)) can be utilised as primary screening values in a Level 1 assessment. These can also be supplemented by World Health Organisation (WHO) guidelines (Ref. 19), where WFD or DWS water quality standards (WQS) do not exist.

In addition to surface and groundwater samples a soil leaching test can be undertaken to provide a preliminary, conservative, assessment of the potential for contaminants in the soil to pollute ground or surface water. Leachate test results are screened in the same way as for groundwater above.

6.2.1 Adopted Controlled Waters Tier 1 Screening Values and Methodology

The results of laboratory analysis of groundwater have been assessed against water framework directive (WFD) WQS, due to the proximity of the River Irwell to the north of the site. The site is underlain by a Principal Aquifer, associated with the Chester Pebble Beds Formation, and so groundwater chemical testing results have also been assessed against UK Drinking Water Standards.

The adopted Level 1 Screening Values are listed in *Appendix F*.

6.2.2 Tier 1 Screening of Groundwater Laboratory Results

The results of the environmental testing can be referred to in *Appendix C*.

With respect to the proposed end use of the site, several exceedances are noted within recovered soil samples as detailed below.

Table 6.2 – Exceedances Recorded in Groundwater Chemical Testing Results

Determinant	Tier 1 Value (µg/l)	Min Conc. (µg/l)	Max Conc. (µg/l)	Samples > Tier 1 Value
Copper	1 ¹ 2000	<1	3	RBH02 (3 µg/l)
Chromium	4.7 50	1	13	RBH02 (10 µg/l) BH04 (13 µg/l) BH02 (7 µg/l)
Nickel	4 ¹ 20	<1	6	BH02 (6 µg/l)

Selenium	- <i>10</i>	<1	<i>27</i>	<i>RBH02 (27 µg/l)</i>
Zinc	10.9¹ <i>5000</i>	1	13	BH02 (13 µg/l)
Anthracene	0.1 -	<0.01	0.74	RBH02 (0.74 µg/l) BH02 (0.69 µg/l)
Benzo(a)pyrene	0.00017 <i>0.01</i>	<0.01	3.06	RBH02 (3.06 µg/l) BH04 (0.02 µg/l) BH02 (2.01 µg/l)
PAHs Sum of: benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene and indeno(1,2,3-c,d)pyrene	- <i>0.1</i>	<0.01	<i>7.60</i>	<i>RBH02 (7.60 µg/l)</i> <i>BH02 (5.78 µg/l)</i>
Fluoranthene	0.0063	0.01	5.94	WS10 (0.01 µg/l) RBH02 (5.94 µg/l) BH04 (0.03 µg/l) BH02 (4.71 µg/l)

Note: **EQS (Freshwater)** screening values in bold, *EU DWS* thresholds are in italics.
Bioavailable fraction.

The chemical testing results identified exceedances, with respect to Water Quality Standards, of numerous heavy metals and PAHs, primarily within RBH02, centrally located within the site, and BH02, at the north of the site. Slightly elevated chromium concentrations were also identified in BH04 at the east of the site.

With respect to EU DWS, limited exceedances of selenium (RBH02) were recorded, in addition to PAH concentration exceedances in RBH02 and BH02, and a very minor exceedance of benzo(a)pyrene in BH04.

The site is located in Manchester city centre, which historically was heavily industrialised throughout the surrounding area. Although it is considered likely that the exceedances recorded in Table 6.2, above, are associated with downward migration of contaminants from on-site Made Ground soils, leaching into bedrock, it is likely that the contaminants are also indicative of the wider historic, industrial, land use of the city centre. It is noted that due to the construction of the double storey basement, all potential sources of contamination within Made Ground will be removed from the site.

6.3 Water Supply Pipe Assessment

It is anticipated that Made Ground soils and superficial soils are to be excavated and removed from site to facilitate the construction of a basement. As such, it is likely that PE/PVC pipes may be used however the exact requirements are to be confirmed with the relevant utility supplier.

6.4 Materials Management

6.4.1 Re-use of Site Soils

Based on the geochemical testing results presented as part of this investigation it is considered that there is no specific requirement to remove soils from site because of them presenting an unacceptable risk to human health or the environment.

The re-use of site-won soils may therefore be undertaken if the following principles are met: i) the geotechnical suitability of the material needs to be confirmed; ii) the re-use of the material needs to be covered as part of the planning approval, e.g. site levels maintained within agreed limits; iii) the volume of the material being re-used needs to be confirmed and traceable and iv) regulatory approval from the relevant authorities has been sought. These principles are outlined within the CL;AIRE Definition of Waste Code of Practice (v2) and if and where the re-use of site-won soils is proposed as part of the development works it is recommended that a Materials Management Plan is produced in line with the Definition of Waste Code of Practice to detail and document the process.

6.4.2 Material Classification

It is envisaged that significant volumes of material are to be removed from site to facilitate the construction of a dual storey basement.

Where any site soils are to be disposed of off-site guidance on the disposal of contaminated soils is provided within the following document published by the Environment Agency, the Guidance on the classification and Assessment of Waste Technical Guidance WM3 (1st Edition 2015) (Ref. 20).

Guidance states that the principal contractor (or any other sub-contractor undertaking excavations) should, in conjunction with the proposed disposal facility, use where possible the relevant environmental chemistry analyses results to classify any surplus material identified for off-site disposal. However, it should be noted that this information is for guidance only and material identified for disposal should be tested and assessed in accordance with WM3 to enable classification during the works.

An initial assessment for the waste classification of the shallow and deeper Made Ground soils encountered on site has been carried out through a comparison of the soil testing results against the Tier 1 Thresholds and using the Waste Soils Characterisation Assessment Tool, Cat-WasteSoil, developed by McArdle and Atkins. This online tool gives a rapid assessment of contaminated soils and their classification as either hazardous or non-hazardous (stable non-reactive hazardous waste) waste, it should be noted that this tool does not classify inert waste.

Persistent Organic Pollutants (POP's) were not tested for as part of the investigation, however based on the Conceptual Site Model the risk of these being present on the site is considered low.

The initial assessment revealed that of the nineteen Made Ground soils tested, seventeen soil samples have indicated to be non-hazardous with respect to Environment Agency waste classes, using the guidance given in WM3. However, two samples have indicated to be hazardous waste for off-site disposal owing to the concentrations of copper and zinc (RBH06 at 0.40m bgl) and benzo(a)anthracene, diesel, copper, lead and zinc (WS03 at 0.30m bgl). A strong diesel odour was identified in WS03 during the service clearance pit, thought to be associated with a historic diesel spill.

In addition to the samples tested, chrysotile board was identified in archaeological trenches undertaken simultaneously with this investigation. A sample of the material was not tested. It is considered likely that more asbestos will be present in locations not tested during this investigation. Additional testing should be undertaken during the excavation phase to confirm the hazardous waste classification of material prior to removal from site.

The initial assessment of the seven natural soil samples tested may be considered non-hazardous waste for off-site disposal. Where natural soils are being considered for off-site disposal as inert waste, Waste Acceptance Criteria (WAC) testing should first be undertaken with confirmation of acceptability from the receiving landfill.

As discussed, preliminary waste classification is undertaken to offer indicative advice with respect to disposal requirements. Landfill operators are not obliged to accept waste and, if they were to do so, may have specific requirements beyond those outlined above prior to acceptance. Landfill operators should be contacted to confirm the above classifications or otherwise.

7.0 Ground Gas Assessment

The assessment of risk presented by ground gases is assessed with reference to guidance published by CIRIA (Assessing Risks Posed by Hazardous Ground Gases to Buildings, C665 (Ref.21), BSI Publication (Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings BS8485:2015 (Ref.22) and other broadly accepted references such as the Ground Gas Handbook 2009 (Ref.23).

The gas risk assessment adopts a tiered approach. In the first instance this involves a re-evaluation of the Conceptual Site Model described within the Phase 1 Preliminary Site Assessment (desk study) and thereafter validating this conceptual model with the ground gas data, the semi-quantitative risk assessment.

7.1 Ground Gas Monitoring Results

To characterise the site's ground gas regime and validate the qualitative assessment of ground gas risk 50mm standpipe installations were incorporated within the six window sample borehole locations and four rotary cored borehole locations. 19mm piezometers were within four rotary cored borehole locations. The details of the response zone of each monitoring installation are outlined in *Section 3.2*.

An initial programme of six gas monitoring visits over three months was proposed. Three gas monitoring visits have been undertaken between 26th July and 23rd August 2018, with barometric pressure recorded between 1009 mb and 1011 mb and the monitoring period included one monitoring visit following precipitation. The results log sheets are contained within *Appendix E* and summarised in *Table 7.1*.

Table 7.1 – Summary of Ground Gas Monitoring Results

Exploratory Hole ID	Maximum Methane Concentration (%)	Maximum Carbon Dioxide Concentration (%)	Minimum Steady Oxygen Concentration (%)	Maximum gas flow (l/hr)	
				Peak	Steady State
WS04	<0.1	5.2	12.2	-*	<0.1
WS05	<0.1	3.4	16.0	-*	<0.1
WS06	<0.1	1.8	19.0	-*	<0.1
WS08	<0.1	0.4	17.0	-*	<0.1
WS10	<0.1	1.5	18.5	-*	<0.1
BH02	<0.1	4.0	2.5	-*	<0.1
BH03	<0.1	0.9	18.1	-*	<0.1
BH04	<0.1	0.2	20.5	-*	<0.1
RBH02	<0.1	0.2	19.0	-7.0	-2.3/1.0
RBH04	<0.1	1.7	17.0	-*	-0.1
RBH05	<0.1	0.3	20.9	16.1	0.3
RBH06	<0.1	0.2	19.7	-	-

Note: WS11 and RBH03 are located within a demolition exclusion zone. These wells could not be monitored.

* Peak flow rate not recorded.

Methane (CH₄), carbon monoxide (CO) and hydrogen sulphide (H₂S) concentrations were recorded below the monitoring instrument's limit of detection within all the monitoring wells throughout the monitoring period.

Carbon Dioxide (CO₂) was recorded in peak concentrations between 0.2% and 5.2%. The greatest concentrations were recorded in WS04, BH02 and WS05.

Maximum, peak, gas flow was recorded between <0.1 and 16.1 litres per hour (l/hr), returning to steady state flow rates of between <0.1 and 1.0 l/hr. Peak flow rates in RBH02 of -7.0 l/hr were recorded, returning to a steady state flow rates of between -2.3 and -1.4 l/hr after 5 minutes on the first monitoring visit.

The highest concentrations of carbon dioxide were consistently recorded from WS04, centrally within the site, with carbon dioxide concentrations of between 4.5% v/v to 5.2% v/v recorded.

7.2 Ground Gas Assessment

The Preliminary Site Model presented in *Section 2.8* identified possible Made Ground deposits as a potential source of Ground Gas generation, both on-site and off-site, resulting from historical development and land use.

A review of geological mapping suggests no records of organic rich drift deposits (e.g. peat) being present. A historic infilled canal is present at orientated northwest to southeast across the centre of the development site, and south to north beneath the existing Old Granada Studios building. This could act as a source of ground. Coal deposits are noted to not underlie the site.

Noxious and asphyxiate gases were attributed to include, but not limited to, carbon dioxide, carbon monoxide, methane and hydrogen sulphide. The consequence was evaluated as Moderate risk.

Made Ground soils were encountered to depths of between 0.60 m to 6.25m bgl with limited putrescible content generally. Soils within WS02 (0.20m), WS03 (0.30m), WS05 (0.80m) and WS10 (0.50m) identified soil organic matter concentrations of >10% w/w.

The ground investigation revealed a ground model generally consistent with the preliminary conceptual site model. Natural deposits were generally sand with no significant putrescible/organic content, however one localised band of 'black spongy peat' was recorded at 2.00m – 2.20m bgl in RBH03. Sandstone bedrock was encountered at depths of between 3.05m (WS04) and 6.25m (RBH02) bgl.

To facilitate the construction of the basement, significant volumes of Made Ground and superficial soils are to be removed from the site. The base level of the basement is likely to be constructed within bedrock deposits, some circa 6m below existing ground level. Consequently, ground gas results from the window sample boreholes are unlikely to be representative of the ground conditions and have

therefore been discounted from the following analysis. Table 7.2, below, summarises the results considered to be representative of ground conditions for the proposed development.

Table 7.2 – Representative Ground Gas Monitoring Results

Exploratory Hole ID	Maximum Methane Concentration (%)	Maximum Carbon Dioxide Concentration (%)	Minimum Steady Oxygen Concentration (%)	Maximum gas flow (l/hr)	
				Peak	Steady State
BH02	<0.1	4.0	2.5	-	<0.1
BH03	<0.1	0.9	18.1	-	<0.1
BH04	<0.1	0.2	20.5	-	<0.1
RBH02	<0.1	0.2	19.0	-7.0	-2.3/1.0
RBH04	<0.1	1.7	17.0	-	-0.1
RBH05	<0.1	0.3	20.9	16.1	0.3
RBH06	<0.1	0.2	19.7	-	-

* Peak flow rate not recorded

Consideration of the recorded soil gas flow rates, presented above, enables hazardous gas flow rates to be evaluated. Q_{hg} can be derived for both 'representative' and 'worst case' scenarios and a comparison made in support of an appropriate assessment of ground gas risk.

The ground gas monitoring data is considered to be representative, given the varying ground conditions, ambient weather conditions and barometric pressures recorded throughout the monitoring period. Therefore, steady state gas flow rates are considered the most appropriate, discounting negative peak flow rates recorded where groundwater levels may have influenced the peak flow rate.

Evaluation of the 'representative' Q_{hg} for carbon dioxide (highest steady state gas flow rate that is realistically possible in a single borehole) records a maximum Q_{hg} of 0.0040 l/hr, from RBH02.

Evaluation of the 'worst case' Q_{hg} for carbon dioxide (highest steady state gas flow rate that is realistically possible in any borehole on any occasion) records a maximum Q_{hg} of 0.0400 l/hr.

The 'representative' scenario has been adopted as the sites Gas Screening Value (GSV) and in accordance with an assessment by CIRIA C665 the GSV indicates a Characteristic Situation 1 (CS1) gas regime which does not require any gas protection measures.

The potential risks from ground gases to the excavations are to be dealt with by the Contractor, in accordance with the Confined Space Regulations, during construction. Appropriate ground gas monitoring and safety measures should be in place during the works, as the potential presence of ground gases could pose a risk in any confined spaces of deep excavations.

8.0 Revised Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) presented in the previous Phase 1 reports and discussed in *Section 3.0* of this report has been revised following the GQRA in *Section 6.0* above. The Revised Conceptual Site Model (CSM) is summarised in the table overleaf and graphically presented as *Appendix A*.

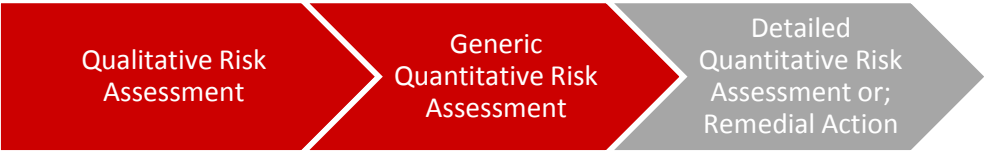
The CSM details the source-pathway-receptor linkages or potential pollutant linkages (PPL) that have been identified as relevant for the site. The GQRA details the associated level of risk relating to these potential pollutant linkages.

The CSM follows the framework outlined within CIRIA C552 (Ref. 24) which is summarised within *Appendix G*.

The 'risk rating' within the CSM refers to the risk that the source, pathway, receptor linkage or PPL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

Risks presented by Unexploded Ordnance is discussed and assessed in *Section 2.6*.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 (Ref. 25) which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements. Reference should be given to the environmental testing results discussed within *Section 8.0* and presented within *Appendix C*.



- The table below represents the Second stage in the land quality risk assessment process; the Revised Conceptual Site Model following the Quantitative Risk Assessment.
- For a development site to be deemed 'suitable for use' the level of risk needs to be brought down to acceptable levels, i.e. low to very low risk. The purpose of each stage of risk assessment is ultimately to establish if there is a requirement for additional levels of assessment to be made to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.
- In the absence of specific site data, a Generic Quantitative Risk Assessment is invariably recommended.

Conceptual Site Model			Generic Qualitative Risk Assessment			Comments	Action
Identified Source	Pathway(s)	Receptor(s)	Consequence	Likelihood of Occurrence	Risk Rating		
Made Ground soils derived from historical development and land use as a source of contamination.	Direct contact and dermal uptake, soil and dust ingestion, dust* and migration inhalation (indoor & outdoor air)	Commercial end users	Medium	Unlikely	Low	It is anticipated that all Made Ground soils will be excavated and removed from the site to facilitate the construction of the basement. This will remove any potential source of contamination from the site, breaking the SPR linkage. Chemical testing results do not identify any exceedances with respect to the nominated screening criteria.	Construction and groundworkers to be provided with appropriate PPE. No further action required.
	Direct contact and dermal uptake, soil and dust ingestion, dust* & migration inhalation (outdoor air)	Construction and maintenance workers	Mild (Standard Health & Safety precautions likely to be used by workers)	Unlikely	Very Low	Asbestos boarding was identified in archaeological trenches undertaken simultaneously with this investigation. The material was not quantified. It is considered likely that more asbestos may be present in other locations across the site. As discussed, Made Ground soils are to be removed from site, limiting the likelihood of exposure to site end users. Construction workers are to be provided with appropriate PPE during all construction activities, to limit the likelihood of exposure to contamination sourced within Made Ground soils.	
	Soil dust and vapour ingestion/inhalation produced during construction (indoor and outdoor air)	Adjacent residents	Medium	Unlikely	Low	Four soil samples (RBH06 at 0.40m, WS02 at 0.30m and WS03 at 0.30m and 1.00m) recorded the presence of SVOCs. All samples are located within 'Zone 1' at the north of the site. Contaminants are likely to have volatilised prior to exposure to members of the public.	No further action required
	Downward vertical migration through superficial soils	Controlled Waters Principal Aquifer (Bedrock) Chester Pebble Beds Formation (Sandstone)	Medium	Unlikely	Low	Groundwater chemical testing results indicated exceedances of selenium, and several PAHS, when compared against EU DWS. No potable groundwater abstractions are located within 250m of the site, limiting the likelihood of exposure to the relatively minor concentrations identified. It is anticipated that Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement. The removal of Made Ground soils will remove the potential source of contamination. As such, no further action to address the elevated concentrations identified in the groundwater samples tested is required.	No further action required.
	Vertical and horizontal migration through superficial soils and bedrock	Controlled Waters Surface Water (River Irwell approximately 60m northwest)	Medium	Unlikely	Low	The chemical testing results identified exceedances, with respect to Water Quality Standards, of numerous heavy metals and PAHs. Contaminants from Made Ground soils may have leached into the underlying aquifer, although it likely that the concentrations identified are indicative of background concentrations associated with historical industrial land use in Manchester city centre. It is anticipated that Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement. The removal of Made Ground soils will remove the potential source of contamination. As such, no further action to address the elevated concentrations identified in the groundwater samples tested is required.	No further action required.

Conceptual Site Model			Qualitative Risk Assessment			Comments	Action
Source	Pathway(s)	Receptor(s)	Consequence	Likelihood of Occurrence	Risk Rating		
Production of ground generating gases from: - Made Ground deposits containing organic/ putrescible content; - Infilling of canal basin directly beneath the site; - Historic St. Johns Church Graveyard.	(Ground gas & vapour) migration and inhalation	Commercial end users	Medium	Unlikely	Low	Made Ground soils are to be excavated and removed from the site to facilitate the construction of the basement. As such, any source of ground gas generation will be removed from the site.	No further action required. Should development plans change, this recommendation may be reassessed.
		Construction and maintenance workers	Medium	Unlikely	Low		
Bedrock deposits as a source of ground gas generation		Commercial end users	Medium	Unlikely	Low	Ground gas monitoring results recorded a maximum carbon dioxide concentration of 4% v/v in BH02 on the third monitoring visit. Methane concentrations were recorded below the limit of detection of the monitoring equipment on each visit throughout the monitoring period. Steady state gas flow rates recorded from this borehole were recorded at <0.1 l.hr on each monitoring visit. A representative Qhg of 0.004 l/hr for carbon dioxide was calculated, corresponding with a Characteristic Gas Situation of CS1, where ground gas protection measures are not required.	No further action required.
		Construction and maintenance workers	Medium	Unlikely	Low		

8.1 Summary of Significant Pollutant Linkages

A **Low to Very Low** risk is presented to site end users and construction workers from Made Ground soils. No exceedances with respect to the nominated GACs were recorded in any soil samples tested, and all Made Ground soils are likely to be removed from the site to facilitate the construction of a single and dual storey basement. Construction workers should be provided with appropriate PPE during all earthworks and groundwork activities.

A **Low** risk is presented to site end users and construction workers from ground gas migration from Made Ground and natural sources. In accordance with an assessment by CIRIA C665, the calculated gas screening value (GSV) indicates a Characteristic Situation 1 (CS1) classification may be assigned to the site, indicating no gas protection measures are required for the proposed development.

A **Low** risk is presented to controlled waters (Groundwater). Limited exceedances of selenium and PAHs were identified in groundwater samples when compared against EU DWS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, and no potable groundwater abstractions are located within 250m of the site.

A **Low** risk is presented to controlled waters (Surface water). Exceedances of heavy metals and PAHs were identified in groundwater samples when compared against WFD EQS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, removing a potential source of contamination.

9.0 Engineering Assessment and Recommendations

9.1 Introduction

This section will assess the relevant geotechnical issues for the proposed redevelopment as generally high rise (up to 36-storeys, 140m above ground level) buildings comprising residential apartments with retail, leisure and commercial spaces with a dual storey basement. The proposed development plan is contained within *Appendix A*. The engineering assessment considers foundation design, excavations, and ground floor slabs for the site. It should be noted that detail may change in the development of designs beyond the issue of this Phase 2 Report and the Construction designer should satisfy themselves regarding the adequacy of their design and proposed approach to construction by reference to the on-going project design proposals, the site investigation information and their own examination of the site.

9.2 Summary of Ground Conditions

The ground conditions at the site generally comprised Made Ground underlain by superficial and residual soil deposits predominately comprising of Sand and Gravel underlain by Chester Pebble Beds Sandstone Formation. Groundwater monitoring recorded groundwater to be between 1.97m – 4.44m bgl with potential artesian groundwater conditions.

The geotechnical parameters recommended for use in the design based on the ground conditions encountered are summarised in *Table 9.2* below.

Table 9.2 – Geotechnical Parameters

Parameter	Granular superficial deposit / residual soil	Sandstone
Unit Weight, γ (kN/m ³) ⁽¹⁾	18	22
Effective Angle of Shearing Resistance, Φ' (°) ⁽²⁾	34	38
Unconfined compressive strength based on laboratory testing and logging (MPa): – 8.0m bgl – 12.0m bgl – 16m bgl – 24m bgl – 40m bgl		1 2 6 9 11
Drained Modulus of Elasticity, E' (kPa) ⁽³⁾	15,000	100-150,000

(1) From published sources (BS8002) and laboratory test results.

(2) Estimated from the relationship between SPT 'N' Value and angle of shearing resistance (Peck et al, 1976) laboratory testing and published values (Hoek & Bray 1974).

(3) From published relationships and sources CIRIA R103, R143, R181 [Ref.27] and C504).

9.3 Excavation and Support

Based on observations on site, together with the results of in-situ and laboratory tests, it is considered that excavations to <1.00m bgl should stand unsupported in the short term (1-14 days). Side support for safety purposes should of course be provided to all excavations which appear unstable, and those >1.20m deep, in accordance with Health and Safety Regulations.

Suitable side slope angles excavated in Clay is likely to be in the region of 20-35 degrees when wet, increasing to 35-45 degrees when dry, based on guidance provided by CIRIA report 97 Trenching Practice (Ref.28). Within Sand and Gravel, it is likely to be in the region of 30-40 degrees when dry, decreasing to 10-30 degrees when wet.

Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. However buried obstructions associated with service runs and significant foundations are expected to be present underlying the current buildings. An allowance should be made for breaking out any concrete which may be encountered.

Monitoring recorded groundwater levels within the bedrock deposits typically above the monitoring installation response zone, to depths of between 1.97m – 4.44m bgl. Therefore, groundwater ingress is likely once rockhead is penetrated. This is likely to cause instability to excavations and may hinder construction of the basements and foundations. It is recommended that groundwater monitoring should continue to allow a greater understanding the groundwater regime at the site with consideration to installing additional monitoring points around the site.

Temporary earthworks support is envisaged to allow the proposed construction which may be in the form of sheet piled walls.

9.4 Foundation Design

The developments range in scale and height from 46m to 140m above ground (9-35 storeys respectively) with both the shortest and tallest buildings in Zone 1, two buildings some 46m and 105m above ground (10 and 31 storeys respectively) are proposed in Zone 6 with one building 114m above ground (35 storey) in Zone 7 proposed. It is understood that the proposed foundations may comprise of a combination of pads, rafts and piles.

The Made Ground and the superficial deposits are not considered to be suitable founding strata due to the likely significant loadings for a high-rise building and it is considered that a piled foundation solution is adopted designed as end bearing in the sandstone bedrock. However, pad foundations for the low-rise buildings may be suitable founding in the superficial deposits /completely weathered sandstone.

Assuming foundation excavations to approximately 4.5mbgl and founding strata having bearing capacity characteristics not less than those of very dense sand then square pad foundations with may be designed to a bearing resistance of approximately 400-600kN/m²

If excavations are taken deeper to found in the partially weathered Sandstone at approximately 8.0m bgl, then spread foundations on may be designed using the method of presumed bearing resistance. The method is based on the relationships outlined in BS EN 1997-1:2004. Assessment of the Chester Pebble Beds based on field descriptions, lab test results and discontinuity spacing indicates that the sandstone beneath the upper weathered layer, provides a presumed bearing resistance of approximately 600 - 1000 kN/m². This assessment assumes square pad foundations bearing onto the weak sandstone for settlements not exceeding 0.5% of the total foundation width. These initial estimates should be reassessed on a plot by plot case and should be undertaken once loadings and configurations are known. If the founding horizon reveals very closely spaced discontinuities, then it would be prudent to adopt a lower presumed bearing resistance. All foundation excavations should be approved by a suitably experienced Geotechnical Engineer.

For the high-rise buildings it is considered that a piled foundation be adopted to accommodate the anticipated significant loads. The load capacity of the piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

Initial estimates in accordance with Eurocode 7 (Ref.7) indicate that a bored pile of 750mm diameter and 16m length would provide a total design resistance of 11,025 kN for combination 1 and 6228 kN for combination 2. Increasing to 14,502 kN combination 1 and 8110 kN combination 2 for a 900mm diameter bored pile of 16m length.

However, this initial estimate should be reassessed on a plot by plot case. This should be undertaken once loadings and configurations are known. It is also recommended that additional analysis be undertaken to model the pile interaction with the sandstone and to obtain a greater understanding of the pile carrying capacity and settlement. From this additional analysis it may become evident that another phase of site investigation and testing may be required to fully validate the detailed design.

Modulus of subgrade reaction values on the weathered Sandstone at 4.5m bgl have been estimated between 7.0MN/m³ and 13.0MN/m³ with values between 10.0MN/m³ and 21.0MN/m³ at in the partially weathered sandstone at 10.0m bgl, however, this should be reassessed on a plot by plot basis.

Due to the likely presence of groundwater into excavations once rockhead is penetrated a contiguous pile or secant piled foundation should be considered to reduce groundwater flow into excavations to

enable basements to be constructed. Hydrostatic uplift should be considered as part of the detailed design following additional groundwater monitoring to develop the groundwater model at the site

9.5 Ground Floor slabs

It is recommended that all ground slabs should be suspended to account for the high structural loads and any potential hydrostatic uplift. Basement slabs should be developed to span between foundations to resist buoyancy. The potential risk of floatation should be considered in the temporary condition during construction.

10.0 Conclusions & Recommendations

10.1 Conclusions

A revised tabulated revised Conceptual Site Model has been derived following the findings on the Generic Quantitative Risk Assessment risk assessment and is presented in *Section 8.0*.

10.1.1 Geotechnical Assessment

The proposed development range in in scale and height from 46m to 140m above ground with a dual storey basement. It is understood that the proposed foundations may comprise of a combination of pads, rafts and piles.

The Made Ground and the superficial deposits are not considered to be suitable founding stratum due to the likely significant loadings for a high-rise building and it is considered that a piled foundation solution is adopted designed as end bearing in the sandstone bedrock. However, pad foundations for the low-rise buildings may be suitable founding in the superficial deposits /completely weathered sandstone.

Square pad foundations maybe suitable for the low-rise buildings with a presumed bearing resistance of approximately 400-600kN/m² founding at 4.5m bgl in the weathered Sandstone increasing to approximately 600 - 1000 kN/m² at 8.0m bgl founding in the partially weathered sandstone.

For the high-rise buildings it is considered that a piled foundation be adopted to accommodate the significant loads. Initial estimates in accordance with Eurocode 7 (Ref.7) indicate that a bored pile of 750mm diameter and 16m length would provide a total design resistance of 11,025 kN for combination 1 and 6228 kN for combination 2. Increasing to 14,502 kN combination 1 and 8110 kN combination 2 for a 900mm diameter bored pile of 16m length.

Due to the likely presence of groundwater into excavations once rockhead is penetrated a contiguous pile or secant piled foundation should be considered to reduce groundwater flow into excavations to enable basements to be constructed.

It is recommended that all ground slabs should be suspended to account for the high structural loads and any potential hydrostatic uplift. Basement slabs should be developed to span between foundations to resist buoyancy. The potential risk of floatation should be considered in the temporary condition during construction.

Excavation through layers of Made Ground and superficial deposits should be feasible using conventional site plant. An allowance should be made for breaking out and removing any encountered concrete obstructions associated with existing foundations. Temporary earthworks

support is envisaged to allow the proposed construction within the Made Ground outside the permanent basement wall, which may be in the form of sheet piled walls, subject to design by a temporary works engineer.

10.1.2 Ground and Groundwater Contamination

The environmental chemistry soil results have been compared with the Tier 1 criteria for soils with respect to human health against '*Commercial*' thresholds. No exceedances were recorded in any of the soil samples tested with respect to these thresholds. Four Made Ground soil samples at the north of the site recorded minor concentrations of SVOCs. All Made Ground soils are likely to be removed from the site to facilitate the construction of a single and dual storey basement. Construction workers should be provided with appropriate PPE during all earthworks and groundwork activities.

A **Low** risk is presented to controlled waters (Groundwater). Limited exceedances of selenium and PAHs were identified in groundwater samples when compared against EU DWS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, and no potable groundwater abstractions are located within 250m of the site.

A **Low** risk is presented to controlled waters (Surface water). Exceedances of heavy metals and PAHs were identified in groundwater samples when compared against WFD EQS thresholds. These concentrations may be sourced from Made Ground soils on site, though are likely to be indicative of background concentrations associated with historical industrial land use in Manchester city centre. Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement, removing a potential source of contamination.

10.1.3 Ground Gas Assessment

Three gas monitoring visits have been undertaken to date, with a maximum carbon dioxide concentration of 4.0% v/v and a maximum, steady state, flow rate of 1.0 l/hr recorded. Methane concentrations were recorded below the limit of detection of the monitoring instrument throughout the monitoring period. The risk to the end user the development site from ground gas generating sources is therefore considered to be Low. The gas regime for the site is CS1, requiring no gas protection measures.

The BGS Radon Mapping confirms the site is situated in an area where less than 1% of homes are above the radon action level. The new development incorporates a single and dual storey basement, and so the advice of a specialist Radon assessor must be obtained.

10.1.4 Additional Considerations

The site is in Manchester City Centre, which during WWII suffered bomb damage. Records obtained to date indicate that the site may have been struck during bombing raids, and land in the vicinity of the site was impacted by them. However, several recommendations have been made for the implementation of mitigation measures during intrusive works which are detailed within *Section 2.6*.

In the unlikely event that material is revealed on the site of a nature that does not accord with the anticipated ground conditions identified in *Section 5.0* the following procedure is to be complied with.

- a) Cease and make safe all excavations in this location and report observations to the Site Manager.
- b) The Site Manager is to notify the Engineer.
- c) Under guidance of the Engineer take representative samples of the suspect materials and forward to a suitably accredited laboratory for analysis.
- d) Await Engineers instructions with respect to re-commencement of the works and or removal from of suspect material to a suitably licensed disposal facility.
- e) Manchester City Council and if relevant the Environment Agency are to be kept fully informed of any site such occurrences.

10.2 Recommendations

Based on the findings of the ground investigation, the following recommendations are made:

- 1) It is anticipated that all Made Ground soils are to be removed from site to facilitate the construction of a single and dual storey basement. It is unlikely that a remediation strategy will be required for this development;
- 2) Further numerical analysis be undertaken to model the pile interaction with the sandstone in order to obtain a greater understanding of the pile carrying capacity and settlement; and
- 3) Notwithstanding, appropriate PPE should be supplied to and worn by all groundwork and construction personnel during the basement excavation, and other groundwork and construction activities, with reference to the environmental testing results presented herein and within *Appendix C*.

11.0 References

- 1 Curtins Phase 1 Preliminary Site Assessment for Bonded Warehouse and Energy Centre (Report ref. B049241/JJ/6744) dated 24th May 2018.
- 2 Curtins Phase 1 Preliminary Site Assessment for St. John's Place, Manchester (Report ref. B049228/JJ/6743) dated 24th May 2018.
- 3 Curtins Phase 1 Preliminary Site Assessment for Central Village, Manchester (Report ref. B061604.010/JJ/6923) dated 12th July 2016.
- 4 Curtins Phase 1 Preliminary Site Assessment for Old Granada Studios, Manchester (Report ref. B049242/JJ/6736 Rev. A) dated 19th June 2017.
- 5 University of Manchester Collections:
http://enriqueta.man.ac.uk/luna/servlet/view/search?q=%22Manchester%20bomb%20damage%22&sort=Reference_Number,Reference_Number,Reference_Number,Page
- 6 Planit, *Explosive Ordnance Threat Assessment St. John's Manchester*, report no. 0123 (dated March 2016).
- 7 Environment Agency (2004) *Model Procedures for the management of land Contamination Contaminated Land Report 11* (CLR11).
- 8 British Standards Institution (2015) *Investigation of Potentially Contaminated Sites* (report no. BS10175).
- 9 British Standards Institution BSI (2010) *Code of Practice for Site Investigations* (report no. BS5930).
- 10 British Standards Institution (2006) *Eurocode 7: Geotechnical Design* (report no. BS EN 1997).
- 11 British Standards Institution (2013) *Guidance on Investigations for Ground Gas, Permanent Gas and Volatile Organic Compounds (VOCs)* (report no. BS8576:2013).
- 12 Environment Agency (2014) *Contaminated Land Exposure (CLEA) Tool* (version 1.06).
- 13 Environment Agency (2009) *Human Health Toxicological Assessment of Contaminants in Soil* (report no. SC050021/SR2)
- 14 Environment Agency (2009) *Updated Technical Background to the CLEA Model* (report no. SC050021/SR3).
- 15 Department of Environment Food and Rural Affairs (DEFRA) (2012) *Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance* (report no. PB13735).
- 16 Environment Agency (2006) *Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination* (report no. ea/br/e/std/vr10thanni).
- 17 European Union (1998) *Drinking Water Directive* (Council Directive 98/83/EC).
- 18 *The Water Framework Directive, (Standards and Classification) Directions* (England and Wales).
- 19 World Health Organisation (2017) *Guidelines for Drinking Water Quality*, 4th edition.
- 20 Environment Agency (2015) *Guidance on the Classification and Assessment of Waste Technical Guidance WM3* (1st Edition 2015)
- 21 CIRIA (2007) *Assessing Risks Posed by Hazardous Ground Gases to Buildings* (report no. C665)
- 22 British Standards Institution (2015) *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* (report no. BS8485).
- 23 S Wilson, G Card, S Haines (2009) *Ground Gas Handbook* Cathness, Scotland, Whittles Publishing.
- 24 Environment Agency (2006) *Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination* (report no. ea/br/e/std/vr10thanni)
- 25 CITB (2015) *Construction (Design and Management) Regulations*.

Appendix A – Drawings

- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20059 Geotechnical Masterplan Without Proposed Buildings
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20055 Geotechnical Masterplan Stage 1
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20056 Geotechnical Masterplan Stage 2
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20057 Geotechnical Masterplan Stage 3
- Curtins drawing ref. 065330-CUR-TMP-XX-DR-S-20058 Geotechnical Masterplan Stage 4



KEY

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- WS** PROPOSED WINDOW SAMPLES

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4	CHAPMAN TAYLOR	R&C	CWC	VECTOS
5	ALLIED LONDON	CURTINS	CWC	VECTOS
6	CARTWRIGHT PICKARD	CURTINS	CWC	VECTOS
7	DCM	CURTINS	CWC	VECTOS
8	CMA	BURRO HAPPOLD	BCP	VECTOS

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ST JOHN'S MASTERPLAN

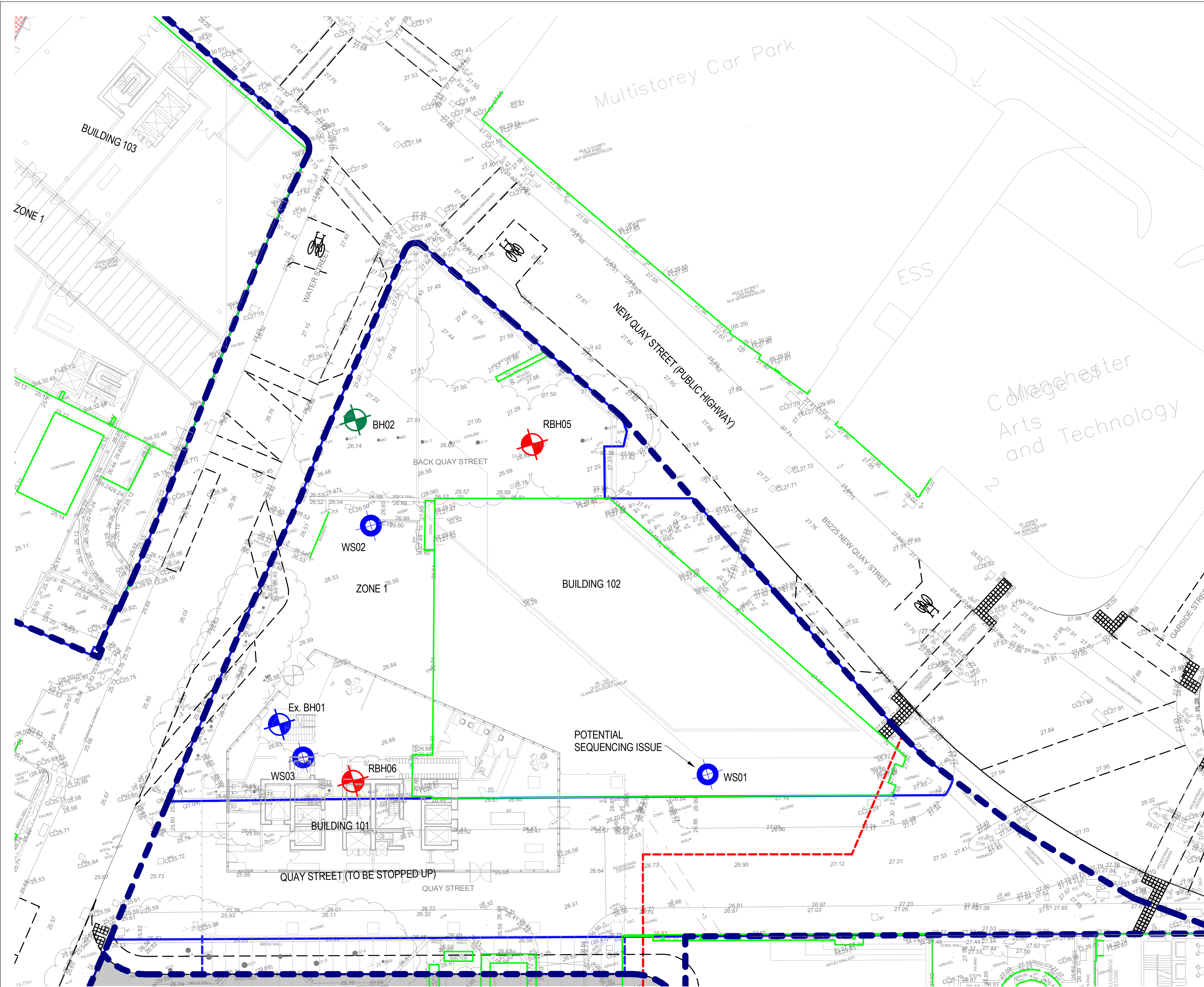
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GEOTECHNICAL MASTERPLAN WITHOUT PROPOSED BUILDINGS

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- - - DENOTES UNDERSAIL OF BUILDING
- - - DENOTES OVERSAIL OF BUILDING
- DENOTES EXTENT OF EXISTING BUILDING
- DENOTES PUBLIC HIGHWAY - TM TEAM
- DENOTES PRIVATE CARRIAGEWAY - TM TEAM

DE-ADOPTION/STOPPING UP PROCESS - VECTOS/SHOOSMITHS

EASEMENT TO SHIP CANAL TBC -

OBSTRUCTIONS - TUNNEL/CANAL -

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5	ALLIED LONDON	CURTINS	CWC	VECTOS
6	CARTWRIGHT PICKARD	CURTINS	CWC	VECTOS
7	DCM	CURTINS	CWC	VECTOS
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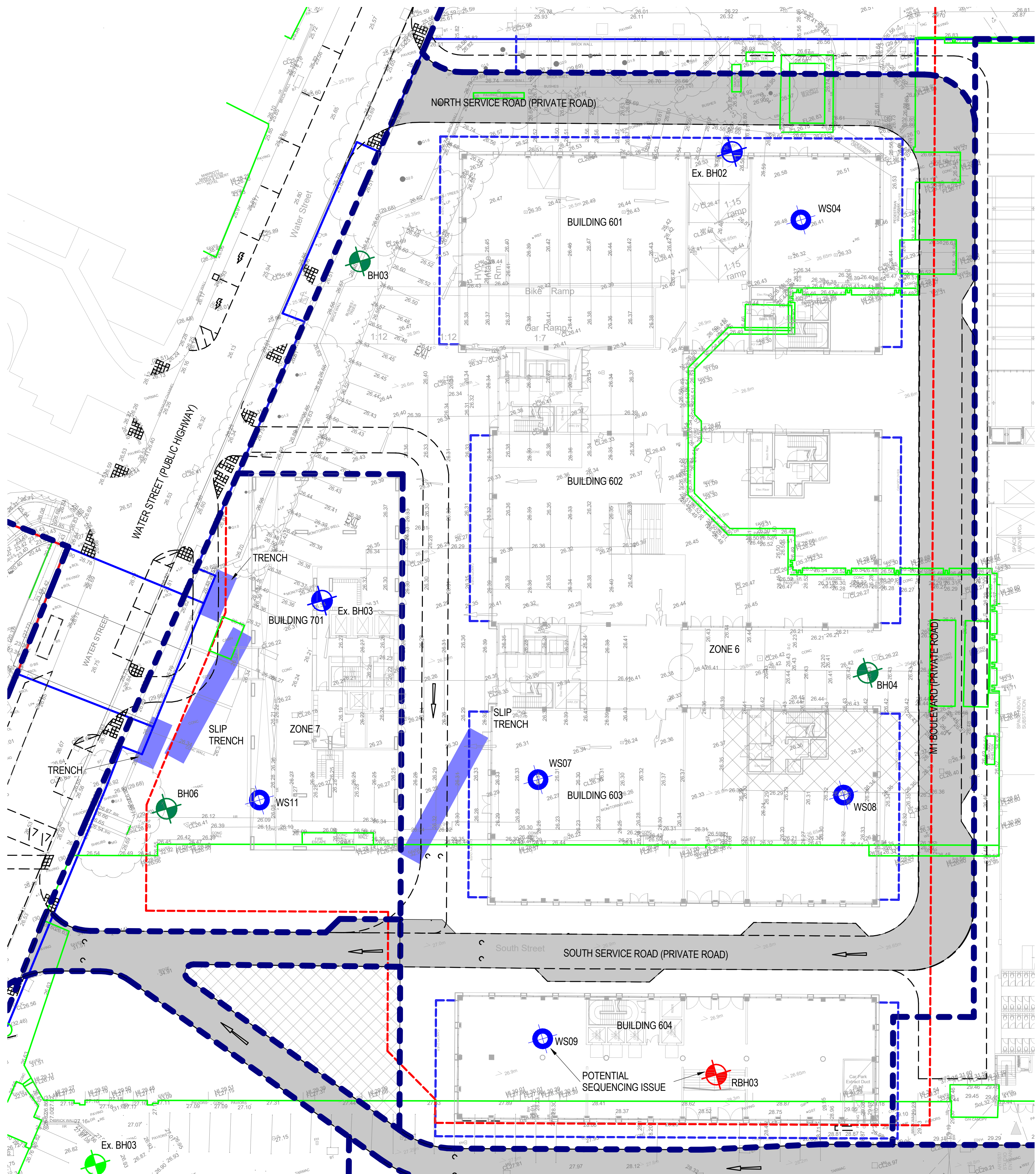
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- - - DENOTES OVERSAIL OF BUILDING
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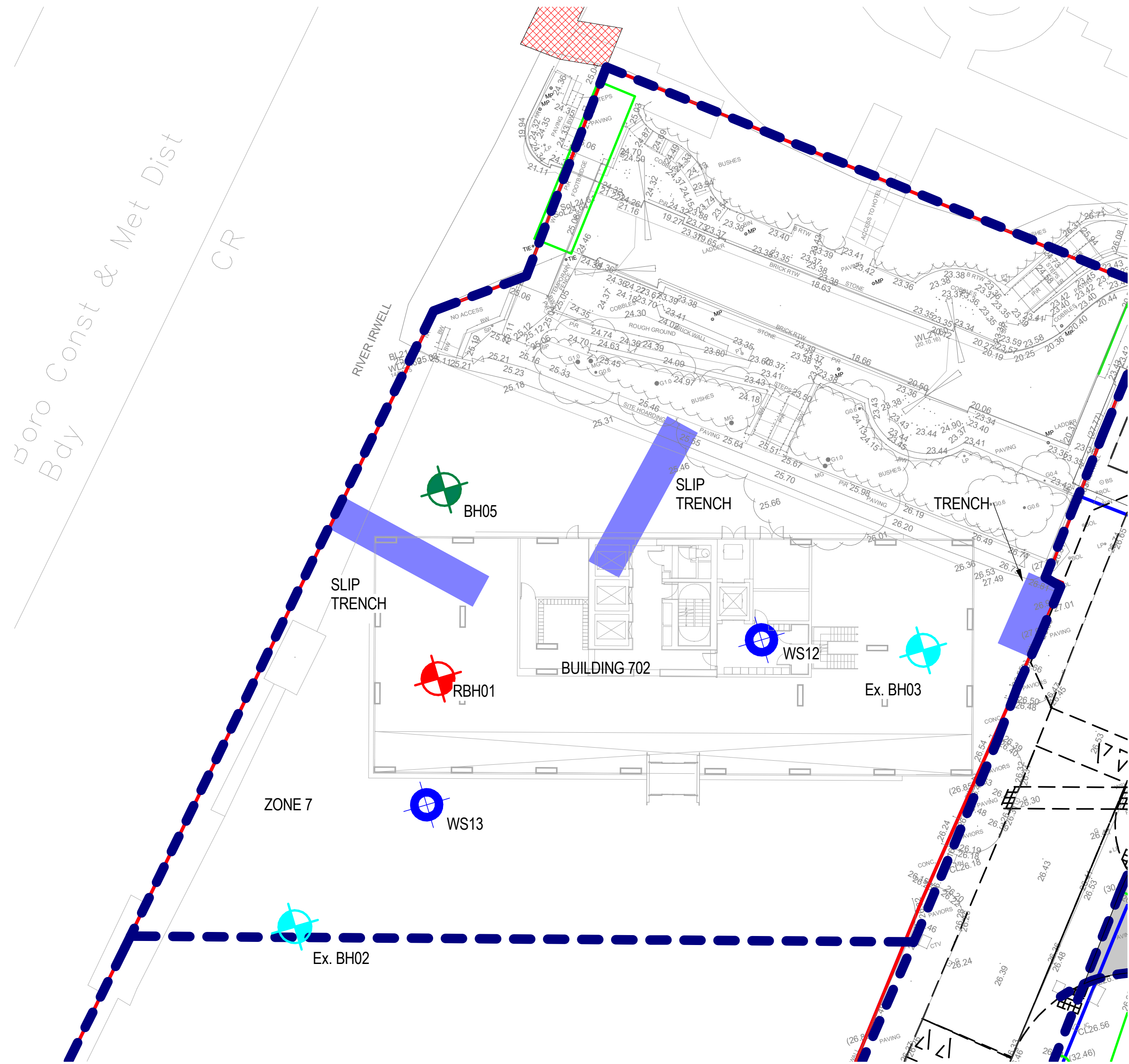
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OBSTRUCTIONS - TUNNEL/CANAL -

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Size:	Date:	Drawn By:	Designed By:	Checked By:			
A1	JAN 18	AJM	PW	AI			
Scale: As indicated							
Project No:	Originator:	Zone:	Level:	Type:	Discipline:	Category / Number:	Rev:

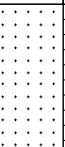
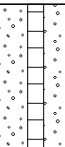
Appendix B – Exploratory Hole Logs

- Rotary Borehole Logs, BH02 to BH04 and RBH02 to RBH06 with Photographic Record of Rock Cores
- Window Sample Borehole Logs, WS02, WS03, WS04, WS05, WS06, WS08, WS10, and WS11

Samples & In Situ Testing				Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.20 0.25 0.50	ES1 B2 ES3	SPT(S) N=16 (2,3/4,4,4,4)		(0.30)	MADE GROUND: Grass over, dark brown, gravelly, fine and medium SAND. Gravel including very angular to rounded, fine to coarse including brick, sandstone, mudstone, frequent rootlets, slate, tile with rare glass (Topsoil). MADE GROUND: Brownish black, gravelly fine to coarse SAND. Gravel including very angular to rounded, fine and coarse including brick, slate, mudstone, sandstone, tile, rare glass with occasional rootlets.				
1.10 1.10 1.20	D5 ES4								
1.20 - 1.50 1.20 - 1.65 1.60 - 2.60	B6 D7 B8								
1.80 2.10 2.10 - 2.55	ES9 D10								
2.90 3.00	D11	SPT(S) 24 (3,3/24 for 160mm)		2.80 3.00	MADE GROUND: Greyish red, gravelly, fine to coarse SAND. Gravel including subangular to rounded, fine to coarse including tile, brick, sandstone and mudstone. Dark yellowish brown, fine to coarse SAND and subangular to subrounded, fine to coarse GRAVEL including sandstone and mudstone.			1	
3.00 - 3.30 3.00 - 3.30 3.20 3.30 - 3.70 3.40	B12 D13 D14 D15								
3.40 - 3.80 4.30	D16								
4.30 - 4.40 4.50	D17 D18								
4.60 - 5.60	70 11 0								
		SPT(S) 50 (8,8/50 for 235mm)		(1.20)	Reddish brown SANDSTONE.			2	
		SPT(S) 20 (25 for 95mm/20 for 70mm)		4.20 (0.40)	Extremely weak to very weak, thickly laminated, reddish brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal, 2-4 degrees, very closely spaced, planar to undulating, open and rough.			3	
		4.70m - SPT(S) 50 (25 for 75mm/50 for 70mm) 4.70m - D19		(1.00)	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal, 2-4 degrees, very closely spaced, planar to undulating, open and rough.			4	
		66 24 0	10	(1.40)	Between 6.20m and 6.23m: weak reddish brown mudstone.			5	
		100 93 42	10	7.00	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal, 1-3 degrees, closely spaced, planar to undulating, open and rough.			6	
		71 12 0	NI	8.70	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with occasional 2-3mm thick brown mudstone laminae. Discontinuities are 1) subhorizontal, 2-6 degrees, very closely spaced, planar to undulating, open, smooth and slightly rough. 2) subvertical 70-80 degrees, medium to widely spaced, planar, open and rough.			7	
		AZCL						8	
		AZCL						9	
TCR/SCR/RQD FI				Continued next sheet				10	

Chiselling				Borehole Diameter		Boring Progress				Remarks:					
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
				4.85	200	13/07	16:00	4.60	4.60	Dry	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R				
						16/07	08:00	4.60	4.60	3.50					
						16/07	16:30	17.20	4.60	2.10					
						17/07	08:00	17.50	4.60	7.20					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				4.70	200							0.00	5.00	Plain	
										5.00	20.00	Slotted			
Checked by:		HH	IFA CP												
Log status:		DRAFT	v01.01												

	Plant used: Comacchio 305		Project: St John's Masterplan			Location ID: BH02	
	Dates: 13/07/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location:		Ground level:	Logged by: HD/NC	Vertical scale: 1:50	Sheet 2 of 3 Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater								
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation							
10.00 - 11.50	60 18 6	9			(5.90)	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with occasional 2-3mm thick brown mudstone laminae. Discontinuities are 1) subhorizontal, 2-6 degrees, very closely spaced, planar to undulating, open, smooth and slightly rough. 2) subvertical 70-80 degrees, medium to widely spaced, planar, open and rough. <i>At 10.00m: medium strong.</i>		11								
		NI														
		AZCL														
11.50 - 13.00	66 25 6	16													12	
		NI														
		10														
		AZCL														
13.00 - 14.50	100 74 52	9													13	
		NI														
		6														
14.50 - 16.00	100 86 41	NI									14					
		8														
		8														
14.50 - 16.00	100 86 41	8									15					
		8														
14.50 - 16.00	100 86 41	8									15					
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14.50 - 16.00	100 86 41	8									15					
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14.50 - 16.00	100 86 41	8									15					
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14.50 - 16.00	100 86 41	8						15								
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14.50 - 16.00	100															

	Plant used: Comacchio 305		Project: St John's Masterplan			Location ID: BH02	
	Dates: 13/07/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location:		Ground level:	Logged by: HD/NC	Vertical scale: 1:50	Sheet 3 of 3 Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
20.50 - 22.00	100 100 71	5				Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional brown 3-8mm thick clay laminae. Discontinuities are subhorizontal, 1-4 degrees, very closely to closely spaced, planar tight to open and slightly rough.	.....	21	
22.00 - 23.50	100 97 82		22.15		Strong, reddish brown, fine grained SANDSTONE with rare off white and black 3-5mm sized quartzite and lignite inclusions. Discontinuities are subhorizontal, 2-5 degrees, widely spaced, planar to undulating, open and slightly rough. <i>At 22.20m: iron staining along fracture.</i> <i>Between 22.20m and 25.00m: occasional brown 10-20mm sized mudstone inclusions.</i>	.....	22		
23.50 - 25.00	100 93 78		(2.85)				.....	23	
						.....	24		
							.....	25	
					25.00	End of Borehole at 25.00m		25	
								26	
								27	
								28	
								29	
								30	

Flush Details				Borehole Diameter		Boring Progress				Remarks:				
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)		
						17/07	16:30	25.00	4.60	6.80	SPT Hammer: N/R, Energy Ratio: N/R			
				Casing Diameter		Water Strikes								
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)		Remarks		
											Monitoring Installations			
											Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		HH	IFA RC											
Log status:		DRAFT	v01.01											

Core Photographs BH02



Core Photographs BH02



Core Photographs BH02



Core Photographs BH02



Core Photographs BH02



Core Photographs BH02



Core Photographs BH02



Samples & In Situ Testing				Strata Details				Groundwater							
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation							
0.20	D2	SPT(S) N=15 (1,2/3,3,4,5)		0.10	MADE GROUND: Tarmacadam										
0.20	ES1			0.30	MADE GROUND: Grey, fine to coarse SAND and very angular to subangular, fine and medium GRAVEL including granite.										
0.50	D4			(0.80)	MADE GROUND: Brownish black, clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including brick, tile and sandstone.										
0.50	ES3														
1.20	D7 ES5 D8 B6	SPT(S) N=20 (3,3/3,4,5,8)		1.10	Medium dense, yellowish brown, clayey, fine to coarse SAND and very angular to rounded, fine to coarse GRAVEL including sandstone, mudstone and limestone (possible made ground).			1							
1.20				(1.10)											
1.20															
1.20															
1.20 - 1.65	D9			2.20	Medium dense, brown, clayey, fine to coarse SAND and angular to rounded, fine to coarse GRAVEL including sandstone, mudstone and limestone.			2							
1.20 - 2.00				2.20											
2.00															
2.20															
2.70	B10	SPT(S) 50 (5,5/50 for 295mm)		(1.60)	Below 3.00m: very dense.			3							
3.00	B11 D12														
3.00 - 3.50															
3.00 - 3.50															
3.70	D13 D14 D15	SPT(S) 50 (12,12/50 for 180mm)		3.80	Reddish brown SANDSTONE recovered as fine to coarse sand.			4							
3.70				(0.90)											
3.70 - 4.15															
4.10															
4.10 - 4.35	84 47 0	18		4.70	Very weak to weak, reddish brown, coarse grained SANDSTONE with rare mudstone lenses (<20x20mm). Discontinuities are subhorizontal, very closely spaced, rough undulating, open to moderately wide sand and angular to subangular, fine to coarse gravel fill. Orange staining on fracture surfaces and reduced strength.			5							
4.70 - 6.20					(1.43)										
										6.13					
6.20 - 7.70	100 100 21	12		(3.47)	Medium strong, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to closely spaced, rough planar, undulating, open to moderately wide, clean and with sand, gravel and rare clay fill. Orange staining on fracture surfaces.			7							
7.70 - 9.20	100 92 25														
										9.60					
9.20 - 10.70	100 94 53				Medium strong, reddish brown, coarse grained SANDSTONE with occasional subangular, medium and coarse gravel of mixed			10							
9.20 - 10.70															
										9.60					
TCR/SCR/RQD		FI	Samples & Tests		Continued next sheet										
Chiselling				Borehole Diameter		Boring Progress				Remarks:					
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	Service inspection pit hand excavated from GL to 1.20m.				
3.00	4.70	90		25.00	107	03/07	08:00	4.70	4.70	2.10					
								29/06	16:30	4.70	4.70	Dry			
								04/07	08:00	25.00		1.90			
								03/07	16:30	25.00	4.70	1.80	SPT Hammer: N/R, Energy Ratio: N/R		
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				4.70	200							0.00	8.80	Plain	19
												8.80	10.00	Slotted	19
Checked by:		HH	IFA CP												
Log status:		DRAFT	v01.01												

Plant used: Dando 2000/Comacchio 205	Project: St John's Masterplan			Location ID: BH03
Dates: 29/06/2018 - 03/07/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: HD	Vertical scale: 1:50	Sheet 2 of 3 Project ID: 42206

		Plant used: Dando 2000/Comacchio 205		Project: St John's Masterplan			Location ID: BH03	
		Dates: 29/06/2018 - 03/07/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location:		Ground level:	Logged by: HD	Vertical scale: 1:50	Sheet 3 of 3 Project ID: 42206	

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
19.70 - 21.20	100 100 71				(5.44)	Medium strong to strong, reddish brown, coarse grained SANDSTONE with medium and coarse subrounded gravel of mixed lithologies and lenses of mudstone. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open to moderately wide, clean and with sand film fill. 2) 15-25 degrees, very closely spaced to medium spaced, rough undulating, open and clean.	.....	21	
21.20 - 22.70	100 100 53						.....	22	
		10					.....	23	
22.70 - 24.20	100 100 73	5					.....	24	
24.20 - 25.20	100 74 42	14			24.50 24.60	Extremely weak to weak, thinly laminated MUDSTONE. Discontinuities are subhorizontal smooth, undulating planar and stepped, very tight to moderately wide, clean and with clay film fill.	.....	25	
		0			24.85 (0.35) 25.20	Weak to medium strong, thinly to thickly laminated medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to closely spaced, rough, stepped and undulating, open and with film of sand.	.....	25	
						Medium strong, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to closely spaced, open with sand and silt film fill.	.....	26	
						End of Borehole at 25.20m	.....	26	
							.....	27	
							.....	28	
							.....	29	
							.....	30	

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)			
											SPT Hammer: N/R, Energy Ratio: N/R				
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		HH	IFA RC												
Log status:		DRAFT	v01.01												

Core Photographs BH03



Core Photographs BH03



Core Photographs BH03



Core Photographs BH03



Core Photographs BH03



Core Photographs BH03



Core Photographs BH03

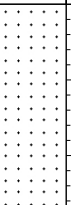
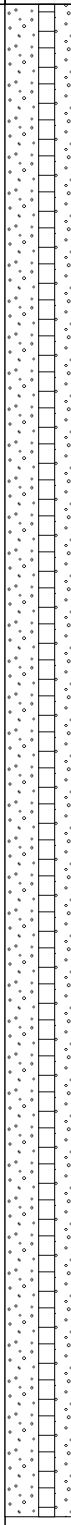
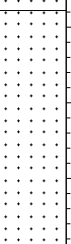
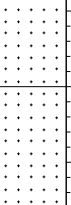
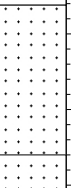
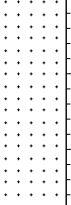


	Plant used: Comacchio 205		Project: St John's Masterplan			Location ID: BH04B	
	Dates: 02/07/2018 - 05/07/2018		Client: Curtins Consulting			Sheet 1 of 3	
Cable Percussion and Rotary Boring Log		Location:		Ground level:	Logged by: NC	Vertical scale: 1:50	Project ID: 42206

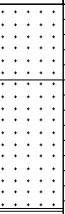
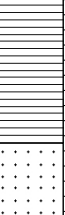
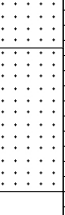
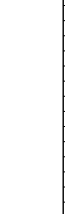
Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.25				0.25	MADE GROUND: Tarmacadam.			
(0.35)				(0.35)	MADE GROUND: Light cream brown, very gravelly, fine to coarse SAND. Gravel is subangular to angular, fine to coarse including tarmacadam and concrete.			
0.60				0.60	MADE GROUND: Dark brown, cobbly, gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including brick. Cobbles are subangular of brick.			
(0.50)				(0.50)	MADE GROUND: Brown mottled orange brown, clayey, gravelly, fine and medium SAND. Gravel is subangular to subrounded, fine to coarse including brick and sandstone. <i>Between 11.16m and 11.39m: non intact recovered as gravel including sandstone and quartzite.</i>			
1.10				1.10				
1.20		SPT(S) N=7 (1,1/1,2,2,2)						
2.10		SPT(S) N=16 (3,3/3,3,3,7)						
3.00		SPT(S) 50 (10,14/50 for 160mm)						
3.30		SPT(S) 50 (10,11/50 for 265mm)						
4.00 - 4.40	0	AZCL		3.40	dark grey, sandy GRAVEL with strong organic odour. Gravel is subrounded to rounded, fine and medium including sandstone and quartzite.			
4.40 - 4.90	39 0 0	NI		3.65	Extremely weak reddish brown weathered SANDSTONE.			
				4.00	Assumed zone of core loss.			
4.90 - 5.90	70 38 0			4.40	Very weak, very thinly bedded, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating, open to moderately wide sand fill. 2) 35-40 degrees, closely to medium spaced, rough undulating, open, sand fill and medium and coarse gravel fill. <i>At 4.40m: non intact recovered as gravel.</i>			
5.90 - 7.40	59 23 0	35		(3.56)	<i>Between 6.40m and 6.45m: medium grained gravel and clay lenses.</i>			
7.40 - 8.50	90 43 0	NI		7.96	<i>Between 7.69m and 7.74m: subrounded, medium grained gravel.</i>			
8.50 - 10.00	100 57 33	31		8.14	Extremely weak to very weak, very thinly bedded reddish brown, coarse SANDSTONE. Completely weathered. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating, partly open to moderately wide clay with subangular to subrounded gravel of quartz fill. 2) 80-90 degrees widely spaced tight with clay fill <3mm. <i>Between 7.96m and 8.16m: non intact recovered as gravel.</i> <i>Between 8.12m and 8.14m: MUDSTONE recovered as gravel.</i>			
				8.86	Medium strong, thickly laminated to thinly bedded, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating open, moderately wide sand and gravel fill. 2) 80-90 degrees widely spaced, tight with clay fill <3mm. Medium strong, thickly laminated to thinly bedded, medium and			
TCR/SCR/ROD			FI	Continued next sheet				

Chiselling				Borehole Diameter		Boring Progress				Remarks:	
From (m)	To (m)	Time (mins)	Remarks	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
3.00	3.30	30		25.10	107	04/07	08:00	3.70	3.70	1.90	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R
						04/07	16:30	14.50	5.90	2.20	
						05/07	08:00	14.50	5.90	2.10	
				Casing Diameter		Water Strikes				Monitoring Installations	
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
				5.90	200						
											Top (m)
											Base (m)
											Pipe Type
											Dia (mm)
											0.00
											5.00
											20.00
											PLAIN
											SLOTTED

Checked by:	HH	IFA CP
Log status:	DRAFT	v01.01

Coring, Samples & In Situ Testing					Strata Details					Groundwater								
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation									
10.00 - 11.50	83 53 0				(2.53)	Medium strong, thickly laminated to thinly bedded, medium and coarse SANDSTONE, poorly sorted with medium and coarse gravel predominantly quartzite with striations along the walls of the subvertical fractures. Discontinuities are 1) subhorizontal to 15 degrees, very closely spaced, rough undulating, open, sand fill. 2) 80-90 degrees, medium spaced, rough striated undulating, open and discoloured grey.		11										
		NI																
11.50 - 13.00	100 89 53	10			11.39	Weak, thickly laminated to thinly bedded reddish brown, medium and coarse SANDSTONE. Walls of subhorizontal fracture one weaker than the solid core. Discontinuities are subhorizontal, very closely to closely spaced, rough undulating open, moderately wide sand fill <1mm and gravel fill.		12										
										(2.11)	Between 12.45m and 12.50m: with localised, subangular to subrounded, fine and medium grained gravel of mixed lithology. Between 13.00m and 13.50m: with localised, subangular to subrounded, fine and medium grained gravel of mixed lithology.	13						
13.00 - 14.50	100 77 23				13.50	(0.81)	Weak thinly laminated to very thinly bedded, reddish brown, coarse grained SANDSTONE interbedded with lenses of mudstone. Discontinuities are 1) subhorizontal, very closely spaced to closely spaced, rough undulating, open clay and sand fill <3mm. 2) 30 degrees, very closely spaced to closely spaced, rough undulating, open sand fill <1mm.						14					
										14.31	Between 13.50m and 14.00m: weathered clay.	15						
14.50 - 16.00	100 89 53				15.30	(0.99)	Medium strong, thinly to thickly laminated reddish brown, medium grained SANDSTONE with lenses and very thinly bedded mudstone. Weathering stained black on surface. Discontinuities are 1) subhorizontal, very closely to closely spaced, rough undulating, open to moderately open sand and gravel fill <1mm 10mm. 2) 30 degrees, closely spaced, rough, planar open stained black.						16					
										16.00 - 17.50	100 71 53	25+		(5.20)	Weak, thinly bedded to thickly bedded, reddish brown, locally poorly sorted, coarse grained SANDSTONE. Discontinuities are 1) 15-20 degrees bedding fracture, very closely to closely spaced, rough undulating, open sand and clay fill. 2) 60 degrees closely to widely spaced, rough undulating, open grey and black staining. 3) 80-90 degrees widely spaces, rough undulating, striated, open with clay <1mm fill.		17	
17.50 - 19.00	100 99 85				7	Between 15.50m and 15.60m: locally fine and medium grained. Between 15.75m and 15.78m: a bed of weak mudstone. Between 16.50m and 16.80m: frequent lenses <10mm of clay.	18											
								19.00 - 20.50		100 92 61		Between 16.98m and 17.11m: medium grained.	19					
				Between 18.71m and 18.72m: poorly sorted, coarse grained with medium grain gravel and lenses of mudstone 40mm by 5mm. Between 18.95m and 19.00m: poorly sorted, coarse grained.	20													
										Between 19.40m and 19.75m: poorly sorted, coarse grained.								
Continued next sheet																		
Flush Details				Borehole Diameter		Boring Progress				Remarks:								
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)		Cased (m)	Water (m)	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R						
				25.10	107	04/07	08:00	3.70		3.70	1.90							
						04/07	16:30	14.50		5.90	2.20							
						05/07	08:00	14.50		5.90	2.10							
				Casing Diameter		Water Strikes					Monitoring Installations							
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)		Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)		
				5.90	200							0.00	5.00	PLAIN				
										5.00						20.00	SLOTTED	
Checked by:		HH	IFA RC v01.01															
Log status:		DRAFT																

	Plant used: Comacchio 205		Project: St John's Masterplan			Location ID: BH04B	
	Dates: 02/07/2018 - 05/07/2018		Client: Curtins Consulting			Sheet 3 of 3	
Rotary Borehole Log		Location:		Ground level:	Logged by: NC	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing			Strata Details					Groundwater	
Depth	TCR/SCR/ RQD	FI	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
20.50 - 22.00	100 73 50	25+		20.50 (0.85)	Weak, thinly bedded to thickly bedded, reddish brown, locally poorly sorted, coarse grained SANDSTONE. Discontinuities are 1) 15-20 degrees bedding fracture, very closely to closely spaced, rough undulating, open sand and clay fill. 2) 60 degrees closely to widely spaced, rough undulating, open grey and black staining. 3) 80-90 degrees widely spaced, rough undulating, striated, open with clay <1mm fill.		21		
				21.35	Medium strong, very thinly bedded to medium bedded, reddish brown, poorly sorted, coarse grained SANDSTONE with inclusions of mudstone. Striations of clay between fracture walls. Walls are weaker than core occasionally broken to gravel sized fragments. Discontinuities are 1) 15-30 degrees bedding fracture, very closely to closely spaced, smooth rough, undulating stepped, open to moderately wide, clay sand and gravel fill. 2) 80 degrees, widely spaced, smooth rough undulating striated, dry sand and gravel fill.				
22.00 - 23.50	100 65 40	3 NI		(1.50)	Strong, medium bedded MUDSTONE with frequent lenses sandstone. Lightly stained, orange black and grey along fracture surface. Discontinuities are 1) subhorizontal bedding fracture, closely spaced, rough undulating open. 2) 30 degrees closely spaced, rough undulating open, stained orange and black. 3) 65-80 degrees, very closely spaced, rough undulating stepped, open clay and gravel fill, grey and orange staining.		22		
				22.85	Between 21.80m and 22.70m: highly fractured with clay fill (possible fault zone). Between 22.07m and 22.20m: non intact recovered as gravel. Between 22.50m and 22.69m: non intact recovered as gravel.				
23.50 - 24.25	75 75 93	11		(1.30)	Medium strong to strong, medium to thickly bedded, medium and coarse grain SANDSTONE. Slight black staining along fracture surface. Weathering along fracture wall. Discontinuities are 1) subhorizontal bedding fracture, very closely to closely spaced, rough undulating rough, tight to open sand fill. 2) 35 degrees, closely spaced to widely spaced, rough undulating, open to moderately wide sand and angular coarse gravel fill. 3) 75-85 degrees, closely spaced, rough undulating, tight to open to closed, stained black sand fill.		23		
				24.15	Between 24.35m and 24.45m: medium grain sandstone with subrounded to rounded, coarse gravel.				
24.25 - 25.10	100 100 100	0		(0.95)	Strong to very strong, thinly to medium bedded, medium and coarse grain SANDSTONE.		24		
				25.10	End of Borehole at 25.10m				
							25		
							26		
							27		
							28		
							29		
							30		

Flush Details				Borehole Diameter		Boring Progress				Remarks:	
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
										SPT Hammer: N/R, Energy Ratio: N/R	
				Casing Diameter		Water Strikes				Monitoring Installations	
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Checked by:		HH	IFA RC								
Log status:		DRAFT	v01.01								

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Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: RBH02
Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting	Sheet 1 of 5
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: Logged by: HD/DO/HH Vertical scale: 1:50 Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
				0.20	MADE GROUND: Tarmacadam.			
0.30	D2			0.40	MADE GROUND: Greyish brown, slightly clayey, fine to coarse SAND very angular to subrounded, fine to coarse GRAVEL including brick, granite, tile, sandstone, limestone and mudstone.			
0.30	ES1				MADE GROUND: Red brick wall (possible canal).			
0.50	D4				Below 0.40m: brownish black.			
0.50	ES3							
1.00	D6							
1.00	ES5							
1.20		SPT(S) 50 (25 for 10mm/50 for 10mm)						
1.20 - 1.65	D8							
1.20 - 2.00	B7							
2.00		SPT(S) 50 (25 for 85mm/50 for 3mm)						
2.00 - 2.45	D10							
2.00 - 3.00	B9							
3.00		SPT(S) 50 (25 for 40mm/50 for 10mm)						
3.00 - 3.45	D11							
3.40	B12							
3.90 - 4.35	D13							
4.00		SPT(S) N=8 (2,3/2,2,2,2)						
4.50 - 5.00	B14							
5.00 - 6.00	100 88 80	5.00m - SPT(S) 50 (5,10/50 for 40mm) 5.00m - D15		5.00	MADE GROUND : Strong, red BRICK and strong light grey CONCRETE well bonded.			
				(1.25)				
6.00 - 7.75	93 93 87			6.25	Weak, reddish brown, fine grained SANDSTONE. Discontinuities are 0-20 degrees, closely spaced, planar and undulating rough, unstained. Between 6.25m and 6.65m: 1no discontinuity, 45 degrees planar, rough, no infill. Colour changing to grey up to 5mm. Between 7.15m and 7.30m: with inclusions of angular to subangular, fine and medium gravel of siltstone.			
				(1.20)				
				7.45	Extremely weak, reddish brown MUDSTONE.			
				7.55	Extremely weak, reddish brown, fine grained SANDSTONE recovered as gravelly, fine SAND. Gravel is angular to subangular, coarse including sandstone.			
				7.65	Assumed zone of core loss.			
				7.75	Medium strong, reddish brown, fine and medium grained SANDSTONE.			
7.75 - 9.25	100 100 100			(1.20)	At 7.88M: 1no of possibly DI fracture, 0 degrees, planar, rough, unstained no infill.			
				9.15	Weak, reddish brown, medium grained SANDSTONE. Discontinuities are 1) 0-10 degrees, predominantly very closely and rarely closely, planar smooth and occasionally rough unstained, no infill.			
				(1.65)	Medium strong, reddish brown, fine grained SANDSTONE. Discontinuities are 1) 0-10 degrees, closely spaced, planar, smooth, unstained, clay infill up to 1mm. 2) 45-60 degrees, medium spaced, planar smooth. Colour changing to grey.			

Dynamic Sample Recovery					Remarks:
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.
					Rotary open hole from 5.00m.
					SPT Hammer: N/R, Energy Ratio: N/R
					Water Strikes
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
					Monitoring Installations
Top (m)	Base (m)	Pipe Type	Dia (mm)		
0.00	6.30	PLAIN			
6.30	20.00	SLOTTED			
Checked by:	HH	IFA DS v01.01			
Log status:	DRAFT				

Plant used: Comacchio 205	Project: St John's Masterplan			Location ID: RBH02
Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: HD/DO/HH	Vertical scale: 1:50	Sheet 2 of 5 Project ID: 42206

	Plant used: Comacchio 205		Project: St John's Masterplan			Location ID: RBH02	
	Dates: 29/06/2018 - 02/07/2018		Client: Curtins Consulting			Sheet 3 of 5	
Rotary Borehole Log		Location:		Ground level:	Logged by: HD/DO/HH	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
19.25 - 20.75	100 100 100	9			(1.60)	Weak, reddish brown, medium and locally coarse grained SANDSTONE with inclusion of angular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, very closely spaced, planar smooth and rough unstained no infill.		21	
20.75 - 22.25	100 100 73				21.10 (1.15)	Weak, reddish brown, fine, locally medium grained SANDSTONE with inclusion of subangular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, very closely spaced, planar smooth and rough unstained no infill.			
22.25 - 23.75	100 100 97	3			22.25	Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional inclusion of angular to subrounded, fine gravel of siltstone and quartzite. Discontinuities are 0-15 degrees, closely to medium spaced, planar smooth with occasional clay infill up to 1mm unstained.	23		
23.75 - 25.25	100 100 97	4			(6.20)	<i>Between 25.75 and 26.05m: 1no discontinuities approx 60-70 degrees, undulating smooth, with silt infill >2mm.</i>		24	
25.25 - 26.75	100 100 80							25	
26.75 - 28.25	100 100 97							3		26
28.25 - 29.75	100 100 73	16						27	
		5						28	
					28.45	Weak, reddish brown, medium grained SANDSTONE with occasional inclusion of angular to subrounded, fine gravel of siltstone. Discontinuities are 0-15 degrees, closely spaced, planar smooth and rough unstained no infill.	29		
					29.30	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-15 degrees, closely spaced, planar smooth with clay infill upto 1mm, unstained.	30		
Continued next sheet									

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)			
										SPT Hammer: N/R, Energy Ratio: N/R					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		HH	IFA RC												
Log status:		DRAFT	v01.01												

	Plant used: Comacchio 205		Project: St John's Masterplan			Location ID: RBH02	
	Dates: 29/06/2018 - 02/07/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location:		Ground level:	Logged by: HD/DO/HH	Vertical scale: 1:50	Sheet 4 of 5 Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation
29.75 - 31.25	100 100 87	5			(3.10)	Medium strong, reddish brown, fine and medium grained SANDSTONE. Discontinuities are 0-15 degrees, closely spaced, planar smooth with clay infill upto 1mm, unstained.			
		3							
		AZCL							
31.25 - 32.75	80 73 40	3			32.40	Between 31.25m and 31.35m: assumed zone of ocre loss.			
		17							
						At 31.75m: gravel infill Between 31.80m and 32.25m: medium spaced discontinuities.			
32.75 - 34.25	100 100 71	5				Weak, red brown, coarse grained SANDSTONE with rare mudstone inclusions (2mm in diameter). Discontinuities are subhorizontal very closely spaced, planar smooth.			
		9				Between 33.25m and 33.85m: medium spaced, undulating smooth discontinuities.			
		6							
34.25 - 35.75	100 100 85	7				Below 34.25m: medium strong.			
		16				Between 35.40m and 35.70m: medium spaced discontinuities.			
35.75 - 37.25	100 100 70	4				Between 35.95m and 36.00m: grey discolouration.			
		NI				Between 36.25m and 36.35m: non intact recovered as coarse gravel. Between 36.30m and 36.90m: medium spaced discontinuities.			
37.25 - 38.75	100 88 57	7			Between 37.15m and 37.25m: grey discolouration.				
		20			Between 37.80m and 37.90m: a subvertical, widely spaced, undulating smooth and open fracture. At 37.90m: grey discolouration.				
		7			Below 38.25m: fine to medium grained At 38.30m: grey discolouration.				
38.75 - 40.00	87 73 64	9			At 38.75m: mudstone gravel. Between 38.75m to 38.95m: non intact recovered as coarse gravel. Between 39.02m and 39.25m: assumed zone of core loss.				
		NI			Below 39.30m: weak, medium to coarse grained.				
		AZCL							
		14							
		NI							
					39.70 39.80 40.00	Very weak, brown MUDSTONE. Weak, red brown, coarse grained SANDSTONE with rare			
						Continued next sheet			

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)			
										SPT Hammer: N/R, Energy Ratio: N/R					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		HH	IFA RC												
Log status:		DRAFT	v01.01												



Plant used: Comacchio 205	Project: St John's Masterplan		Location ID: RBH02		
Dates: 29/06/2018 - 02/07/2018	Client: Curtins Consulting				
Rotary Borehole Log	Location:	Ground level:	Logged by: HD/DO/HH	Vertical scale: 1:50	Sheet 5 of 5 Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
						Weak, red brown, coarse grained SANDSTONE with rare mudstone inclusions (2mm in diameter). Discontinuities are subhorizontal very closely spaced, planar smooth. <i>Between 39.90m and 40.00m: non intact recovered as coarse gravel.</i> End of Borehole at 40.00m			
								41	
								42	
								43	
								44	
								45	
								46	
								47	
								48	
								49	
								50	

Flush Details				Borehole Diameter		Boring Progress				Remarks: SPT Hammer: N/R, Energy Ratio: N/R					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)			Water (m)			
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		HH	IFA RC												
Log status:		DRAFT	v01.01												

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Core Photographs RBH02



Core Photographs RBH02



Core Photographs RBH02



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Core Photographs RBH02



Plant used:	Project: St John's Masterplan			Location ID: RBH03
Dates: 03/04/2018 - 06/04/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: RS/HH	Vertical scale: 1:50	Sheet 1 of 5 Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.20 0.25 - 0.60 0.40	D1 B2 ES3	SPT(S) N=8 (2,2/2,2,2,2)		0.17 0.25	MADE GROUND: Concrete.			
					MADE GROUND: Light pinkish grey, slightly sandy, subrounded to angular, fine to coarse GRAVEL including limestone.			
					MADE GROUND: Loose, brown, gravelly, slightly clayey, fine to coarse SAND with medium cobble content and low boulder content. Gravel is angular to subrounded of brick, sandstone and rare granite. Boulders are subangular to subrounded including sandstone and granite.			
1.20 1.20 - 1.65	D4			(1.75)				
2.20 2.20 - 2.65	D5	SPT(S) N=27 (4,5/7,6,7,7)		2.00 2.20	Black, spongy PEAT.		2	
			(1.00)	Medium dense, light, brown, gravelly SAND.				
3.20 3.20 - 3.65	D6	SPT(S) N=30 (4,5/5,5,7,13)		3.20	Dense, SAND and GRAVEL (driller's description).		3	
			(1.00)					
4.20 - 5.40	0 0 0	NR		4.20 (0.66)	Reddish brown SAND, possibly weathered sandstone (driller's description).		4	
5.40 - 6.30	0 0 0		4.86	No recovery assumed red SANDSTONE. Driller notes pushing a boulder down				
6.30 - 7.30	0 0 0		(3.44)				5	
7.30 - 8.30	0 0 0							
8.30 - 8.80	100 80 36	NI 7		8.30	Weak, red brown, medium and coarse SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, undulating rough, open. <i>Between 8.30 and 8.48m: angular and coarse gravel.</i> <i>At 8.58m: mudstone infill.</i> <i>At 8.62m: siltstone inclusion at 2cm in diameter.</i> <i>Between 8.91m and 9.13m: extremely closely spaced, undulating, smooth.</i> <i>Between 9.07m and 9.13m: mudstone infill.</i> <i>Between 9.23m and 9.30m: subhorizontal.</i>		6	
		25+		(1.20)				
8.80 - 10.30	100 100 31	9		9.50	Weak, very weak, red brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open.		7	
TCR/SCR/ROD	FI	Samples & Tests		Continued next sheet				

Dynamic Sample Recovery					Remarks:								
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.								
					SPT Hammer: N/R, Energy Ratio: N/R								
					Water Strikes					Monitoring Installations			
					Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
										0.00	14.50	PLAIN	
										14.50	16.50	SLOTTED	
Checked by:		HH		IFA DS v01.01									
Log status:		DRAFT											

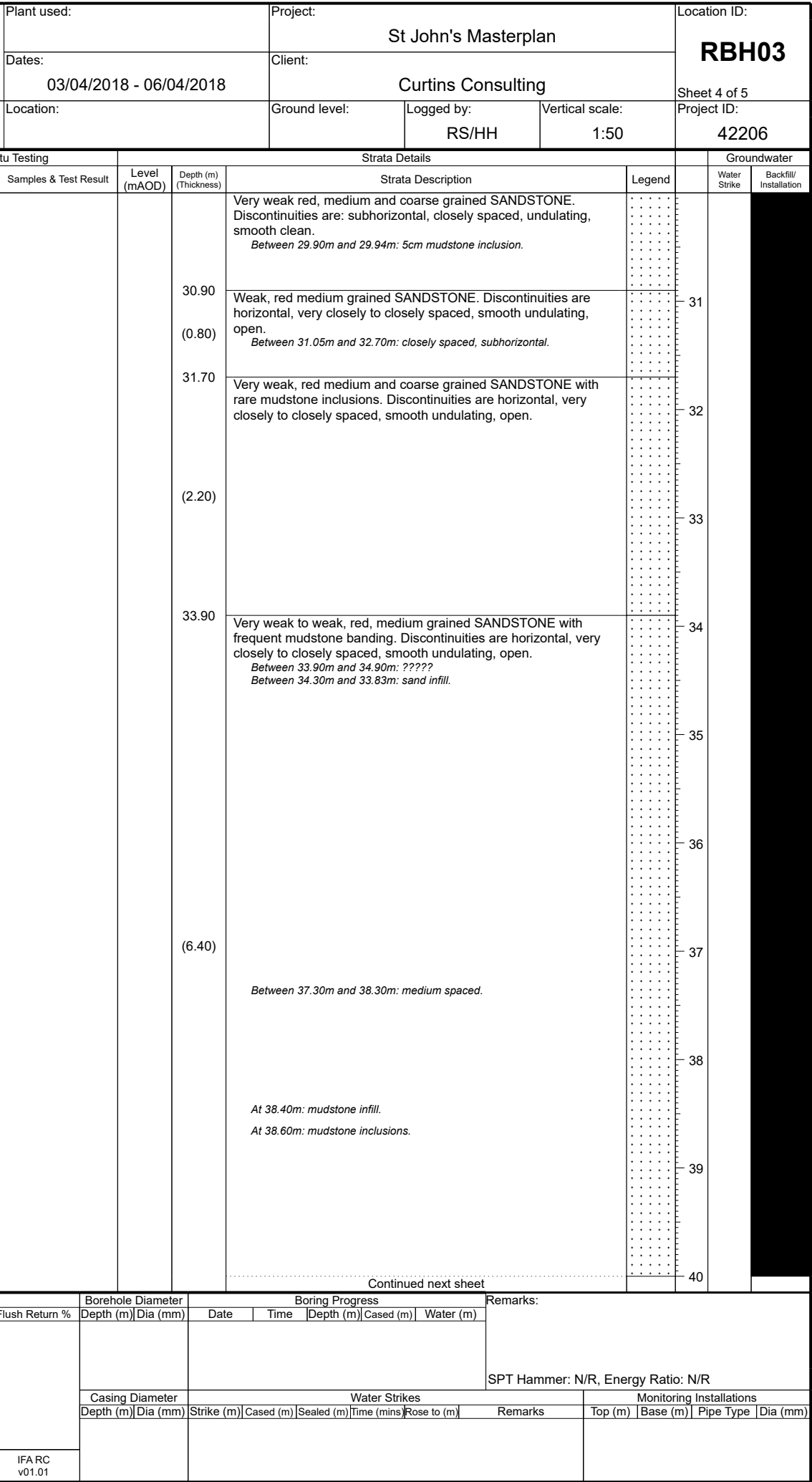
	Plant used:		Project: St John's Masterplan			Location ID: RBH03	
	Dates: 03/04/2018 - 06/04/2018		Client: Curtins Consulting			Sheet 2 of 5	
Rotary Borehole Log		Location:		Ground level:	Logged by: RS/HH	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
10.30 - 11.80	100 100 69	6				Weak, very weak, red brown, fine and medium SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open. <i>Below 10.50m: subhorizontal.</i>		11	
		25+				<i>At 11.20m: mudstone inclusion 2cm in diameter.</i> <i>Extremely closely spaced, undulating smooth, clay infill.</i>			
11.80 - 13.30	100 100 45	6			(5.40)	<i>Between 11.80m and 12.80m: medium and coarse grained sandstone.</i> <i>At 12.52m: quartzite inclusions.</i>		12	
		25+				<i>At 13.10m: sand infill.</i> <i>At 13.30m: subvertical widely spaced.</i>		13	
13.30 - 14.80	100 100 84	4						14	
		25+							
14.80 - 16.30	100 100 78	4			14.90 15.14	Weak, red micaceous, fine grained SANDSTONE. Discontinuities are horizontal, very closely spaced, planar, smooth, open and clean. Weak, very weak, red brown, fine and medium grained SANDSTONE. Discontinuities are horizontal, very closely to closely spaced, smooth undulating, open. <i>At 15.20m: yellow band (subvertical)></i> <i>Between 15.37m and 15.40m: mudstone infill.</i>		15	
		25+						16	
16.30 - 17.80	100 100 66	5			(5.06)	<i>Between 17.30m and 17.80m: mudstone inclusions 3cm in diameter.</i> <i>Below 17.80m: medium and coarse grained with occasional quartzite clasts.</i>		17	
		25+						18	
17.80 - 19.30	100 100 61	6				<i>At 19.10m: sand infill.</i>		19	
								20	
Continued next sheet									

Flush Details				Borehole Diameter		Boring Progress				Remarks:							
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)							
5.40	4.20	Air mist		40.30	92	03/04	16:30	4.20		3.50	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R						
6.30	5.40	Air mist				04/04	08:00	4.20		3.20							
6.80	6.30	Air mist				04/04	16:30	5.40	4.20	3.20							
7.30	6.80	Air mist				05/04	08:00	5.40									
7.80	7.30	Air mist															
7.80	7.30	Air mist				Casing Diameter					Water Strikes						
7.80	7.30	Air mist				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Monitoring Installations			
8.30	7.80	Air mist				5.40	200							Top (m)	Base (m)	Pipe Type	Dia (mm)
														0.00	14.50	PLAIN	
														14.50	16.50	SLOTTED	

Checked by:	HH	IFA RC
Log status:	DRAFT	v01.01

Flush Details				Borehole Diameter		Boring Progress						Remarks:						
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)								
8.80	8.30	Air mist				05/04	16:30	32.80	5.40	3.97	SPT Hammer: N/R, Energy Ratio: N/R							
10.30	8.80	Air mist				06/04	08:00	32.80	5.40									
11.80	10.30	Air mist				06/04	16:00	40.30	5.40									
13.30	11.80	Air mist				Casing Diameter		Water Strikes						Monitoring Installations				
14.80	13.30	Air mist				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)		Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
16.30	14.80	Air mist																
Checked by:		HH				IFARC v01.01												
Log status:		DRAFT																



Flush Details				Borehole Diameter		Boring Progress						Remarks:			
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
26.80	25.30	Air mist									SPT Hammer: N/R, Energy Ratio: N/R				
28.30	26.80	Air mist													
29.80	28.30	Air mist													
31.30	29.80	Air mist													
32.80	31.30	Air mist													
34.30	32.80	Air mist													
Checked by:		HH	IFA RC v01.01												
Log status:		DRAFT													

Core Photographs RBH03



Core Photographs RBH03



**Core Photographs
RBH03**

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Core Photographs RBH03



**Core Photographs
RBH03**

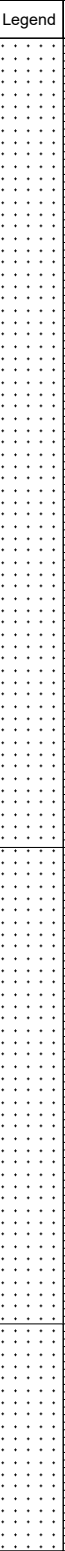
Plant used: Comacchio 205	Project: St John's Masterplan	Location ID: RBH04
Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting	Sheet 1 of 5
Location:	Ground level:	Logged by: NC/MD
Dynamic Sampling and Rotary Boring Log	Vertical scale: 1:50	Project ID: 42206

Samples & In Situ Testing				Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.18 - 0.28	B1	SPT(S) N=8 (1,1/2,2,2,2)		0.18	MADE GROUND: Grey tarmacadam.				
0.20	D3			0.28	MADE GROUND: Grey brown, gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including brick and concrete.				
0.20	ES2			0.48	MADE GROUND: Reddish brown, gravelly, fine and medium SAND. Gravel is subrounded to rounded, coarse of sandstone. Brown mottled orange brown, very clayey, fine SAND (driller's description).				
0.28 - 0.48	B4			(0.72)					
0.40	D6			1.20	Loose, brown, clayey, gravelly, fine and medium SAND.				
0.40	ES5								
0.48 - 1.20	B7								
1.00	D9								
1.00	ES8								
1.20	D10								
1.20 - 1.65									
2.00		SPT(S) N=21 (5,6/5,5,6,5)			Below 2.00m: medium dense.		2		
2.00 - 2.45	D11			(4.30)	Between 2.00m and 8.00m: rare red brown mudstone and grey sandstone.				
3.00		SPT(S) N=41 (6,5/14,14,6,7)			Below 3.00m: dense.				
3.00 - 3.45	B12								
4.00 - 5.00	13 0 0	AZCL			Between 4.00m and 4.87m: assumed zone of core loss.				
		NA							
5.00 - 6.00	50 17 0	AZCL			Between 4.87m and 5.00m: single cobble of limestone.				
		NA		5.50	Between 5.00m and 5.50m: assumed zone of core loss.				
		15		5.70					
				5.80					
6.00 - 7.50	40 0 0	AZCL		(0.80)	Recovered as medium and coarse, rounded GRAVEL including granite, sandstone and basalt.				
					Firm, red brown, slightly sandy, very gravelly CLAY. Gravel is subrounded to rounded including granite and sandstone.				
		NI		(0.90)	Extremely weak, very thinly bedded, red brown, fine and medium grained SANDSTONE. Discontinuities are horizontal, very closely spaced, planar rough and clean.				
				6.60	Between 6.00m and 7.50m: non intact.				
					Extremely weak, reddish brown SANDSTONE recovered as red brown, gravelly SAND. Gravel is angular, fine to coarse including sandstone.				
7.50 - 9.00	86 56 18	14		(1.50)					
		NI							
		AZCL			Assumed zone of core loss.				
				7.70					
					Extremely weak, thinly bedded, red brown, fine and medium grained SANDSTONE. Discontinuities are subhorizontal 5-10 degrees, closely spaced, planar rough clean.				
9.00 - 10.50	86 38 27	NI		(1.30)					
					Between 8.90m to 9.00m: non-intact recovered as coarse gravel.				
					Between 9.00m and 9.20m: assumed zone of core loss.				
				9.20					
					Extremely weak, thinly bedded, red brown, fine and medium grained SANDSTONE. Locally recovered as red brown, gravelly sand.				
					Between 9.20m and 10.50m: recovered as non intact with occasional solid core sections.				
	TCR/SCR/ROD	FI	Samples & Tests	Continued next sheet				10	

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R									
					Water Strikes					Monitoring Installations				
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)					
						0.00	9.20	PLAIN	19					
						9.20	10.20	SLOTTED	19					
Checked by:		HH		IFA DS v01.01										
Log status:		DRAFT												

Coring, Samples & In Situ Testing				Strata Details				Groundwater											
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation										
						Extremely weak, thinly bedded, red brown, fine and medium grained SANDSTONE. Locally recovered as red brown, gravelly sand.													
10.50 - 12.00	83 0 0	AZCL			10.50	Assumed zone of core loss.													
		NI			10.75	Between 10.73m and 10.83m: non intact recovered as slightly gravelly sand.													
		10			(1.63)	Extremely weak, reddish brown, fine and medium grained, slightly weathered SANDSTONE. Discontinuities are 1) 0-30 degrees, very closely to closely spaced, planar and occasionally undulating, rough and clean. 2) medium spaced, planar, rough, occasionally weathered with light brown infill <5mm of clayey, fine and medium sand. Between 11.60m and 11.65m: non intact recovered as gravel and cobbles.													
		NI																	
		12																	
		27																	
12.00 - 13.50	93 0 0	NI			12.38	Very weak, reddish brown, medium grained, slightly weathered SANDSTONE. Discontinuities are 1) 0-25 degrees, very close to closely spaced, planar, rough and clean. 2) 45-60 degrees, medium to widely spaced, planar, rough and clean.													
		AZCL																	
		30																	
13.50 - 15.00	100 91 52	NI			(5.12)														
		11																	
15.00 - 16.50	100 94 47	16			17.50	At 15.62m: Discontinuity is 10 degrees, stepped, rough light, yellowish brown, infilled <5mm with fine to coarse sand. Between 15.62m and 15.77m: 1 no 75 degrees, discontinuity, planar, rough and smooth, stained yellowish brown and infilled <3mm with soft reddish brown clay. At 15.63m: band of <20mm of extremely weak reddish brown mudstone. Between 16.21m and 16.27m: sandy gravel. Below 16.50m: indistinctly very thinly bedded.													
		6																	
		NI																	
16.50 - 18.00	100 80 53	4			(0.50)	Very weak to weak, reddish brown mottled light yellowish brown indistinctly, very thinly bedded, partially weathered, fine and medium grained SANDSTONE. Discontinuities are 1) 10-30 degrees, extremely closely to closely spaced, planar and undulating, rough, clean. 2) 45-80 degrees, very closely to closely spaced, planar and undulating, filled <5mm with light yellowish brown, fine sand, rough. Weak, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 0-15 degrees, very closely to closely spaced, planar, rough, clean. between 18.00m and 18.27m: occasional light yellowish brown mottling. Between 18.00m and 18.11m: non intact recovered as gravel. Between 18.27m and 18.37m: 1no 55 degrees discontinuity, planar, rough, clean. Between 18.40m and 18.46m: non intact recovered as gravel.													
		15																	
		19																	
18.00 - 19.50	100 87 57	5			18.00														
		NI																	
		7																	
		9																	
		NI																	
				Continued next sheet															
Flush Details				Borehole Diameter		Boring Progress			Remarks:										
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: N/R, Energy Ratio: N/R								
				40.00	107	26/06	16:30	6.00	5.00										
						27/06	08:00	6.00	6.00	1.80									
						27/06	16:30	33.00	6.00	1.50									
						28/06	08:00	33.00	6.00	1.50									
				Casing Diameter		Water Strikes					Monitoring Installations								
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)				
				6.00	200								0.00	9.20	PLAIN	19			
																9.20	10.20	SLOTTED	19
Checked by:		HH		IFA RC															
Log status:		DRAFT		v01.01															

	Plant used: Comacchio 205		Project: St John's Masterplan			Location ID: RBH04	
	Dates: 26/06/2018 - 28/06/2018		Client: Curtins Consulting			Sheet 3 of 5	
Rotary Borehole Log		Location:		Ground level:	Logged by: NC/MD	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater									
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation								
19.50 - 21.00	100 84 54	NI			(7.35)	Weak, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are 0-15 degrees, very closely to closely spaced, planar, rough, clean. <i>Between 20.37m and 20.43m: non intact recovered as gravel.</i> <i>Between 20.37m and 20.45m: frequent clasts and inclusions of subrounded <40mm mudstone and siltstone.</i> <i>Between 20.64m and 20.84m: frequent clasts of subangular to subrounded <30mm quartzite.</i> <i>Between 20.72m and 20.78m: non intact recovered as sandy gravel, unweathered.</i> <i>Between 21.00m and 21.05m: assumed zone of core loss.</i> <i>Between 21.05m and 21.20m: non intact recovered as gravel.</i> <i>Between 21.27m and 21.32m: 1no 0-45 degrees discontinuity infilled <50mm with soft, reddish brown very sandy clay, sand is fine to coarse, surface is rough.</i> <i>Between 21.42m and 21.48m: non intact recovered as gravel.</i>											
		3															
		NI															
		5															
		AZCL															
NI																	
23																	
NI																	
21.00 - 22.50	97 43 40	8								21							
		4									22						
												23	23				
22.50 - 24.00	100 71 35	7								24							
		23									25						
												NI	26				
24.00 - 25.50	100 55 21	10								27							
		8									28						
												26	29				
25.50 - 27.00	100 83 43	3								30							
		13									31						
												NI	32				
27.00 - 28.50	100 85 65	6								33							
		19									34						
												19	35				
28.50 - 30.00	100 90 47	19								36							
		19									37						
												19	38				
Continued next sheet																	

Flush Details				Borehole Diameter		Boring Progress				Remarks:	
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
						28/06	16:30	40.00	6.00	1.80	
						SPT Hammer: N/R, Energy Ratio: N/R					
				Casing Diameter		Water Strikes				Monitoring Installations	
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Checked by:		HH	IFA RC								
Log status:		DRAFT	v01.01								

	Plant used: Comacchio 205		Project: St John's Masterplan			Location ID: RBH04	
	Dates: 26/06/2018 - 28/06/2018		Client: Curtins Consulting			Sheet 4 of 5	
Rotary Borehole Log		Location:		Ground level:	Logged by: NC/MD	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
30.00 - 31.50	100 100 58	7			(4.50)	Very weak, reddish brown, medium and coarse grained SANDSTONE with rare mudstone inclusions <70mm of extremely weak reddish brown mudstone. Discontinuities are 0-10 degrees, very closely spaced, planar and occasionally undulating, rough, clean.			
31.50 - 33.00	100 67 38	16				Between 32.00m and 32.65m: extremely weak, stained orangish brown with 3no discontinuities, 10-90 degrees, very closely spaced, planar and undulating, rough and smooth infilled <10mm with soft sandy clay.			
		4							
33.00 - 34.50	100 33 11	NI			33.00	Extremely weak to very weak, reddish brown, occasionally mottled orangish brown, medium and coarse grained SANDSTONE. Discontinuities are 1) 0-20 degrees, very closely to closely spaced, undulating and planar, rough, clean. 2) 50-90 degrees, closely spaced, planar, occasionally infilled <10mm with light brown and blackish brown. Between 33.00m and 33.50m: 2no discontinuities, 80 degrees, planar, rough, infilled <15mm with soft clay. Between 33.00m and 33.78m: non intact recovered as clayey gravel.			
		8							
34.50 - 36.00	100 59 9	27 NI 23 NI				Between 34.69m and 34.73m: non intact recovered as gravel.			
		9				Between 35.15m and 35.17m: non intact recovered as gravel.			
36.00 - 37.50	100 64 9	NI			(6.70)	Between 36.33m and 36.50m: non intact recovered as gravel.			
		10							
37.50 - 39.00	83 0 0	AZCL NI				Between 38.50m and 38.75m: non intact 40+.			
		NI				Between 38.75m and 39.00m: non intact recovered as gravel.			
39.00 - 40.50	67 13 0	AZCL 15			39.70	Extremely weak, poorly cemented, medium and coarse grained SANDSTONE recovered as non intact, sandy gravel. Probable			
						Continued next sheet			

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
										SPT Hammer: N/R, Energy Ratio: N/R					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:		HH	IFA RC												
Log status:		DRAFT	v01.01												

Plant used: Comacchio 205	Project: St John's Masterplan			Location ID: RBH04
Dates: 26/06/2018 - 28/06/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: NC/MD	Vertical scale: 1:50	Sheet 5 of 5 Project ID: 42206

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Plant used: Comacchio 305	Project: St John's Masterplan	Location ID: RBH05
Dates: 12/07/2018	Client: Curtins Consulting	Sheet 1 of 4
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: Logged by: NC/RS
		Vertical scale: 1:50
		Project ID: 42206

Samples & In Situ Testing				Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
0.10 - 0.60	B1	SPT(S) N=17 (1,4/5,4,4,4)		0.20	Grass over Black TOPSOIL.				
0.20	D2			(0.30)	MADE GROUND: brown slightly gravelly fine to coarse SAND. Gravel is subangular to subrounded, fine to medium including sandstone, brick and metal wire fragments.				
0.40	ES3			0.50	MADE GROUND: Greyish brown gravelly fine to coarse SAND. Gravel is subangular to subrounded, fine to medium including brick.				
0.50	D5			0.60	Medium dense, light brown slightly gravelly fine to coarse SAND. Gravel is subagnaulr to subrounded, fine and medium including sandstone and coal.				
0.50	ES4								
0.70 - 1.20	B6								
0.80	ES7								
1.00	D8								
1.20	D9								
1.20	D10								
1.50 - 2.00	B10								
2.00	D11	SPT(S) N=25 (7,6/5,6,7,7)					1		
2.00									
2.50 - 3.00	B12						2		
3.00	D13	SPT(S) N=40 (8,9/9,10,11,10)		(4.90)	Below 3.00m: dense.		3		
3.00									
4.00	B14 D15	SPT(S) 50 (10,12/50 for 235mm)			Below 4.00m: very dense.		4		
4.00									
4.00									
5.00 - 5.50	0 0 0	NR		5.50	Medium strong, reddish brown, fine grained SANDSTONE with occasional off white 5-10mm sized quartzite inclusions. Discontinuities are 2-50 degrees, very closely to closely spaced, subhorizontal, open and rough.		5		
		NI							
5.50 - 6.00	100 68 0	14							
		NI							
		AZCL							
6.00 - 7.50	86 80 35	12		(3.50)			6		
							7		
7.50 - 9.00	40 37 0	AZCL					8		
							9		
9.00 - 10.50	100 100 0	19		9.00 (1.36)	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with rare grey 10mm sized quartzite inclusions. Discontinuities are 3-50 degrees, very closely to closely spaced, subhorizontal, planar to undulating, open and rough.		9		
							10		
	TCR/SCR/ROD	FI		Continued next sheet					

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: JT.01 Energy Ratio: 64%									
					Water Strikes					Monitoring Installations				
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)					
						0.00	5.00	Plain						
						5.00	20.00	Slotted						
Checked by:		HH		IFA DS v01.01										
Log status:		DRAFT												

	Plant used: Comacchio 305		Project: St John's Masterplan			Location ID: RBH05	
	Dates: 12/07/2018		Client: Curtins Consulting				
Rotary Borehole Log		Location:		Ground level:	Logged by: NC/RS	Vertical scale: 1:50	Sheet 2 of 4 Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater			
Depth	TCR/SCR/ROD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/Installation		
10.50 - 12.00	66 42 22	NR			10.36	Weak to medium strong, reddish brown, fine and medium grained SANDSTONE with rare grey 10mm sized quartzite inclusions. Discontinuities are 3-50 degrees, very closely to closely spaced, subhorizontal, planar to undulating, open and rough.					
		NI			(0.64)					Medium strong, reddish brown, medium and coarse grained SANDSTONE with occasional off white and grey 4-8mm sized quartzite inclusions. Discontinuities are 1-30 degrees, closely spaced, subhorizontal, planar, open and rough.	
		10			11.00							Medium strong, reddish brown, fine and medium grained SANDSTONE with occasional brown and grey 3-6mm sized quartzite and mudstone inclusions. Discontinuities are 2-6 degrees, closely spaced, subhorizontal, planar to undulating, open and rough.
NI	10	(3.00)									
83 66 42							12.00 - 13.50	12			
66 61 48	13.50 - 15.00	AZCL			9	(4.00)	14.00	Strong, reddish brown, fine and medium grained SANDSTONE with occasional off white and grey 3-10mm sized quartzite inclusions. Discontinuities are very 1-8 degrees, closely to closely spaced, subhorizontal, planar to undulating, open and rough.			
NI		15									
100 90 34	15.00 - 16.50										
100 100 48									16.50 - 18.00		16
18.00 - 19.50	100 92 55	6					18.00	Weak, reddish brown, thinly to medium bedded, medium and coarse grained SANDSTONE with very rare thin bands and pockets of extremely weak, reddish brown mudstone and rare clasts of subrounded quartzite. Discontinuities are 0-15 degrees, very closely spaced, undulating rough and clean.			
		NI	17								
		16	18								
		6	19								
		NI				Between 19.73m and 19.81m: band of extremely weak reddish brown mudstone.					
Continued next sheet											

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)		Water (m)				
5.00	6.00	Air mist	50	40.00	102	12/07	16:30	19.50	8.00	8.40	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: JT.01 Energy Ratio: 64%				
6.00	13.50	Air mist	0			13/07	08:00	19.50	8.00	4.90					
13.50	19.50	Air mist	25			13/07	16:30	40.00	8.00	7.40					
19.50	40.00	Air mist	20												
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				8.00	146							0.00	5.00	Plain	
												5.00	20.00	Slotted	

Checked by:	HH	IFA RC v01.01
Log status:	DRAFT	

Plant used:	Project:			Location ID:
Comacchio 305	St John's Masterplan			
Dates:	Client:			RBH05 Sheet 3 of 4
12/07/2018	Curtins Consulting			
Location:	Ground level:	Logged by:	Vertical scale:	Project ID:
		NC/RS	1:50	42206

Plant used:	Project:			Location ID:
Comacchio 305	St John's Masterplan			
Dates:	Client:			RBH05 Sheet 4 of 4
12/07/2018	Curtins Consulting			
Location:	Ground level:	Logged by:	Vertical scale:	Project ID:
		NC/RS	1:50	42206

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Core Photographs RBH05



Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan	Location ID: RBH06
Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting	Sheet 1 of 6
Dynamic Sampling and Rotary Boring Log	Location:	Ground level: Logged by: NC/NC/LVC
		Vertical scale: 1:50
		Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.35 - 0.55	B1			0.18	MADE GROUND: Light grey concrete.			
0.55 - 1.00	B2			0.38	MADE GROUND: Yellow and orange subangular COBBLES of brick and sandstone.			
1.20 - 2.00	B3			0.55	MADE GROUND: Yellow and dark brown, clayey, gravelly, fine to coarse SAND with low cobble content. Gravel is subangular, fine to coarse including brick. Cobbles are subangular including brick and sandstone.			
					MADE GROUND: Firm, orange brown and grey, sandy, gravelly CLAY. Gravel is angular to subangular, fine to coarse including concrete, sandstone and brick.			
2.00		SPT(S) N=17 (1,2/3,5,4,5)		(2.45)				
2.00 - 2.45	D5							
2.00 - 3.00	B4							
3.00		SPT(S) N=18 (1,3/5,4,5,4)		3.00	Medium dense, orange brown, gravelly, fine and medium SAND. Gravel is subrounded to rounded, fine and medium including sandstone.			
3.00 - 3.45	D7							
3.00 - 4.00	B6			(1.65)				
4.00		SPT(S) 50 (6,7/50 for 225mm)			Below 4.00m: very dense.			
4.00 - 4.45	D9							
4.00 - 5.00	B8							
4.50 - 5.00	70	AZCL		4.65	Extremely weak to weak, very thinly bedded, reddish brown, coarse grained SANDSTONE with subangular, medium gravel including mudstone, quartzite and with lenses of mudstone <60x30mm. Discontinuities are subhorizontal, closely spaced, rough planar.			
	50	NI			Between 5.39m and 5.40m: mudstone.			
	0	15		(1.07)	Between 5.44m and 5.66m: mudstone.			
		NI			Between 5.58m and 5.60m: mudstone.			
5.00 - 6.00	73	AZCL		5.72	Weak to medium strong, thickly laminated, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely spaced, rough stepped, undulating, open with clay and sand fill.			
	49	9						
	0	NI						
		11						
6.00 - 7.00	100	NI		(1.68)				
	65	NI						
	0	25						
		NI						
		17						
7.00 - 8.50	97	AZCL		7.40	Extremely weak to weak, very thinly bedded, reddish brown, coarse grained SANDSTONE with subangular, medium gravel of mixed lithologies. Locally recovered as sand and gravel. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide with sand and gravel fill <160mm.			
	65	NI		(1.05)				
	0	17						
		NI						
		7						
		NI						
8.50 - 10.00	73	AZCL		8.45	Medium strong, very thinly bedded, mica rich reddish brown medium grained SANDSTONE.			
	55	NI		(0.47)	Extremely weak, very thinly bedded, reddish brown, coarse grained SANDSTONE with subangular, medium gravel of mixed lithologies. Locally recovered as sand.			
	0	12		9.00	Medium strong, very thinly bedded, coarse grained SANDSTONE with subangular, fine and medium gravel of mixed lithologies. Discontinuities are subhorizontal, very closely to closely spaced, rough undulating planar, open with sand film.			
				(1.46)				
TCR/SCR/ROD	FI	Samples & Tests		Continued next sheet				

Dynamic Sample Recovery					Remarks:
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.
1.20	2.00		100		
2.00	3.00		100		
3.00	4.00		100		
4.00	4.50		100		
SPT Hammer: JT.01 Energy Ratio: 64%					
Water Strikes					Monitoring Installations
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
10.20	10.50	Slotted	19		
0.00	10.20	Plain	19		
Checked by:	HH	IFA DS v01.01			
Log status:	DRAFT				

	Plant used: Comacchio 205/Comacchio 305		Project: St John's Masterplan			Location ID: RBH06	
	Dates: 06/07/2018 - 10/07/2018		Client: Curtins Consulting			Sheet 2 of 6	
Rotary Borehole Log		Location:		Ground level:	Logged by: NC/NC/LVC	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater		
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation	
10.00 - 11.50	100 35 7	18			10.46	Medium strong, very thinly bedded, coarse grained SANDSTONE with subangular, fine and medium gravel of mixed lithologies. Discontinuities are subhorizontal, very closely to closely spaced, rough undulating planar, open with sand film.	11			
		NI			(0.74)	Extremely weak to weak, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely spaced, rough undulating open, moderately wide with sand and gravel fill <200mm.				
		6								
		NI								
11.50 - 13.00	83 53 28	10			11.20	Weak to strong, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, rough undulating, open to wide with clay sand fill <5mm and gravel fill 120mm.	12			
		8								
		AZCL								
13.00 - 14.50	95 88 55	6			14.21	Extremely weak, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely spaced, rough undulating open, moderately wide with sand film fill. 2) 80 degrees, very widely spaced, rough undulating, moderately wide with sand film fill.	13			
		20			14.31	Weak to thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 10-15 degrees, closely spaced, rough undulating, with sand fill and stained orange yellow.				
		6			(0.97)	Extremely weak, reddish brown, coarse grained SANDSTONE. Recovered as coarse sand.				
14.50 - 16.00	97 53 37	NI			15.28	Weak to medium strong, very closely to closely bedded, reddish brown, coarse grained SANDSTONE, locally with subrounded fine to coarse gravel of mixed lithologies.	14			
		AZCL			15.55	Between 15.77m and 15.78m: with coarse subhorizontal gravel.				
		3								
16.00 - 17.50	100 100 40	11				Between 16.77m and 16.78m: with coarse subrounded gravel.	15			
17.50 - 19.00	100 100 18					Between 18.72m and 18.88m: with coarse subhorizontal gravel. Between 18.81m and 18.86m: lenses of clay <10mm x 40mm.	16			
19.00 - 20.50	100 97 63	0				Between 19.05m and 19.06m: medium gravel.	17			
		14								
Continued next sheet										

Flush Details				Borehole Diameter		Boring Progress				Remarks:					
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)					
8.50	4.50	Air mist	80	55.00	102	06/07	09:00	1.20		Dry	Service inspection pit hand excavated from GL to 1.20m. SPT Hammer: JT.01 Energy Ratio: 64%				
10.00	8.50	Air mist	70			09/07	08:00	1.20		Dry					
50.50	10.00	Air mist	10			09/07	16:30	14.50	7.50	4.80					
55.00	50.50	Air mist	0			10/07	08:00	14.50	7.50	2.80					
				Casing Diameter		Water Strikes				Monitoring Installations					
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
				7.50	146							10.20	10.50	Slotted	19
												0.00	10.20	Plain	19

Checked by:	HH	IFA RC
Log status:	DRAFT	v01.01

Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan			Location ID: RBH06
Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: NC/NC/LVC	Vertical scale: 1:50	Sheet 3 of 6 Project ID: 42206

Plant used: Comacchio 205/Comacchio 305	Project: St John's Masterplan			Location ID: RBH06
Dates: 06/07/2018 - 10/07/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: NC/NC/LVC	Vertical scale: 1:50	Sheet 4 of 6 Project ID: 42206

	Plant used: Comacchio 205/Comacchio 305		Project: St John's Masterplan			Location ID: RBH06	
	Dates: 06/07/2018 - 10/07/2018		Client: Curtins Consulting			Sheet 5 of 6	
Rotary Borehole Log		Location:		Ground level:	Logged by: NC/NC/LVC	Vertical scale: 1:50	Project ID: 42206

Coring, Samples & In Situ Testing				Strata Details				Groundwater				
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation			
40.00 - 41.50	100 100 93	12			(2.00)	Medium strong to strong, thinly bedded to medium bedded, reddish brown, medium and coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open, clean and reduced strength <3mm.						
		0										
41.50 - 43.00	100 98 93	8			42.00	(1.00)	Medium strong, thickly laminated to thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, very closely to widely spaced, rough undulating, open moderately wide, clean and with sand and angular, fine to coarse gravel fill.				41	
		0										42
		36										
43.00 - 44.50	100 100 100	1			43.00	(0.84)	Strong, thinly to thickly laminated, reddish brown, medium grained SANDSTONE. Discontinuities are subhorizontal, widely spaced, rough undulating, open and clean.				43	
		5										43.84
44.50 - 46.00	100 97 83				45.35	(0.67)	Strong, thinly laminated, reddish brown, fine grained SILTSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open to moderately wide with clay fill <6mm. <i>Between 45.52m and 45.53m: mica present.</i> <i>Between 45.54m and 45.55m: clay fill.</i>				45	
		7										46.23
46.00 - 47.50	100 99 69				47.46		Medium strong to strong, very thinly bedded to medium bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely to medium spaced, rough undulating, open moderately wide clean and with sand film fill. 2) 50 degrees, very widely spaced, rough undulating, moderately wide and with clay sand and fine gravel fill. <i>Between 47.86m and 48.00m: with subangular, fine to coarse gravel of mixed lithologies.</i>				47	
		0	49									
47.50 - 49.00	100 100 77	10		49.07		<i>Between 49.07m and 49.18m: with subangular, fine to coarse gravel of mixed lithologies.</i>		48				
		0	50									
49.00 - 50.50	100 100 87			Continued next sheet								

Flush Details				Borehole Diameter		Boring Progress				Remarks:	
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)	
										SPT Hammer: JT.01 Energy Ratio: 64%	
				Casing Diameter		Water Strikes				Monitoring Installations	
				Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
Checked by:		HH	IFA RC								
Log status:		DRAFT	v01.01								

Plant used:
Comacchio 205/Comacchio 305

Project:
St John's Masterplan

Location ID:
RBH06

Dates:
06/07/2018 - 10/07/2018

Client:
Curtins Consulting

Sheet 6 of 6
Project ID:
42206

**Rotary
Borehole Log**

Location:

Ground level:

Logged by:
NC/NC/LVC

Vertical scale:
1:50

Coring, Samples & In Situ Testing				Strata Details				Groundwater	
Depth	TCR/SCR/ RQD	FI	Samples & Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
		6				Medium strong to strong, very thinly bedded to medium bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are 1) subhorizontal, very closely to medium spaced, rough undulating, open moderately wide clean and with sand film fill. 2) 50 degrees, very widely spaced, rough undulating, moderately wide and with clay sand and fine gravel fill.		51	
50.50 - 52.00	100 100 36	19			(5.14)				
		0							
		12							
52.00 - 53.50	100 97 88	1			52.60 (0.48)	Between 52.48m and 52.60m: with sandstone with subangular, fine to coarse gravel of mixed lithologies.		53	
					53.08 (0.92)	Strong, very thinly bedded, reddish brown, medium grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide and clean. Between 52.77m and 52.79m: subrounded, coarse gravel of mudstone. Between 52.88m and 52.89m: subangular gravel.			
53.50 - 55.00	100 100 81	9			54.00 (0.75)	Strong, very thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open moderately wide, clean and with clay, sand and subangular, fine to coarse gravel fill. Between 53.17m and 53.45m: sandstone with coarse gravel.		54	
		0			54.75 (0.75)	Strong, thinly laminated, reddish brown, medium grained SANDSTONE. Discontinuities are subhorizontal, closely to medium spaced, rough undulating, open moderately wide and clean.			
		9			55.00	Strong, thinly bedded, reddish brown, coarse grained SANDSTONE. Discontinuities are subhorizontal, closely spaced, rough undulating, open and clean. End of Borehole at 55.00m		55	
								56	
								57	
								58	
								59	
								60	

Flush Details				Borehole Diameter		Boring Progress					Remarks:									
Top (m)	Base (m)	Flush Type	Flush Return %	Depth (m)	Dia (mm)	Date	Time	Depth (m)	Cased (m)	Water (m)										
											SPT Hammer: JT.01 Energy Ratio: 64%									
											Casing Diameter		Water Strikes					Monitoring Installations		
											Depth (m)	Dia (mm)	Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)
Checked by:		HH	IFA RC v01.01																	
Log status:		DRAFT																		

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Plant used:	Comacchio 205	Project:	St John's Masterplan		Location ID: WS02
Dates:	09/07/2018	Client:	Curtins Consulting		
Dynamic Sample Borehole Log	Location:	Ground level:	Logged by:	Vertical scale:	Sheet 1 of 1
			NC	1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.30	ES1			0.05 0.15 (0.65) 0.80	MADE GROUND: Dark grey Tarmacadam. MADE GROUND: Light grey concrete. MADE GROUND: Orange brown, sandy, gravelly, angular COBBLE. Gravel is subangular, fine to coarse including brick and concrete. End of Borehole at 0.80m			
							1	
							2	
							3	
							4	
							5	
							6	
							7	
							8	
							9	
							10	

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 0.8m. Borehole terminated at 0.80m due to dense material unable to progress further.									
					Water Strikes					Monitoring Installations				
					Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:	HH		IFA DS v01.01											
Log status:	DRAFT													



Plant used:	Comacchio 205	Project:	St John's Masterplan		Location ID: WS03
Dates:	09/07/2018	Client:	Curtins Consulting		
Dynamic Sample Borehole Log	Location:	Ground level:	Logged by:	Vertical scale:	Sheet 1 of 1
			NC	1:50	Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.10 - 0.90	B1			0.10	MADE GROUND: Light grey Tarmacadam.			
0.30 - 0.80	ES2			(0.80)	MADE GROUND: Orange brown, gravelly, fine to coarse SAND with low cobble content. Gravel is subangular to angular, fine to coarse including slag, concrete and brick. Cobbles are subangular including brick.			
0.80	ES3			0.90	MADE GROUND: Very soft, greenish grey, gravelly, sandy CLAY with low cobble content. Gravel is subangular including brick and slag. Cobbles are subangular including brick.		1	
0.90 - 1.20	B4			(0.30) 1.20	End of Borehole at 1.20m			
							2	
							3	
							4	
							5	
							6	
							7	
							8	
							9	
							10	

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.									
					Water Strikes					Monitoring Installations				
					Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by:	HH		IFA DS v01.01											
Log status:	DRAFT													

Dynamic Sample Recovery					Remarks: Service inspection pit hand excavated from GL to 1.20m.									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks										
1.20	2.00		100		SPT Hammer: N/R, Energy Ratio: N/R									
2.00	3.00		80											
3.00	4.00		20											
					Water Strikes					Monitoring Installations				
Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)					
						0.00	2.00	PLAIN						
						2.00	3.00	SLOTTED						
Checked by:		HH		IFA DS v01.01										
Log status:		DRAFT												

Plant used:	Project: St John's Masterplan			Location ID: WS05
Dates: 24/06/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: HD	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 42206



Plant used:	Project:		Location ID: WS06		
Dates:	Client:				
23/06/2018	Curtins Consulting		Sheet 1 of 1		
Dynamic Sample Borehole Log	Location:	Ground level:	Logged by:	Vertical scale:	Project ID: 42206
			RS	1:50	

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.30	ES1	SPT(S) N=7 (1,1/1,2,2,2)		0.25	MADE GROUND: CONCRETE.		1	
0.50 - 1.00	B2			(0.55)	MADE GROUND: Dark reddish brown/black, gravelly fine to coarse SAND. Gravel is subangular to angular, fine to coarse including concrete, brick and sandstone.			
0.60	D3							
0.80	ES4			0.80	MADE GROUND: Soft, black, sandy CLAY.		1	
1.00 - 1.50	B5			(0.50)				
1.20	D6	SPT(S) N=13 (2,3/3,3,3,4)		1.30	Firm, light brown, sandy, slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium including sandstone.		2	
1.30	ES7			(0.70)				
1.70	D8						2	
2.00	D9			2.00	Medium dense, reddish brown, gravelly, fine to coarse SAND. Gravel is subangular to subrounded fine to coarse including sandstone and coal.			
2.00	ES10							
2.50 - 3.00	B11	SPT(S) 53 (2,2/53 for 260mm)		(1.41)	Below 3m: dense.		3	
2.70	D12							
3.00								
3.00 - 3.41	D13			3.41	End of Borehole at 3.41m			
							4	
							5	
							6	
							7	
							8	
							9	
							10	

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.									
					SPT Hammer: N/R, Energy Ratio: N/R									
					Water Strikes					Monitoring Installations				
					Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by: HH Log status: DRAFT					IFA DS v01.01					0.00 2.00 PLAIN				
										2.00 3.00 SLOTTED				

Plant used:	Project: St John's Masterplan			Location ID: WS08
Dates: 23/06/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: RS	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 42206

Plant used:	Project: St John's Masterplan			Location ID: WS10
Dates: 24/06/2018	Client: Curtins Consulting			
Location:	Ground level:	Logged by: HD	Vertical scale: 1:50	Sheet 1 of 1 Project ID: 42206

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Strata Description	Legend	Water Strike	Backfill/ Installation
0.15	D2	SPT(S) N=0 (1,0/0,0,0,0)		0.15	MADE GROUND: Tarmacadam.			
0.15	ES1			0.15	MADE GROUND: Brownish black, slightly clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including brick, tile, porcelain, mudstone, sandstone, slag, limestone and wood fragments.			
0.50	D4			0.40	MADE GROUND: Brownish black, slightly clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including brick, tile, porcelain, mudstone, sandstone, slag, limestone and wood fragments.			
0.50	ES3			(0.60)	MADE GROUND: Brownish black, slightly clayey, gravelly, fine to coarse SAND. Gravel is very angular to subrounded, fine to coarse including brick, tile, porcelain, mudstone, sandstone, slag, limestone and wood fragments.			
				1.00	MADE GROUND: Very soft, orangy brown mottled black, gravelly, slightly sandy CLAY. Gravel is angular to rounded, fine to coarse including mudstone, brick, sandstone and limestone (reworked).			
1.20	D6	SPT(S) N=21 (4,3/4,5,6,6)		(0.60)	MADE GROUND: Very soft, orangy brown mottled black, gravelly, slightly sandy CLAY. Gravel is angular to rounded, fine to coarse including mudstone, brick, sandstone and limestone (reworked).		1	
1.20	ES5			1.60	Medium dense, orangy brown, slightly clayey, gravelly, fine to coarse SAND. Gravel is angular to rounded, fine to coarse including sandstone, mudstone and limestone.			
1.20 - 1.65	D7							
2.00	D9	SPT(S) N=37 (5,5/9,8,7,13)		(1.70)			2	
2.00	ES8							
2.00								
3.00		SPT(S) N=50 (6,9/50 for 160mm)			Below 3.00m: dense.		3	
3.50	D10			3.30	Orangey brown, gravelly, slightly clayey, fine to coarse SAND with lenses of brownish grey, fine to coarse SAND. Gravel is angular to rounded, fine to coarse including sandstone, mudstone and limestone.			
4.00				(0.60)				
4.00	D11	SPT(S) 50 (6,9/50 for 160mm)		3.90	Very dense, brownish red, fine to coarse SAND.		4	
4.00 - 4.31	D12			(0.41)				
				4.31	End of Borehole at 4.31m			
							5	
							6	
							7	
							8	
							9	
							10	

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks										
1.20	2.00		100		Service inspection pit hand excavated from GL to 1.20m.									
2.00	3.00		100											
3.00	4.00		100											
					SPT Hammer: N/R, Energy Ratio: N/R									
					Water Strikes					Monitoring Installations				
Strike (m)		Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks				Top (m)	Base (m)	Pipe Type	Dia (mm)	
										0.00	2.00	PLAIN		
										2.00	4.00	SLOTTED		
Checked by:		HH		IFA DS v01.01										
Log status:		DRAFT												

Dynamic Sample Recovery					Remarks:									
Top (m)	Base (m)	Dia (mm)	Recovery %	Remarks	Service inspection pit hand excavated from GL to 1.20m.									
					SPT Hammer: N/R, Energy Ratio: N/R									
					Water Strikes					Monitoring Installations				
					Strike (m)	Cased (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks	Top (m)	Base (m)	Pipe Type	Dia (mm)
Checked by: HH IFA DS v01.01 Log status: DRAFT										0.00	1.50	PLAIN		
										1.50	3.50	SLOTTED		

Appendix C – Chemical Laboratory Testing Results

- Environmental Chemistry Analysis Results (Soil)
 - Envirolab Certificate Number: 18-02606-1
 - Envirolab Certificate Number: 18-05180-1
 - Envirolab Certificate Number: 18-05337-1
 - Envirolab Certificate Number: 18-05734-1
 - Envirolab Certificate Number: 18-05735-1

- Environmental Chemistry Analysis Results (Groundwater)
 - Envirolab Certificate Number: 18-06429-1

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/02606
Issue Number: 1

Date: 18 April, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 44368
Date Samples Received: 06/04/18
Date Instructions Received: 10/04/18
Date Analysis Completed: 18/04/18

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
% Stones >10mm _A	16.6								% w/w	A-T-044
pH _D ^{M#}	7.75								pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	1.23								g/l	A-T-026s
Cyanide (total) _A ^{M#}	2								mg/kg	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2								mg/kg	A-T-050s
Sulphide _A	<5								mg/kg	A-T-S2-s
Sulphur (elemental) _D ^{M#}	15								mg/kg	A-T-029s
Organic matter _D ^{M#}	9.7								% w/w	A-T-032 OM
Arsenic _D ^{M#}	23								mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	1.4								mg/kg	A-T-027s
Cadmium _D ^{M#}	1.1								mg/kg	A-T-024s
Copper _D ^{M#}	128								mg/kg	A-T-024s
Chromium _D ^{M#}	30								mg/kg	A-T-024s
Chromium (hexavalent) _D	<1								mg/kg	A-T-040s
Lead _D ^{M#}	970								mg/kg	A-T-024s
Mercury _D	0.91								mg/kg	A-T-024s
Nickel _D ^{M#}	41								mg/kg	A-T-024s
Selenium _D ^{M#}	<1								mg/kg	A-T-024s
Zinc _D ^{M#}	188								mg/kg	A-T-024s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
Asbestos in Soil (inc. matrix)										
Asbestos in soil _A [#]	NAD									A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A									

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
PAH-16MS										
Acenaphthene _A ^{M#}	0.07								mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	0.05								mg/kg	A-T-019s
Anthracene _A ^{M#}	0.21								mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.61								mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.47								mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.59								mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.35								mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.19								mg/kg	A-T-019s
Chrysene _A ^{M#}	0.73								mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.08								mg/kg	A-T-019s
Fluoranthene _A ^{M#}	1.52								mg/kg	A-T-019s
Fluorene _A ^{M#}	0.06								mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.38								mg/kg	A-T-019s
Naphthalene _A ^{M#}	0.04								mg/kg	A-T-019s
Phenanthrene _A ^{M#}	0.73								mg/kg	A-T-019s
Pyrene _A ^{M#}	1.48								mg/kg	A-T-019s
PAH (total 16) _A ^{M#}	7.55								mg/kg	A-T-019s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
VOC										
Dichlorodifluoromethane _A [#]	<1								µg/kg	A-T-006s
Chloromethane _A [#]	<10								µg/kg	A-T-006s
Vinyl Chloride _A [#]	<1								µg/kg	A-T-006s
Bromomethane _A [#]	<1								µg/kg	A-T-006s
Chloroethane _A [#]	<1								µg/kg	A-T-006s
Trichlorofluoromethane _A [#]	<1								µg/kg	A-T-006s
1,1-Dichloroethene _A [#]	<1								µg/kg	A-T-006s
Carbon Disulphide _A [#]	<1								µg/kg	A-T-006s
Dichloromethane _A	<5								µg/kg	A-T-006s
trans 1,2-Dichloroethene _A [#]	<1								µg/kg	A-T-006s
1,1-Dichloroethane _A [#]	<1								µg/kg	A-T-006s
cis 1,2-Dichloroethene _A [#]	<1								µg/kg	A-T-006s
2,2-Dichloropropane _A [#]	<1								µg/kg	A-T-006s
Bromochloromethane _A [#]	<5								µg/kg	A-T-006s
Chloroform _A [#]	<1								µg/kg	A-T-006s
1,1,1-Trichloroethane _A [#]	<1								µg/kg	A-T-006s
1,1-Dichloropropene _A [#]	<1								µg/kg	A-T-006s
Carbon Tetrachloride _A [#]	<1								µg/kg	A-T-006s
1,2-Dichloroethane _A [#]	<2								µg/kg	A-T-006s
Benzene _A [#]	<1								µg/kg	A-T-006s
Trichloroethene _A [#]	<1								µg/kg	A-T-006s
1,2-Dichloropropane _A [#]	<1								µg/kg	A-T-006s
Dibromomethane _A [#]	<1								µg/kg	A-T-006s
Bromodichloromethane _A [#]	<10								µg/kg	A-T-006s
cis 1,3-Dichloropropene _A [#]	<1								µg/kg	A-T-006s
Toluene _A [#]	<1								µg/kg	A-T-006s
trans 1,3-Dichloropropene _A [#]	<1								µg/kg	A-T-006s
1,1,2-Trichloroethane _A [#]	<1								µg/kg	A-T-006s
1,3-Dichloropropane _A [#]	<1								µg/kg	A-T-006s
Tetrachloroethene _A [#]	<1								µg/kg	A-T-006s
Dibromochloromethane _A [#]	<3								µg/kg	A-T-006s
1,2-Dibromoethane _A [#]	<1								µg/kg	A-T-006s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
Chlorobenzene _A [#]	<1								µg/kg	A-T-006s
1,1,1,2-Tetrachloroethane _A	<1								µg/kg	A-T-006s
Ethylbenzene _A [#]	<1								µg/kg	A-T-006s
m & p Xylene _A [#]	<1								µg/kg	A-T-006s
o-Xylene _A [#]	<1								µg/kg	A-T-006s
Styrene _A [#]	<1								µg/kg	A-T-006s
Bromoform _A [#]	<1								µg/kg	A-T-006s
Isopropylbenzene _A [#]	<1								µg/kg	A-T-006s
1,1,2,2-Tetrachloroethane _A	<1								µg/kg	A-T-006s
1,2,3-Trichloropropane _A [#]	<1								µg/kg	A-T-006s
Bromobenzene _A [#]	<1								µg/kg	A-T-006s
n-Propylbenzene _A [#]	<1								µg/kg	A-T-006s
2-Chlorotoluene _A [#]	<1								µg/kg	A-T-006s
1,3,5-Trimethylbenzene _A [#]	<1								µg/kg	A-T-006s
4-Chlorotoluene _A [#]	<1								µg/kg	A-T-006s
tert-Butylbenzene _A [#]	<2								µg/kg	A-T-006s
1,2,4-Trimethylbenzene _A [#]	<1								µg/kg	A-T-006s
sec-Butylbenzene _A [#]	<1								µg/kg	A-T-006s
4-Isopropyltoluene _A [#]	<1								µg/kg	A-T-006s
1,3-Dichlorobenzene _A	<1								µg/kg	A-T-006s
1,4-Dichlorobenzene _A [#]	<1								µg/kg	A-T-006s
n-Butylbenzene _A [#]	<1								µg/kg	A-T-006s
1,2-Dichlorobenzene _A [#]	<1								µg/kg	A-T-006s
1,2-Dibromo-3-chloropropane _A	<2								µg/kg	A-T-006s
1,2,4-Trichlorobenzene _A	<3								µg/kg	A-T-006s
Hexachlorobutadiene _A [#]	<1								µg/kg	A-T-006s
1,2,3-Trichlorobenzene _A	<3								µg/kg	A-T-006s

Envirolab Job Number: 18/02606

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/02606/1								Units	Method ref
Client Sample No	2									
Client Sample ID	RBH03									
Depth to Top	0.40									
Depth To Bottom										
Date Sampled	03-Apr-18									
Sample Type	Soil - ES									
Sample Matrix Code	4AB									
TPH CWG										
Ali >C5-C6 _A [#]	<0.01								mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01								mg/kg	A-T-022s
Ali >C8-C10 _A [#]	<0.01								mg/kg	A-T-022s
Ali >C10-C12 _A [#]	2.2								mg/kg	A-T-023s
Ali >C12-C16 _A [#]	11.7								mg/kg	A-T-023s
Ali >C16-C21 _A [#]	14.9								mg/kg	A-T-023s
Ali >C21-C35 _A [#]	192								mg/kg	A-T-023s
Total Aliphatics _A	221								mg/kg	A-T-023s
Aro >C5-C7 _A [#]	<0.01								mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01								mg/kg	A-T-022s
Aro >C8-C9 _A [#]	<0.01								mg/kg	A-T-022s
Aro >C9-C10 _A [#]	<0.01								mg/kg	A-T-022s
Aro >C10-C12 _A [#]	0.9								mg/kg	A-T-023s
Aro >C12-C16 _A [#]	6.1								mg/kg	A-T-023s
Aro >C16-C21 _A [#]	19.0								mg/kg	A-T-023s
Aro >C21-C35 _A [#]	182								mg/kg	A-T-023s
Total Aromatics _A	208								mg/kg	A-T-023s
TPH (Ali & Aro) _A	430								mg/kg	A-T-023s
BTEX - Benzene _A [#]	<0.01								mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01								mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01								mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01								mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01								mg/kg	A-T-022s
MTBE _A [#]	<0.01								mg/kg	A-T-022s

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

FINAL ANALYTICAL TEST REPORT

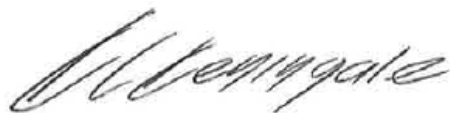
Envirolab Job Number: 18/05180
Issue Number: 1

Date: 09 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin/Michelle Louise Hirst-Watson
Project Name: St Johns
Project Ref: 42206
Order No: 44837
Date Samples Received: 25/06/18
Date Instructions Received: 29/06/18
Date Analysis Completed: 09/07/18

Prepared by:



Kate Keningale
Sales Executive

Approved by:



Danielle Bescoby
Quality Manager

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
% Stones >10mm _A	<0.1	22.8	<0.1	21.7	21.9	33.8	7.5	25.4	% w/w	A-T-044
pH _D ^{M#}	7.05	7.58	7.40	7.64	7.57	7.31	7.00	7.27	pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	0.05	0.02	0.20	0.04	0.16	0.04	0.10	0.02	g/l	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	mg/kg	A-T-050s
Organic matter _D ^{M#}	3.8	1.5	3.8	0.5	4.3	0.2	17.5	1.5	% w/w	A-T-032 OM
Arsenic _D ^{M#}	11	2	9	3	12	3	19	1	mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	1.7	<1.0	1.4	<1.0	1.6	<1.0	<1.0	<1.0	mg/kg	A-T-027s
Cadmium _D ^{M#}	0.6	<0.5	0.6	0.5	0.9	<0.5	1.6	<0.5	mg/kg	A-T-024s
Copper _D ^{M#}	25	5	47	3	27	4	125	6	mg/kg	A-T-024s
Chromium _D ^{M#}	21	6	19	9	10	7	21	8	mg/kg	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-040s
Lead _D ^{M#}	80	8	254	5	751	6	921	8	mg/kg	A-T-024s
Mercury _D	0.26	<0.17	0.48	<0.17	0.20	<0.17	1.66	<0.17	mg/kg	A-T-024s
Nickel _D ^{M#}	16	9	16	12	16	8	38	10	mg/kg	A-T-024s
Selenium _D ^{M#}	<1	<1	<1	<1	<1	<1	2	<1	mg/kg	A-T-024s
Zinc _D ^{M#}	47	18	125	31	35	18	119	27	mg/kg	A-T-024s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD		A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
PAH-16MS										
Acenaphthene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.02	mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	mg/kg	A-T-019s
Anthracene _A ^{M#}	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.11	0.11	mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	<0.04	<0.04	0.06	<0.04	<0.04	<0.04	0.59	0.61	mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	<0.04	<0.04	0.06	<0.04	<0.04	<0.04	0.59	0.45	mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	<0.05	<0.05	0.08	<0.05	0.06	<0.05	0.72	0.54	mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.38	0.18	mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.25	0.19	mg/kg	A-T-019s
Chrysene _A ^{M#}	<0.06	<0.06	0.08	<0.06	<0.06	<0.06	0.68	0.62	mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.10	0.06	mg/kg	A-T-019s
Fluoranthene _A ^{M#}	<0.08	<0.08	0.13	<0.08	<0.08	<0.08	0.96	1.22	mg/kg	A-T-019s
Fluorene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.02	mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	<0.03	<0.03	0.04	<0.03	<0.03	<0.03	0.40	0.23	mg/kg	A-T-019s
Naphthalene _A ^{M#}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Phenanthrene _A ^{M#}	<0.03	<0.03	0.08	<0.03	<0.03	<0.03	0.40	0.30	mg/kg	A-T-019s
Pyrene _A ^{M#}	<0.07	<0.07	0.11	<0.07	<0.07	<0.07	1.02	1.18	mg/kg	A-T-019s
Total PAH-16MS _A ^{M#}	<0.08	<0.08	0.64	<0.08	<0.08	<0.08	6.30	5.73	mg/kg	A-T-019s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/2	18/05180/4	18/05180/6	18/05180/8	18/05180/10	18/05180/12	18/05180/14	18/05180/16	Units	Method ref
Client Sample No							3	8		
Client Sample ID	WS6	WS6	WS8	WS8	WS11	WS11	WS10	WS10		
Depth to Top	0.80	2.20	0.60	2.20	0.40	1.70	0.50	2.00		
Depth To Bottom										
Date Sampled	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	23-Jun-18	24-Jun-18	24-Jun-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES		
Sample Matrix Code	6	4A	6A	5A	6A	5A	6AB	4A		
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C8-C10 _A ^{M#}	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-055s
Ali >C12-C16 _A ^{M#}	<1	2	<1	<1	<1	<1	2	<1	mg/kg	A-T-055s
Ali >C16-C21 _A ^{M#}	<1	2	<1	<1	<1	<1	2	2	mg/kg	A-T-055s
Ali >C21-C35 _A ^{M#}	7	2	<1	<1	5	<1	4	2	mg/kg	A-T-055s
Total Aliphatics >C5-C35 _A [#]	7	4	<1	<1	6	<1	9	5	mg/kg	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C8-C10 _A ^{M#}	<1	<1	<1	<1	<1	<1	2	<1	mg/kg	A-T-055s
Aro >C10-C12 _A ^{M#}	<1	<1	<1	<1	<1	<1	2	<1	mg/kg	A-T-055s
Aro >C12-C16 _A ^{M#}	3	2	<1	<1	3	<1	7	2	mg/kg	A-T-055s
Aro >C16-C21 _A ^{M#}	3	<1	<1	<1	15	<1	19	8	mg/kg	A-T-055s
Aro >C21-C35 _A ^{M#}	11	2	3	<1	55	<1	59	21	mg/kg	A-T-055s
Total Aromatics >C5-C35 _A [#]	16	4	3	<1	73	<1	89	31	mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35) _A [#]	23	9	3	<1	79	<1	98	36	mg/kg	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
% Stones >10mm _A	19.7	<0.1	8.5	<0.1					% w/w	A-T-044
pH _D ^{M#}	7.34	7.31	7.51	4.46					pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	1.24	0.07	0.17	0.20					g/l	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1	<1	<1					mg/kg	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2	<0.2					mg/kg	A-T-050s
Organic matter _D ^{M#}	11.2	0.3	2.5	0.3					% w/w	A-T-032 OM
Arsenic _D ^{M#}	35	<1	7	15					mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	1.2	<1.0	1.4	<1.0					mg/kg	A-T-027s
Cadmium _D ^{M#}	1.0	<0.5	0.6	1.5					mg/kg	A-T-024s
Copper _D ^{M#}	163	5	22	<1					mg/kg	A-T-024s
Chromium _D ^{M#}	18	5	10	5					mg/kg	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1					mg/kg	A-T-040s
Lead _D ^{M#}	511	6	49	6					mg/kg	A-T-024s
Mercury _D	2.63	<0.17	<0.17	<0.17					mg/kg	A-T-024s
Nickel _D ^{M#}	38	5	16	15					mg/kg	A-T-024s
Selenium _D ^{M#}	2	<1	<1	<1					mg/kg	A-T-024s
Zinc _D ^{M#}	128	15	46	18					mg/kg	A-T-024s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD	NAD						A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A						

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
PAH-16MS										
Acenaphthene _A ^{M#}	0.05	<0.01	<0.01	<0.01					mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	0.05	<0.01	<0.01	<0.01					mg/kg	A-T-019s
Anthracene _A ^{M#}	0.17	<0.02	0.03	<0.02					mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.50	<0.04	0.11	<0.04					mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.49	<0.04	0.11	<0.04					mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.63	<0.05	0.14	<0.05					mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.36	<0.05	0.07	<0.05					mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.20	<0.07	<0.07	<0.07					mg/kg	A-T-019s
Chrysene _A ^{M#}	0.58	<0.06	0.13	<0.06					mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.08	<0.04	<0.04	<0.04					mg/kg	A-T-019s
Fluoranthene _A ^{M#}	1.01	<0.08	0.22	<0.08					mg/kg	A-T-019s
Fluorene _A ^{M#}	0.07	<0.01	<0.01	<0.01					mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.34	<0.03	0.08	<0.03					mg/kg	A-T-019s
Naphthalene _A ^{M#}	<0.03	<0.03	<0.03	<0.03					mg/kg	A-T-019s
Phenanthrene _A ^{M#}	0.68	<0.03	0.07	<0.03					mg/kg	A-T-019s
Pyrene _A ^{M#}	0.96	<0.07	0.21	<0.07					mg/kg	A-T-019s
Total PAH-16MS _A ^{M#}	6.17	<0.08	1.17	<0.08					mg/kg	A-T-019s

Envirolab Job Number: 18/05180

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05180/18	18/05180/20	18/05180/22	18/05180/24					Units	Method ref
Client Sample No	3	9	3	9						
Client Sample ID	WS05	WS05	WS04	WS04						
Depth to Top	0.80	1.90	0.60	2.00						
Depth To Bottom										
Date Sampled	24-Jun-18	24-Jun-18	24-Jun-18	24-Jun-18						
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES						
Sample Matrix Code	4A	5B	2A	5						
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Ali >C8-C10 _A ^{M#}	<1	<1	<1	<1					mg/kg	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	<1	<1					mg/kg	A-T-055s
Ali >C12-C16 _A ^{M#}	<1	<1	<1	<1					mg/kg	A-T-055s
Ali >C16-C21 _A ^{M#}	2	<1	<1	<1					mg/kg	A-T-055s
Ali >C21-C35 _A ^{M#}	8	<1	1	<1					mg/kg	A-T-055s
Total Aliphatics >C5-C35 _A [#]	11	<1	1	<1					mg/kg	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Aro >C8-C10 _A ^{M#}	<1	<1	<1	<1					mg/kg	A-T-055s
Aro >C10-C12 _A ^{M#}	<1	<1	<1	<1					mg/kg	A-T-055s
Aro >C12-C16 _A ^{M#}	5	<1	2	<1					mg/kg	A-T-055s
Aro >C16-C21 _A ^{M#}	9	<1	3	<1					mg/kg	A-T-055s
Aro >C21-C35 _A ^{M#}	36	1	10	1					mg/kg	A-T-055s
Total Aromatics >C5-C35 _A [#]	53	1	15	1					mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35) _A [#]	64	1	16	1					mg/kg	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05337
Issue Number: 1

Date: 17 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 44842
Date Samples Received: 29/06/18
Date Instructions Received: 05/07/18
Date Analysis Completed: 17/07/18

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Richard Wong
Client Manager

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
% Stones >10mm _A	27.3	<0.1	6.9						% w/w	A-T-044
pH _D ^{M#}	9.99	10.01	7.99						pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	0.06	0.06	0.03						g/l	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1	<1						mg/kg	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2						mg/kg	A-T-050s
Organic matter _D ^{M#}	4.7	4.3	1.3						% w/w	A-T-032 OM
Arsenic _D ^{M#}	4	4	3						mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	<1.0	<1.0	<1.0						mg/kg	A-T-027s
Cadmium _D ^{M#}	0.6	1.4	<0.5						mg/kg	A-T-024s
Copper _D ^{M#}	19	32	12						mg/kg	A-T-024s
Chromium _D ^{M#}	17	17	9						mg/kg	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1						mg/kg	A-T-040s
Lead _D ^{M#}	104	581	61						mg/kg	A-T-024s
Mercury _D	0.91	0.99	<0.17						mg/kg	A-T-024s
Nickel _D ^{M#}	15	18	12						mg/kg	A-T-024s
Selenium _D ^{M#}	<1	<1	<1						mg/kg	A-T-024s
Zinc _D ^{M#}	46	107	27						mg/kg	A-T-024s

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD							A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A							

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
PAH-16MS										
Acenaphthene _A ^{M#}	<0.01	0.39	<0.01						mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	0.12	<0.01						mg/kg	A-T-019s
Anthracene _A ^{M#}	<0.02	1.17	<0.02						mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	<0.04	4.52	<0.04						mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	<0.04	4.07	<0.04						mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	<0.05	4.47	<0.05						mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	<0.05	2.55	<0.05						mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	<0.07	1.76	<0.07						mg/kg	A-T-019s
Chrysene _A ^{M#}	<0.06	5.13	<0.06						mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	<0.04	0.57	<0.04						mg/kg	A-T-019s
Fluoranthene _A ^{M#}	<0.08	9.69	<0.08						mg/kg	A-T-019s
Fluorene _A ^{M#}	<0.01	0.31	<0.01						mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	<0.03	2.96	<0.03						mg/kg	A-T-019s
Naphthalene _A ^{M#}	<0.03	<0.30	<0.03						mg/kg	A-T-019s
Phenanthrene _A ^{M#}	<0.03	4.18	<0.03						mg/kg	A-T-019s
Pyrene _A ^{M#}	<0.07	8.68	<0.07						mg/kg	A-T-019s
Total PAH-16MS _A ^{M#}	<0.08	50.6	<0.08						mg/kg	A-T-019s

Envirolab Job Number: 18/05337

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05337/2	18/05337/5	18/05337/8						Units	Method ref
Client Sample No	3	3	5							
Client Sample ID	BH03	RBH02	RBH04							
Depth to Top	0.50	0.50	0.40							
Depth To Bottom										
Date Sampled	29-Jun-18	29-Jun-18	26-Jun-18							
Sample Type	Soil - ES	Solid	Soil - ES							
Sample Matrix Code	4AB	7	4A							
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Ali >C8-C10 _A ^{M#}	<1	<1	<1						mg/kg	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	<1						mg/kg	A-T-055s
Ali >C12-C16 _A ^{M#}	<1	3	<1						mg/kg	A-T-055s
Ali >C16-C21 _A ^{M#}	<1	4	<1						mg/kg	A-T-055s
Ali >C21-C35 _A ^{M#}	2	94	1						mg/kg	A-T-055s
Total Aliphatics >C5-C35 _A [#]	2	100	1						mg/kg	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
Aro >C8-C10 _A ^{M#}	<1	2	<1						mg/kg	A-T-055s
Aro >C10-C12 _A ^{M#}	<1	4	<1						mg/kg	A-T-055s
Aro >C12-C16 _A ^{M#}	2	16	2						mg/kg	A-T-055s
Aro >C16-C21 _A ^{M#}	<1	118	1						mg/kg	A-T-055s
Aro >C21-C35 _A ^{M#}	3	1070	4						mg/kg	A-T-055s
Total Aromatics >C5-C35 _A [#]	4	1210	6						mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35) _A [#]	6	1310	8						mg/kg	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01						mg/kg	A-T-022s

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05734
Issue Number: 1

Date: 26 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 44884
Date Samples Received: 09/07/18
Date Instructions Received: 18/07/18
Date Analysis Completed: 26/07/18

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Georgia King
Admin & Client Services Supervisor

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
% Stones >10mm _A	<0.1	3.6	<0.1	18.7	<0.1				% w/w	A-T-044
pH _D ^{M#}	7.71	7.87	8.36	7.56	8.49				pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	0.22	0.04	0.50	0.02	0.07				g/l	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1	<1	<1	<1				mg/kg	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2	<0.2	<0.2				mg/kg	A-T-050s
Organic matter _D ^{M#}	5.2	2.5	14.9	4.2	21.4				% w/w	A-T-032 OM
Arsenic _D ^{M#}	17	8	29	10	31				mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	<1.0	1.4	<1.0	<1.0	<1.0				mg/kg	A-T-027s
Cadmium _D ^{M#}	1.5	0.8	12.7	1.2	0.9				mg/kg	A-T-024s
Copper _D ^{M#}	4820	26	530	74	294				mg/kg	A-T-024s
Chromium _D ^{M#}	17	14	61	18	20				mg/kg	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1				mg/kg	A-T-040s
Lead _D ^{M#}	698	228	2010	281	444				mg/kg	A-T-024s
Mercury _D	<0.17	<0.17	1.67	0.55	1.93				mg/kg	A-T-024s
Nickel _D ^{M#}	32	14	72	15	31				mg/kg	A-T-024s
Selenium _D ^{M#}	<1	<1	1	<1	<1				mg/kg	A-T-024s
Zinc _D ^{M#}	8230	131	1880	130	150				mg/kg	A-T-024s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD	NAD	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A					

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
PAH-16MS										
Acenaphthene _A ^{M#}	0.05	<0.01	9.43	5.54	0.21				mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	<0.01	0.17	0.04	0.13				mg/kg	A-T-019s
Anthracene _A ^{M#}	0.10	<0.02	10.9	3.65	0.52				mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.46	<0.04	23.6	6.94	1.50				mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.45	<0.04	17.8	5.63	1.62				mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.53	<0.05	23.1	6.44	1.85				mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.30	<0.05	8.17	3.19	1.07				mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.21	<0.07	8.45	2.24	0.63				mg/kg	A-T-019s
Chrysene _A ^{M#}	0.53	<0.06	25.9	7.42	1.71				mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.08	<0.04	2.54	0.94	0.29				mg/kg	A-T-019s
Fluoranthene _A ^{M#}	1.01	<0.08	55.5	20	2.94				mg/kg	A-T-019s
Fluorene _A ^{M#}	0.02	<0.01	7.65	4.37	0.29				mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.32	<0.03	9.86	3.40	1.05				mg/kg	A-T-019s
Naphthalene _A ^{M#}	<0.03	<0.03	0.93	4.35	0.30				mg/kg	A-T-019s
Phenanthrene _A ^{M#}	0.46	<0.03	43	21.1	2.16				mg/kg	A-T-019s
Pyrene _A ^{M#}	0.93	<0.07	49.4	19.5	3.05				mg/kg	A-T-019s
Total PAH-16MS _A ^{M#}	5.45	<0.08	296	115	19.3				mg/kg	A-T-019s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
SVOC excluding PAH-16										
Hexachlorobenzene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Diethyl phthalate _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Dimethyl phthalate _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Dibenzofuran _A	<100	<100	6150	2710	644				µg/kg	A-T-052s
Carbazole _A	<100	<100	3680	1110	683				µg/kg	A-T-052s
Butylbenzyl phthalate _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Bis(2-ethylhexyl)phthalate _A	<500	<500	<5000	<5000	<500				µg/kg	A-T-052s
Bis(2-chloroethoxy)methane _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Bis(2-chloroethyl)ether _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
4-Nitrophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
4-Methylphenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
4-Chloro-3-methylphenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Nitrophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Methylphenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
1,2,4-Trichlorobenzene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Chlorophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,6-Dinitrotoluene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,4-Dinitrotoluene _A	<100	<100	1190	1230	<100				µg/kg	A-T-052s
2,4-Dimethylphenol _A	<100	<100	<1000	1320	<100				µg/kg	A-T-052s
2,4-Dichlorophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,4,6-Trichlorophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2,4,5-Trichlorophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
1,4-Dichlorobenzene _A	<100	<100	1400	1350	<100				µg/kg	A-T-052s
1,3-Dichlorobenzene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
1,2-Dichlorobenzene _A	<100	<100	9190	7440	<100				µg/kg	A-T-052s
2-Chloronaphthalene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
2-Methylnaphthalene _A	<100	<100	2280	3460	751				µg/kg	A-T-052s
Bis(2-chloroisopropyl)ether _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Phenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Pentachlorophenol _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
n-Nitroso-n-dipropylamine _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
n-Diethylphthalate _A	<500	<500	<5000	<5000	<500				µg/kg	A-T-052s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
n-Dibutylphthalate _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Nitrobenzene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Isophorone _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Hexachloroethane _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Hexachlorocyclopentadiene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Hexachlorobutadiene _A	<100	<100	<1000	<1000	<100				µg/kg	A-T-052s
Perylene _A	276	<100	4490	2760	1120				µg/kg	A-T-052s

Envirolab Job Number: 18/05734

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/05734/1	18/05734/2	18/05734/3	18/05734/4	18/05734/5				Units	Method ref
Client Sample No	1	2	1	2	1					
Client Sample ID	RBH06	RBH06	WS03	WS03	WS02					
Depth to Top	0.40	0.80	0.30	1.00	0.30					
Depth To Bottom										
Date Sampled	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18	06-Jul-18					
Sample Type	Solid	Soil - ES	Solid	Soil - ES	Solid					
Sample Matrix Code	7	3A	7	6AB	7					
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	0.06	0.09	<0.01				mg/kg	A-T-022s
Ali >C8-C10 _A ^{M#}	<1	<1	159	409	2				mg/kg	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	<1	566	1350	4				mg/kg	A-T-055s
Ali >C12-C16 _A ^{M#}	35	<1	591	1370	10				mg/kg	A-T-055s
Ali >C16-C21 _A ^{M#}	101	<1	665	1390	9				mg/kg	A-T-055s
Ali >C21-C35 _A ^{M#}	31	<1	156	207	28				mg/kg	A-T-055s
Total Aliphatics >C5-C35 _A [#]	167	<1	2140	4710	54				mg/kg	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C10 _A ^{M#}	<1	<1	148	377	4				mg/kg	A-T-055s
Aro >C10-C12 _A ^{M#}	<1	<1	403	962	5				mg/kg	A-T-055s
Aro >C12-C16 _A ^{M#}	6	<1	1100	897	20				mg/kg	A-T-055s
Aro >C16-C21 _A ^{M#}	26	<1	4080	718	38				mg/kg	A-T-055s
Aro >C21-C35 _A ^{M#}	58	6	6040	700	145				mg/kg	A-T-055s
Total Aromatics >C5-C35 _A [#]	90	6	11800	3650	211				mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35) _A [#]	257	6	14000	8360	265				mg/kg	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01	0.04	<0.01				mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/05735
Issue Number: 1

Date: 26 July, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

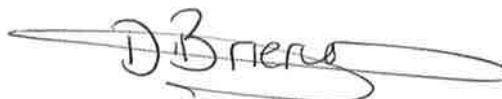
Project Manager: Hannah Hadwin
Project Name: St Johns Manchester
Project Ref: 42206
Order No: 44888
Date Samples Received: 13/07/18
Date Instructions Received: 18/07/18
Date Analysis Completed: 26/07/18

Prepared by:



Richard Wong
Client Manager

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
% Stones >10mm _A	16.0	4.1	12.2	20.3	<0.1				% w/w	A-T-044
pH _D ^{M#}	8.05	7.90	7.67	8.05	7.91				pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	<0.01	<0.01	<0.01	<0.01	0.04				g/l	A-T-026s
Cyanide (total) _A ^{M#}	<1	<1	<1	<1	<1				mg/kg	A-T-042sTCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2	<0.2	<0.2				mg/kg	A-T-050s
Organic matter _D ^{M#}	7.0	1.2	4.0	3.3	0.9				% w/w	A-T-032 OM
Arsenic _D ^{M#}	12	4	10	14	<1				mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	<1.0	<1.0	<1.0	<1.0	<1.0				mg/kg	A-T-027s
Cadmium _D ^{M#}	1.0	<0.5	0.6	0.6	<0.5				mg/kg	A-T-024s
Copper _D ^{M#}	88	17	32	44	4				mg/kg	A-T-024s
Chromium _D ^{M#}	18	8	13	14	9				mg/kg	A-T-024s
Chromium (hexavalent) _D	<1	<1	<1	<1	<1				mg/kg	A-T-040s
Lead _D ^{M#}	307	43	106	144	19				mg/kg	A-T-024s
Mercury _D	0.90	<0.17	0.51	9.99	<0.17				mg/kg	A-T-024s
Nickel _D ^{M#}	16	12	11	13	4				mg/kg	A-T-024s
Selenium _D ^{M#}	<1	<1	2	<1	<1				mg/kg	A-T-024s
Zinc _D ^{M#}	202	42	105	101	19				mg/kg	A-T-024s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	NAD	NAD	NAD	NAD					A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	N/A	N/A	N/A	N/A					

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
PAH-16MS										
Acenaphthene _A ^{M#}	1.02	6.10	0.74	0.26	<0.01				mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	0.25	<1.00	0.03	0.07	<0.01				mg/kg	A-T-019s
Anthracene _A ^{M#}	1.97	8.78	0.94	0.54	<0.02				mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	5.33	14.1	1.61	1.51	<0.04				mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	5.22	10	1.43	1.52	<0.04				mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	6.21	12.4	1.73	1.76	<0.05				mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	2.85	<5.00	0.83	1.00	<0.05				mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	2.07	<7.00	0.58	0.57	<0.07				mg/kg	A-T-019s
Chrysene _A ^{M#}	5.59	17.9	1.81	1.66	<0.06				mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	0.77	<4.00	0.22	0.26	<0.04				mg/kg	A-T-019s
Fluoranthene _A ^{M#}	12.3	33.1	4.31	3.14	<0.08				mg/kg	A-T-019s
Fluorene _A ^{M#}	1.10	6.04	0.52	0.25	<0.01				mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	2.98	5.37	0.86	1.01	<0.03				mg/kg	A-T-019s
Naphthalene _A ^{M#}	0.78	4.50	0.11	0.11	<0.03				mg/kg	A-T-019s
Phenanthrene _A ^{M#}	8.67	51.7	4.22	2.24	<0.03				mg/kg	A-T-019s
Pyrene _A ^{M#}	12.1	33.8	3.68	3.00	<0.07				mg/kg	A-T-019s
Total PAH-16MS _A ^{M#}	69.2	204	23.6	18.9	<0.08				mg/kg	A-T-019s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
SVOC excluding PAH-16										
Hexachlorobenzene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Diethyl phthalate _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Dimethyl phthalate _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Dibenzofuran _A	459	1930	<100	661	<100				µg/kg	A-T-052s
Carbazole _A	617	1350	107	716	<100				µg/kg	A-T-052s
Butylbenzyl phthalate _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Bis(2-ethylhexyl)phthalate _A	<500	<500	<500	<500	<500				µg/kg	A-T-052s
Bis(2-chloroethoxy)methane _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Bis(2-chloroethyl)ether _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
4-Nitrophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
4-Methylphenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
4-Chloro-3-methylphenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Nitrophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Methylphenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,2,4-Trichlorobenzene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Chlorophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,6-Dinitrotoluene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4-Dinitrotoluene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4-Dimethylphenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4-Dichlorophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4,6-Trichlorophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2,4,5-Trichlorophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,4-Dichlorobenzene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,3-Dichlorobenzene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
1,2-Dichlorobenzene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Chloronaphthalene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
2-Methylnaphthalene _A	254	1770	<100	517	<100				µg/kg	A-T-052s
Bis(2-chloroisopropyl)ether _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Phenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Pentachlorophenol _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
n-Nitroso-n-dipropylamine _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
n-Dioctylphthalate _A	<500	<500	<500	<500	<500				µg/kg	A-T-052s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
n-Dibutylphthalate _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Nitrobenzene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Isophorone _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Hexachloroethane _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Hexachlorocyclopentadiene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Hexachlorobutadiene _A	<100	<100	<100	<100	<100				µg/kg	A-T-052s
Perylene _A	1430	1680	387	1010	<100				µg/kg	A-T-052s

Envirolab Job Number: 18/05735

Client Project Name: St Johns Manchester

Client Project Ref: 42206

Lab Sample ID	18/05735/1	18/05735/3	18/05735/5	18/05735/6	18/05735/7				Units	Method ref
Client Sample No			3	4	7					
Client Sample ID	BH02	BH02	RBH05	RBH05	RBH05					
Depth to Top	0.20	1.80	0.40	0.50	0.80					
Depth To Bottom										
Date Sampled	13-Jul-18	13-Jul-18	12-Jul-18	12-Jul-18	12-Jul-18					
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES					
Sample Matrix Code	6ABD	5A	4AE	4A	5					
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Ali >C8-C10 _A ^{M#}	<1	<1	<1	<1	<1				mg/kg	A-T-055s
Ali >C10-C12 _A ^{M#}	<1	2	<1	<1	<1				mg/kg	A-T-055s
Ali >C12-C16 _A ^{M#}	4	6	<1	2	<1				mg/kg	A-T-055s
Ali >C16-C21 _A ^{M#}	5	6	2	4	<1				mg/kg	A-T-055s
Ali >C21-C35 _A ^{M#}	27	5	16	19	1				mg/kg	A-T-055s
Total Aliphatics >C5-C35 _A [#]	38	20	20	27	1				mg/kg	A-T-055s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C10 _A ^{M#}	2	1	<1	3	<1				mg/kg	A-T-055s
Aro >C10-C12 _A ^{M#}	4	14	3	4	<1				mg/kg	A-T-055s
Aro >C12-C16 _A ^{M#}	20	104	8	11	2				mg/kg	A-T-055s
Aro >C16-C21 _A ^{M#}	105	338	24	40	<1				mg/kg	A-T-055s
Aro >C21-C35 _A ^{M#}	373	736	100	218	5				mg/kg	A-T-055s
Total Aromatics >C5-C35 _A [#]	502	1190	137	275	6				mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35) _A [#]	541	1210	157	302	8				mg/kg	A-T-055s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01				mg/kg	A-T-022s

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/06429
Issue Number: 1

Date: 21 August, 2018

Client: Ian Farmer Associates (Warrington)
14/15 Rufford Court
Hardwick Grange
Warrington
WA1 4RF

Project Manager: Hannah Hadwin
Project Name: St Johns
Project Ref: 42206
Order No: 45039
Date Samples Received: 10/08/18
Date Instructions Received: 13/08/18
Date Analysis Completed: 21/08/18

Prepared by:



Melanie Marshall
Laboratory Coordinator

Approved by:



Danielle Brierley
Client Manager

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
pH (w) _A [#]	6.96	8.54	8.42	7.00					pH	A-T-031w
Hardness Total _A [#]	536	119	232	495					mg/l Ca CO3	A-T-049w
Sulphate (w) _A [#]	254	187	114	195					mg/l	A-T-026w
Cyanide (total) (w) _A [#]	0.007	0.014	<0.005	<0.005					mg/l	A-T-042wTCN
Phenols - Total by HPLC (w) _A	<0.01	<0.01	<0.01	<0.01					mg/l	A-T-050w
Sulphide (w) _A	<0.1	<0.1	<0.1	<0.1					mg/l	A-T-S2-w
Arsenic (dissolved) _A [#]	<1	8	1	<1					µg/l	A-T-025w
Boron (dissolved) _A [#]	158	64	155	99					µg/l	A-T-025w
Cadmium (dissolved) _A [#]	<0.2	<0.2	<0.2	<0.2					µg/l	A-T-025w
Copper (dissolved) _A [#]	<1	3	<1	<1					µg/l	A-T-025w
Chromium (dissolved) _A [#]	1	10	13	7					µg/l	A-T-025w
Lead (dissolved) _A [#]	<1	<1	<1	<1					µg/l	A-T-025w
Mercury (dissolved) _A [#]	<0.1	<0.1	<0.1	<0.1					µg/l	A-T-025w
Nickel (dissolved) _A [#]	<1	4	2	6					µg/l	A-T-025w
Selenium (dissolved) _A [#]	<1	27	2	<1					µg/l	A-T-025w
Zinc (dissolved) _A [#]	8	3	1	13					µg/l	A-T-025w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
PAH 16MS (w)										
Acenaphthene (w) _A [#]	<0.01	0.23	<0.01	0.45					µg/l	A-T-019w
Acenaphthylene (w) _A [#]	<0.01	0.05	<0.01	0.13					µg/l	A-T-019w
Anthracene (w) _A [#]	<0.01	0.74	<0.01	0.69					µg/l	A-T-019w
Benzo(a)anthracene (w) _A [#]	<0.01	2.47	0.02	2.03					µg/l	A-T-019w
Benzo(a)pyrene (w) _A [#]	<0.01	3.06	0.02	2.01					µg/l	A-T-019w
Benzo(b)fluoranthene (w) _A [#]	<0.01	2.96	0.02	2.01					µg/l	A-T-019w
Benzo(ghi)perylene (w) _A [#]	<0.01	1.51	<0.01	0.80					µg/l	A-T-019w
Benzo(k)fluoranthene (w) _A [#]	<0.01	1.08	<0.01	0.66					µg/l	A-T-019w
Chrysene (w) _A [#]	<0.01	2.63	0.02	2.28					µg/l	A-T-019w
Dibenzo(ah)anthracene (w) _A [#]	<0.01	0.32	<0.01	0.22					µg/l	A-T-019w
Fluoranthene (w) _A [#]	0.01	5.94	0.03	4.71					µg/l	A-T-019w
Fluorene (w) _A [#]	<0.01	0.17	<0.01	0.46					µg/l	A-T-019w
Indeno(123-cd)pyrene (w) _A [#]	<0.01	2.05	0.01	0.96					µg/l	A-T-019w
Naphthalene (w) _A [#]	<0.01	0.01	<0.01	0.18					µg/l	A-T-019w
Phenanthrene (w) _A [#]	0.01	2.29	0.01	3.79					µg/l	A-T-019w
Pyrene (w) _A [#]	0.01	5.39	0.03	4.97					µg/l	A-T-019w
Total PAH 16MS (w) _A [#]	0.03	30.9	0.16	26.4					µg/l	A-T-019w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
SVOC (excluding PAH-16) (w)										
2,4,5-Trichlorophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
2,4,6-Trichlorophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
2,4-Dichlorophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
2,4-Dimethylphenol _A	<1	<1	<1	<1					µg/l	A-T-052w
2,4-Dinitrotoluene _A	<1	<1	<1	<1					µg/l	A-T-052w
2,6-Dinitrotoluene _A	<1	<1	<1	<1					µg/l	A-T-052w
2-Chloronaphthalene _A	<1	<1	<1	<1					µg/l	A-T-052w
2-Chlorophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
2-Methylnaphthalene _A	<1	<1	<1	<1					µg/l	A-T-052w
2-Methylphenol _A	<1	<1	<1	<1					µg/l	A-T-052w
2-Nitrophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
4-Bromophenyl phenyl ether _A	<1	<1	<1	<1					µg/l	A-T-052w
4-Chloro-3-methylphenol _A	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-chloroisopropyl)ether _A	<1	<1	<1	<1					µg/l	A-T-052w
4-Methylphenol _A	<1	<1	<1	<1					µg/l	A-T-052w
4-Nitrophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-chloroethyl)ether _A	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-chloroethoxy)methane _A	<1	<1	<1	<1					µg/l	A-T-052w
Bis(2-ethylhexyl)phthalate _A	<10	<10	<10	<10					µg/l	A-T-052w
Butylbenzyl phthalate _A	<1	<1	<1	<1					µg/l	A-T-052w
Carbazole _A	<1	<1	<1	<1					µg/l	A-T-052w
Dibenzofuran _A	<1	<1	<1	<1					µg/l	A-T-052w
n-Dibutylphthalate _A	<1	<1	<1	<1					µg/l	A-T-052w
n-Dioctylphthalate _A	<10	<10	<10	<10					µg/l	A-T-052w
n-Nitroso-n-dipropylamine _A	<1	<1	<1	<1					µg/l	A-T-052w
Diethyl phthalate _A	<1	<1	<1	<1					µg/l	A-T-052w
Dimethyl phthalate _A	<1	<1	<1	<1					µg/l	A-T-052w
Hexachlorobenzene _A	<1	<1	<1	<1					µg/l	A-T-052w
Pentachlorophenol _A	<1	<1	<1	<1					µg/l	A-T-052w
Phenol _A	<1	<1	<1	<1					µg/l	A-T-052w
Hexachloroethane _A	<1	<1	<1	<1					µg/l	A-T-052w
Nitrobenzene _A	<1	<1	<1	<1					µg/l	A-T-052w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
Isophorone _A	<1	<1	<1	<1					µg/l	A-T-052w
Hexachlorocyclopentadiene _A	<1	<1	<1	<1					µg/l	A-T-052w
Perylene _A	<1	<1	<1	<1					µg/l	A-T-052w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
VOC (w)										
Dichlorodifluoromethane _A	<1	<1	<1	<1					µg/l	A-T-006w
Chloromethane _A	<10	<10	<10	<10					µg/l	A-T-006w
Vinyl Chloride _A [#]	<1	2	<1	<1					µg/l	A-T-006w
Bromomethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Chloroethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Trichlorofluoromethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
trans 1,2-Dichloroethene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Dichloromethane _A	<5	<5	<5	<5					µg/l	A-T-006w
Carbon Disulphide _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,1-Dichloroethene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,1-Dichloroethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
cis 1,2-Dichloroethene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Bromochloromethane _A [#]	<5	<5	<5	<5					µg/l	A-T-006w
Chloroform _A [#]	<1	5	1	2					µg/l	A-T-006w
2,2-Dichloropropane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dichloroethane _A [#]	<2	<2	<2	<2					µg/l	A-T-006w
1,1,1-Trichloroethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,1-Dichloropropene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Benzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Carbon Tetrachloride _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Dibromomethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dichloropropane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Bromodichloromethane _A [#]	<10	<10	<10	<10					µg/l	A-T-006w
Trichloroethene _A [#]	1	<1	<1	<1					µg/l	A-T-006w
cis 1,3-Dichloropropene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
trans 1,3-Dichloropropene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,1,2-Trichloroethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Toluene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,3-Dichloropropane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Dibromochloromethane _A [#]	<3	<3	<3	<3					µg/l	A-T-006w
1,2-Dibromoethane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Tetrachloroethene _A	<1	<1	<1	<1					µg/l	A-T-006w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
1,1,1,2-Tetrachloroethane _A	<1	<1	<1	<1					µg/l	A-T-006w
Chlorobenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Ethylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
m & p Xylene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Bromoform _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Styrene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,1,2,2-Tetrachloroethane _A	<1	<1	<1	<1					µg/l	A-T-006w
o-Xylene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,2,3-Trichloropropane _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Isopropylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
Bromobenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
2-Chlorotoluene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
n-propylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
4-Chlorotoluene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,2,4-Trimethylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
4-Isopropyltoluene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,3,5-Trimethylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dichlorobenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,4-Dichlorobenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
sec-Butylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
tert-Butylbenzene _A [#]	<2	<2	<2	<2					µg/l	A-T-006w
1,3-Dichlorobenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
n-butylbenzene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w
1,2-Dibromo-3-chloropropane _A [#]	<2	<2	<2	<2					µg/l	A-T-006w
1,2,4-Trichlorobenzene _A [#]	<3	<3	<3	<3					µg/l	A-T-006w
1,2,3-Trichlorobenzene _A [#]	<3	<3	<3	<3					µg/l	A-T-006w
Hexachlorobutadiene _A [#]	<1	<1	<1	<1					µg/l	A-T-006w

Envirolab Job Number: 18/06429

Client Project Name: St Johns

Client Project Ref: 42206

Lab Sample ID	18/06429/1	18/06429/2	18/06429/3	18/06429/4					Units	Method ref
Client Sample No										
Client Sample ID	WS10	RBH02	BH04	BH02						
Depth to Top										
Depth To Bottom										
Date Sampled	09-Aug-18	09-Aug-18	09-Aug-18	09-Aug-18						
Sample Type	Water - EW	Water - EW	Water - EW	Water - EW						
Sample Matrix Code	N/A	N/A	N/A	N/A						
TPH CWG (w)										
Ali >C5-C6 (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C6-C8 (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
Ali >C8-C10 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C10-C12 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C12-C16 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C16-C21 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Ali >C21-C35 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Total Aliphatics >C5-C35 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C5-C7 (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C7-C8 (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
Aro >C8-C10 (w) _A	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C10-C12 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C12-C16 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C16-C21 (w) _A [#]	<5	<5	<5	<5					µg/l	A-T-055w
Aro >C21-C35 (w) _A [#]	<10	<10	<10	<10					µg/l	A-T-055w
Total Aromatics >C5-C35 (w) _A	<10	<10	<10	<10					µg/l	A-T-055w
TPH (Ali & Aro >C5-C35) (w) _A	<10	<10	<10	<10					µg/l	A-T-055w
BTEX - Benzene (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - Toluene (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - Ethyl Benzene (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - m & p Xylene (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
BTEX - o Xylene (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w
MTBE (w) _A [#]	<1	<1	<1	<1					µg/l	A-T-022w

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Appendix D – Geotechnical Laboratory Testing Results

- Geotechnical Analysis Results
 - Ian Farmer Associates, Test Report 42206
 - Ian Farmer Associates, Test Report 42206A
 - Ian Farmer Associates, Test Report 42206B
 - Ian Farmer Associates, Test Report 42206 Brazilian Test
 - Ian Farmer Associates, Test Report 42206 Hoek Triaxial Test
 - Ian Farmer Associates, Test Report 42206 Hoek Shear Box Test
 - Ian Farmer Associates, Test Report 42206 Sound Velocity Test

F.A.O.

Test Report - 42206 / 3

Site: St John's Masterplan

Job Number: 42206

Originating Client: Curtins Consulting

Originating Reference: 42206

Date Sampled: 25/07/2018

Date Scheduled: 01/08/2018

Date Testing Started: 08/08/2018

Date Testing Finished: 21/08/2018

Remarks:

Authorised By:



Tim Robinson
Quality Technician

Date: 22/08/2018



Site: St John's Masterplan

Job Number: 42206

Client: Curtins Consulting

Page: 2

ROCK INDEX TESTS - SUMMARY OF RESULTS

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content ¹ %	Caliper ²		Buoyancy ³		Natural Bulk density Mg/m ³	Remarks
					Dry density Mg/m ³	Porosity %	Dry density Mg/m ³	Porosity %		
RBH02	13.20	C20	Red/Brown SANDSTONE	13.3			1.98	26.7	2.24	
RBH02	17.12	C44	Red/Brown SANDSTONE	11.0			2.04	24.7	2.27	
RBH02	26.32	C46	Red/Brown SANDSTONE	11.9			1.97	26.7	2.20	
RBH02	33.25	C34	Red/Brown SANDSTONE	13.6			1.96	27.6	2.23	
RBH02	39.25	C39	Red/Brown SANDSTONE	13.4			1.94	28.0	2.20	
RBH03	13.40	C11	Red/Brown SANDSTONE	9.7			2.09	21.2	2.29	
RBH03	19.12	C16	Red/Brown SANDSTONE	10.9			2.06	22.5	2.29	
RBH03	29.20	C24	Red/Brown SANDSTONE	11.1			1.87	30.6	2.08	
RBH03	35.01	C29	Red/Brown SANDSTONE	10.1			2.10	23.5	2.31	
RBH04	9.70	C15	Red/Brown SANDSTONE	12.6			1.98	26.3	2.23	
RBH04	12.70	C18	Red/Brown SANDSTONE	5.3			1.92	28.0	2.02	
RBH04	17.34	C23	Red/Brown SANDSTONE	5.9			2.22	17.0	2.35	
RBH04	24.25	C30	Red/Brown SANDSTONE	9.6			1.95	28.3	2.13	
RBH04	29.10	C35	Red/Brown SANDSTONE	9.5			2.06	23.6	2.25	
RBH04	36.10	C40	Red/Brown SANDSTONE	10.6			1.97	26.0	2.18	

Notes 1. ISRM p87 test 1, water content at 105 ± 3 °C, specimen as received at the laboratory 3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper 2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.

Part 1.1 Suggested method for determination of the water content of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.

Part 1.1 Suggested method for determination of the water content of a rock sample

**Site:** St John's Masterplan**Job Number:** 42206**Client:** Curtins Consulting**Page:** 3**UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS**

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions ²			Bulk Density ² Mg/m ³	Water Content 1 %	Uniaxial Compression ³				Remarks
				Dia. mm	Length mm	H/D			Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
RBH02	10.20	C17	Red/Brown SANDSTONE	101.7	124.2	*1.2	1.94	12.7	as received	0.3444	AC	0.9	
RBH02	13.20	C20	Red/Brown SANDSTONE	100.9	156.3	*1.5	2.22	11.8	as received	0.3501	AC	0.9	
RBH02	14.34	C22	Red/Brown SANDSTONE	101.6	242.0	*2.4	2.24	9.5	as received	0.3454	AC	5.9	
RBH02	18.32	C27	Red/Brown SANDSTONE	100.4	207.6	*2.1	2.17	13.2	as received	0.3534	AC	5.8	
RBH02	22.56	C44	Red/Brown SANDSTONE	101.4	223.2	*2.2	2.21	12.7	as received	0.3469	AC	10.6	
RBH02	26.32	C46	Red/Brown SANDSTONE	100.6	116.1	*1.2	2.25	11.9	as received	0.3523	AC	3.9	
RBH02	30.91	C32	Red/Brown SANDSTONE	101.8	243.6	*2.4	2.22	11.3	as received	0.3440	AC	12.0	
RBH02	33.25	C34	Red/Brown SANDSTONE	100.7	208.0	*2.1	2.30	8.3	as received	0.3513	AC	13.1	
RBH02	35.40	C36	Red/Brown SANDSTONE	101.0	201.3	*2	2.25	11.0	as received	0.3496	AC	8.8	
RBH02	39.25	C39	Red/Brown SANDSTONE	99.3	169.7	*1.7	2.21	11.1	as received	0.3616	S	4.6	
RBH03	10.50	C8	Red/Brown SANDSTONE	101.1	96.7	*1	2.19	11.0	as received	0.3487	AC	8.3	
RBH03	12.40	C10	Red/Brown SANDSTONE	100.9	79.1	*0.8	2.18	12.1	as received	0.3503	AC	4.9	
RBH03	14.30	C12	Red/Brown SANDSTONE	100.9	99.8	*1	2.19	9.5	as received	0.3502	AC	6.3	
RBH03	16.52	C	Red/Brown SANDSTONE	101.2	226.5	*2.2	0.22	9.7	as received	0.3484	AC	10.8	
RBH03	17.06	C37	Red/Brown SANDSTONE	99.8	143.7	*1.4	2.24	11.3	as received	0.3582	AC	7.1	
RBH03	19.12	C16	Red/Brown SANDSTONE	101.3	127.8	*1.3	2.15	4.5	as received	0.3475	AC	13.3	
RBH03	22.00	C18	Red/Brown SANDSTONE	101.0	125.1	*1.2	2.20	10.5	as received	0.3498	AC	7.9	
RBH03	26.90	C21	Red/Brown SANDSTONE	101.5	226.4	*2.2	2.19	12.2	as received	0.3459	S	6.4	
RBH03	30.42	C25	Red/Brown SANDSTONE	101.5	300.8	3	2.35	10.2	as received	0.3463	AC	11.7	
RBH03	33.90	C28	Red/Brown SANDSTONE	102.1	294.6	2.9	2.30	9.5	as received	0.3419	AC	18.6	
RBH04	14.56	C20	Red/Brown SANDSTONE	100.0	186.7	*1.9	2.23	11.9	as received	0.3562	AC	1.3	
RBH04	15.90	C22	Red/Brown SANDSTONE	101.3	186.0	*1.8	2.22	11.9	as received	0.3476	S	1.8	
RBH04	18.78	C25	Red/Brown SANDSTONE	101.4	217.6	*2.1	2.21	11.4	as received	0.3465	AC	10.7	

Notes 1 ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS

*Denotes length diameter ratio outside ISRM specification

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

Mode of failure :

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

S - Single shear MS - multiple shear

above notes apply unless annotated otherwise in the remarks

AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007**Method of Test:** International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Page: 4

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Site: St John's Masterplan

Job Number: 42206

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH02	8.95	C16	Red/Brown SANDSTONE As received	D	PL	YES	70.0	98.8	98.8	95.8	0.1	98.8	0.01	0.02	
RBH02	8.95	C16	Red/Brown SANDSTONE As received	A	PD	YES		98.7	69.5	63.5	0.5	93.5	0.06	0.08	
RBH02	11	C18	Red/Brown SANDSTONE As received	D	PL	YES	52.7	101.6	101.6	99.6	0.1	101.6	0.01	0.02	
RBH02	11	C18	Red/Brown SANDSTONE As received	A	PD	YES		101.3	50.9	47.9	0.1	81.0	0.01	0.01	
RBH02	12.07	C19	Red/Brown SANDSTONE As received	D	PL	YES	67.4	101.5	101.5	102.5	0.1	101.5	0.01	0.02	
RBH02	12.07	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.2	69.7	67.7	0.1	94.8	0.01	0.01	
RBH02	14	C21	Red/Brown SANDSTONE As received	D	PL	YES	83.3	102.0	102.0	99.0	0.4	102.0	0.04	0.06	
RBH02	14	C21	Red/Brown SANDSTONE As received	A	PD	YES		101.1	81.0	79.0	0.1	102.1	0.01	0.01	
RBH02	15.5	C23	Red/Brown SANDSTONE As received	D	PL	YES	68.3	101.7	101.7	99.7	0.5	101.7	0.05	0.07	
RBH02	15.5	C23	Red/Brown SANDSTONE As received	A	PD	YES		101.7	65.8	62.8	0.4	92.3	0.05	0.06	
RBH02	15.97	C24	Red/Brown SANDSTONE As received	A	PD	YES		96.8	89.1	80.1	0.1	104.8	0.01	0.01	
RBH02	17.12	C44	Red/Brown SANDSTONE Saturated	A	PD	YES		99.6	85.2	81.2	0.2	104.0	0.02	0.03	
RBH02	18	C26	Red/Brown SANDSTONE As received	D	PL	YES	78.2	100.2	100.2	98.2	0.8	100.2	0.08	0.11	
RBH02	18	C26	Red/Brown SANDSTONE As received	A	PD	YES		100.9	107.4	96.4	1.4	117.4	0.10	0.15	
RBH02	20	C28	Red/Brown SANDSTONE As received	A	PD	YES		100.0	71.8	65.8	0.3	95.6	0.03	0.04	
RBH02	20.94	C29	Red/Brown SANDSTONE As received	A	PD	YES		99.5	56.8	53.8	0.3	84.8	0.04	0.05	
RBH02	23.92	C45	Red/Brown SANDSTONE As received	D	PL	YES	55.3	101.4	101.4	98.4	1.1	101.4	0.11	0.15	
RBH02	23.92	C45	Red/Brown SANDSTONE As received	A	PD	YES		101.3	57.2	48.2	1.6	85.9	0.22	0.28	
RBH02	27.99	C30	Red/Brown SANDSTONE As received	D	PL	YES	44.5	100.9	100.9	97.9	0.1	100.9	0.01	0.02	
RBH02	27.99	C30	Red/Brown SANDSTONE As received	A	PD	YES		101.0	48.6	47.6	0.1	79.1	0.02	0.02	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction

PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

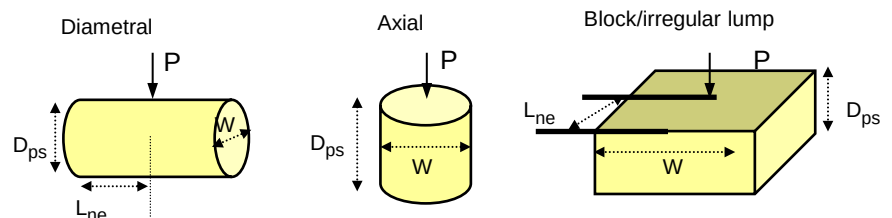
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Site: St John's Masterplan

Job Number: 42206

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH02	29.35	C31	Red/Brown SANDSTONE As received	D	PL	YES	97.8	100.9	100.9	98.9	1.1	100.9	0.11	0.15	
RBH02	29.35	C31	Red/Brown SANDSTONE As received	A	PD	YES		100.7	102.5	96.5	1.1	114.7	0.09	0.12	
RBH02	31.82	C33	Red/Brown SANDSTONE As received	D	PL	YES	67.9	100.3	100.3	98.3	1.2	100.3	0.12	0.17	
RBH02	31.82	C33	Red/Brown SANDSTONE As received	A	PD	YES		101.2	73.1	70.1	1.0	97.0	0.10	0.14	
RBH02	34.02	C35	Red/Brown SANDSTONE As received	A	PD	YES		100.7	64.0	59.0	1.0	90.6	0.12	0.15	
RBH02	36.31	C37	Red/Brown SANDSTONE As received	D	PL	YES	59.7	99.7	99.7	98.7	0.7	99.7	0.07	0.10	
RBH02	36.31	C37	Red/Brown SANDSTONE As received	A	PD	YES		100.3	59.5	42.5	0.9	87.2	0.12	0.16	
RBH02	38.04	C38	Red/Brown SANDSTONE As received	D	PL	YES	69.5	100.0	100.0	97.0	1.1	100.0	0.11	0.14	
RBH02	38.04	C38	Red/Brown SANDSTONE As received	A	PD	YES		100.6	111.6	97.6	3.0	119.5	0.21	0.31	
RBH03	9.6	C7	Red/Brown SANDSTONE As received	D	PL	YES	52.7	101.3	101.3	98.3	0.6	101.3	0.05	0.07	
RBH03	9.6	C7	Red/Brown SANDSTONE As received	A	PD	YES		101.4	56.8	50.8	0.9	85.6	0.13	0.16	
RBH03	11.3	C9	Red/Brown SANDSTONE As received	D	PL	YES	63.3	101.5	101.5	98.5	0.6	101.5	0.06	0.08	
RBH03	11.3	C9	Red/Brown SANDSTONE As received	A	PD	YES		101.2	73.7	68.7	1.4	97.4	0.14	0.19	
RBH03	13.4	C11	Red/Brown SANDSTONE As received	A	PD	YES		101.1	92.2	66.2	1.1	108.9	0.09	0.13	
RBH03	15.4	C13	Red/Brown SANDSTONE As received	D	PL	YES	96.5	101.2	101.2	99.2	0.5	101.2	0.05	0.07	
RBH03	15.4	C13	Red/Brown SANDSTONE As received	A	PD	YES		101.2	109.6	98.6	1.6	118.8	0.11	0.16	
RBH03	18	C15	Red/Brown SANDSTONE As received	D	PL	YES	96.8	100.8	100.8	97.8	0.5	100.8	0.04	0.06	
RBH03	18	C15	Red/Brown SANDSTONE As received	A	PD	YES		100.7	86.1	77.1	1.2	105.1	0.11	0.15	
RBH03	20	C17	Red/Brown SANDSTONE As received	D	PL	YES	107.4	101.3	101.3	98.3	0.5	101.3	0.05	0.06	
RBH03	20	C17	Red/Brown SANDSTONE As received	A	PD	YES		101.2	115.4	104.4	1.5	121.9	0.10	0.15	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

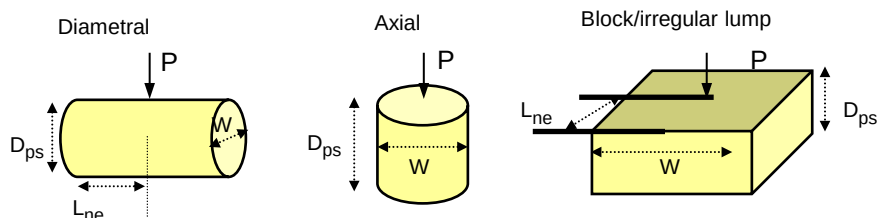
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)



Site: St John's Masterplan

Job Number: 42206

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH03	24.3	C19	Red/Brown SANDSTONE As received	D	PL	YES	76.2	101.2	101.2	99.2	0.5	101.2	0.05	0.07	
RBH03	24.3	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.2	80.6	59.6	0.7	101.9	0.07	0.10	
RBH03	26.1	C20	Red/Brown SANDSTONE As received	D	PL	YES	80.1	101.5	101.5	99.5	0.6	101.5	0.06	0.08	
RBH03	26.1	C20	Red/Brown SANDSTONE As received	A	PD	YES		101.1	83.5	78.5	1.3	103.7	0.12	0.17	
RBH03	28.04	C22	Red/Brown SANDSTONE As received	D	PL	YES	88.2	101.8	101.8	98.8	0.9	101.8	0.09	0.12	
RBH03	28.04	C22	Red/Brown SANDSTONE As received	A	PD	YES		101.7	89.4	81.4	1.9	107.6	0.17	0.23	
RBH03	28.94	C23	Red/Brown SANDSTONE As received	D	PL	YES	24.9	101.3	101.3	99.3	0.3	101.3	0.03	0.05	
RBH03	28.94	C23	Red/Brown SANDSTONE As received	A	PD	YES		101.2	85.8	77.8	1.3	105.2	0.11	0.16	
RBH03	29.2	C24	Red/Brown SANDSTONE As received	D	PL	YES	78.7	101.8	101.8	99.8	1.7	101.8	0.17	0.23	
RBH03	29.2	C24	Red/Brown SANDSTONE As received	A	PD	YES		101.8	73.9	67.9	2.7	97.8	0.28	0.38	
RBH03	31.3	C26	Red/Brown SANDSTONE As received	D	PL	YES	68.1	100.3	100.3	92.3	1.8	100.3	0.18	0.24	
RBH03	31.3	C26	Red/Brown SANDSTONE As received	A	PD	YES		101.4	101.7	85.7	2.2	114.5	0.17	0.24	
RBH03	32.5	C27	Red/Brown SANDSTONE As received	A	PD	YES		99.9	82.6	76.6	2.5	102.5	0.24	0.33	
RBH03	35.01	C29	Red/Brown SANDSTONE As received	D	PL	YES	64.7	101.5	101.5	98.5	0.8	101.5	0.08	0.10	
RBH03	35.01	C29	Red/Brown SANDSTONE As received	A	PD	YES		101.1	66.0	59.0	2.4	92.1	0.29	0.38	
RBH03	36.3	C30	Red/Brown SANDSTONE As received	A	PD	YES		101.0	111.1	102.1	0.7	119.5	0.05	0.07	
RBH03	37.95	C31	Red/Brown SANDSTONE As received	A	PD	YES		100.5	87.7	78.7	2.7	106.0	0.24	0.34	
RBH03	39.35	C32	Red/Brown SANDSTONE As received	D	PL	YES	82.0	101.1	101.1	99.1	1.5	101.1	0.15	0.20	
RBH03	39.35	C32	Red/Brown SANDSTONE As received	A	PD	YES		101.6	98.0	83.0	3.4	112.6	0.26	0.38	
RBH03	39.7	C33	Red/Brown SANDSTONE As received	A	PD	YES		100.7	100.7	94.7	3.7	113.6	0.29	0.42	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

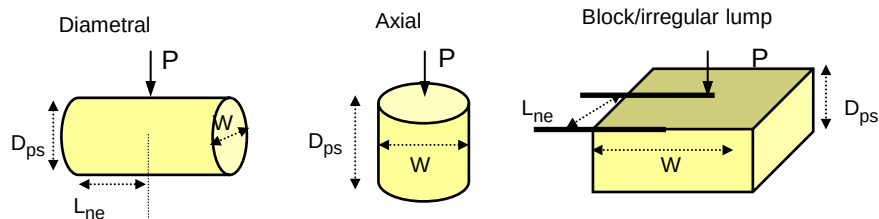
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)



Site: St John's Masterplan

Job Number: 42206

Client: Curtins Consulting

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**Point Load Strength Index Tests
Summary of Results**

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH04	9.27	C14	Red/Brown SANDSTONE As received	D	PL	YES	63.0	99.0	99.0	95.0	0.1	99.0	0.01	0.02	
RBH04	9.27	C14	Red/Brown SANDSTONE As received	A	PD	YES		99.4	77.5	68.5	0.3	99.1	0.03	0.03	
RBH04	9.7	C15	Red/Brown SANDSTONE As received	D	PL	YES	54.7	100.5	100.5	98.5	0.2	100.5	0.02	0.02	
RBH04	9.7	C15	Red/Brown SANDSTONE As received	A	PD	YES		100.0	57.0	52.0	0.2	85.2	0.02	0.03	
RBH04	11.05	C16	Red/Brown SANDSTONE As received	A	PD	YES		97.9	90.2	83.2	0.5	106.0	0.04	0.06	
RBH04	12.35	C17	Red/Brown SANDSTONE As received	D	PL	YES	74.2	97.9	97.9	94.9	0.3	97.9	0.03	0.04	
RBH04	12.35	C17	Red/Brown SANDSTONE As received	A	PD	YES		98.0	69.3	59.3	0.6	93.0	0.07	0.09	
RBH04	12.7	C18	Red/Brown SANDSTONE As received	A	PD	YES		99.1	79.1	62.1	1.2	99.9	0.12	0.16	
RBH04	13.85	C19	Red/Brown SANDSTONE As received	D	PL	YES	65.5	101.0	101.0	99.0	0.2	101.0	0.02	0.03	
RBH04	13.85	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.4	92.6	85.6	0.3	109.3	0.03	0.04	
RBH04	15.1	C21	Red/Brown SANDSTONE As received	D	PL	YES	56.8	100.7	100.7	98.7	0.1	100.7	0.01	0.01	
RBH04	15.1	C21	Red/Brown SANDSTONE As received	A	PD	YES		101.2	66.6	55.6	0.3	92.7	0.04	0.05	
RBH04	17.34	C23	Red/Brown SANDSTONE As received	D	PL	YES	100.0	101.5	101.5	97.5	1.2	101.5	0.12	0.16	
RBH04	17.34	C23	Red/Brown SANDSTONE As received	A	PD	YES		101.6	67.4	57.4	2.7	93.4	0.31	0.41	
RBH04	18.1	C24	Red/Brown SANDSTONE As received	D	PL	YES	85.7	100.6	100.6	97.6	0.4	100.6	0.04	0.06	
RBH04	18.1	C24	Red/Brown SANDSTONE As received	A	PD	YES		99.9	84.3	81.3	0.6	103.6	0.06	0.08	
RBH04	19.92	C26	Red/Brown SANDSTONE As received	D	PL	YES	76.6	100.6	100.6	98.6	0.5	100.6	0.05	0.07	
RBH04	19.92	C26	Red/Brown SANDSTONE As received	A	PD	YES		100.9	76.5	71.5	1.8	99.1	0.18	0.25	
RBH04	21.31	C27	Red/Brown SANDSTONE As received	A	PD	YES		99.4	93.6	81.6	1.2	108.8	0.10	0.14	
RBH04	22.93	C29	Red/Brown SANDSTONE As received	D	PL	YES	56.9	100.4	100.4	98.4	0.3	100.4	0.03	0.04	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

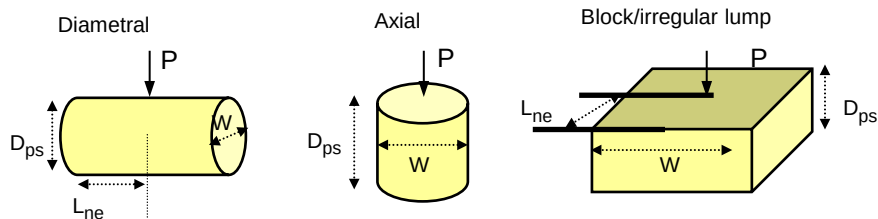
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Site: St John's Masterplan

Job Number: 42206

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH04	22.93	C29	Red/Brown SANDSTONE As received	A	PD	YES		100.8	72.0	65.0	1.1	96.1	0.12	0.17	
RBH04	24.25	C30	Red/Brown SANDSTONE As received	D	PL	YES	98.7	100.9	100.9	98.9	0.5	100.9	0.05	0.07	
RBH04	24.25	C30	Red/Brown SANDSTONE As received	A	PD	YES		100.7	86.5	71.5	2.6	105.3	0.23	0.32	
RBH04	24.94	C31	Red/Brown SANDSTONE As received	D	PL	YES	83.9	100.8	100.8	98.8	1.9	100.8	0.18	0.25	
RBH04	24.94	C31	Red/Brown SANDSTONE As received	A	PD	YES		100.8	94.6	89.6	2.0	110.2	0.17	0.24	
RBH04	27.09	C33	Red/Brown SANDSTONE As received	D	PL	YES	78.4	101.3	101.3	97.3	0.7	101.3	0.07	0.09	
RBH04	27.09	C33	Red/Brown SANDSTONE As received	A	PD	YES		101.4	53.4	54.4	1.2	83.0	0.17	0.22	
RBH04	28.04	C34	Red/Brown SANDSTONE As received	D	PL	YES	83.4	100.6	100.6	98.6	0.5	100.6	0.05	0.07	
RBH04	28.04	C34	Red/Brown SANDSTONE As received	A	PD	YES		101.5	95.6	85.6	1.7	111.1	0.14	0.20	
RBH04	29.1	C35	Red/Brown SANDSTONE As received	D	PL	YES	42.2	99.3	99.3	97.3	0.2	99.3	0.02	0.03	
RBH04	29.1	C35	Red/Brown SANDSTONE As received	A	PD	YES		99.5	46.2	41.2	1.4	76.5	0.24	0.29	
RBH04	31.05	C37	Red/Brown SANDSTONE As received	A	PD	YES		100.2	79.3	65.3	1.5	100.6	0.15	0.21	
RBH04	33.87	C39	Red/Brown SANDSTONE As received	D	PL	YES	86.8	99.9	99.9	96.9	1.5	99.9	0.15	0.21	
RBH04	33.87	C39	Red/Brown SANDSTONE As received	A	PD	YES		97.0	113.7	102.7	1.4	118.5	0.10	0.15	
RBH04	36.1	C40	Red/Brown SANDSTONE As received	D	PL	YES	63.0	100.2	100.2	98.2	0.2	100.2	0.02	0.03	
RBH04	36.1	C40	Red/Brown SANDSTONE As received	A	PD	YES		100.1	68.9	58.9	0.3	93.7	0.04	0.05	
RBH04	38	C42	Red/Brown SANDSTONE As received	D	U	YES	28.7	101.2	101.2	93.2	0.0	101.2	0.00	0.01	
RBH04	39.5	C41	Red/Brown SANDSTONE As received	A	PD	YES		99.6	90.1	71.1	0.3	106.9	0.03	0.04	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

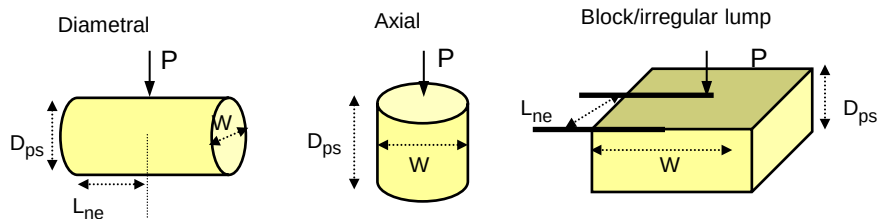
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, $F = (De/50)^{0.45}$ for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)



Test Report - 42206 / 3

Site: St John's Masterplan

Job Number: 42206

Originating Client: Curtins Consulting

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Date: 22/08/2018

F.A.O.

Test Report - 42206A / 2

Site: St John's Masterplan

Job Number: 42206A

Originating Client: Curtins Consulting

Originating Reference: 42206

Date Sampled: 30/07/2018

Date Scheduled: 02/08/2018

Date Testing Started: 08/08/2018

Date Testing Finished: 14/08/2018

Remarks:

Authorised By:



Tim Robinson
Quality Technician

Date: 20/08/2018

Site: St John's Masterplan

Job Number: 42206A

Client: Curtins Consulting

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ROCK INDEX TESTS - SUMMARY OF RESULTS

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Notes 1. ISRM p87 test 1, water content at $105 \pm 3^\circ\text{C}$, specimen as received at the laboratory

3. ISRM p88 test 3. Porosity/density determination using saturation and buoyancy

2. ISRM p87 test 2, Porosity/density determination using saturation and caliper

2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring. 2007.

Part 1.1 Suggested method for determination of the water content of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.

Part 1.1 Suggested method for determination of the water content of a rock sample

**Site:** St John's Masterplan**Job Number:** 42206A**Client:** Curtins Consulting**Page:** 3**UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS**

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions ²			Bulk Density ² Mg/m ³	Water Content 1 %	Uniaxial Compression ³				Remarks
				Dia. mm	Length mm	H/D			Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH04B	9.66	C2	Red/Brown SANDSTONE	101.5	104.8	*1	2.12	10.8	as received	0.3460	AC	8.8	
BH04B	11.72	C6	Red/Brown SANDSTONE	100.6	149.4	*1.5	2.21	11.4	as received	0.3526	AC	14.5	
BH04B	13.05	C11	Red/Brown SANDSTONE	101.5	108.5	*1.1	2.19	10.5	as received	0.3460	AC	8.6	
BH04B	14.90	C14	Red/Brown SANDSTONE	100.7	178.0	*1.8	2.24	7.0	as received	0.3512	S	8.9	
BH04B	18.26	C18	Red/Brown SANDSTONE	100.9	124.8	*1.2	2.23	11.3	as received	0.3499	AC	9.1	
BH04B	20.14	C21	Red/Brown SANDSTONE	101.2	215.1	*2.1	2.29	8.5	as received	0.3482	AC	12.2	
BH04B	20.73	C22	Red/Brown SANDSTONE	101.4	146.0	*1.4	1.95	9.6	as received	0.3468	AC	7.7	
RBH06	12.47	C15	Red/Brown SANDSTONE	100.5	101.6	*1	2.14	13.4	as received	0.3528	AC	3.4	
RBH06	14.00	C18	Red/Brown SANDSTONE	99.7	107.1	*1.1	2.26	11.2	as received	0.3586	AC	6.3	
RBH06	15.10	C21	Red/Brown SANDSTONE	100.8	112.4	*1.1	2.20	11.8	as received	0.3507	AC	3.9	
RBH06	17.16	C24	Red/Brown SANDSTONE	99.7	107.4	*1.1	2.21	9.7	as received	0.3589	AC	9.2	
RBH06	19.09	C27	Red/Brown SANDSTONE	101.2	207.0	*2	2.22	10.0	as received	0.3479	AC	15.5	
RBH06	21.56	C31	Red/Brown SANDSTONE	100.1	193.6	*1.9	2.22	11.8	as received	0.3561	AC	13.0	
RBH06	22.59	C34	Red/Brown SANDSTONE	100.2	226.0	*2.3	2.25	10.4	as received	0.3552	AC	11.0	
RBH06	24.06	C38	Red/Brown SANDSTONE	100.7	198.8	*2	2.19	12.3	as received	0.3519	S	8.3	
RBH06	25.76	C40	Red/Brown SANDSTONE	100.3	172.8	*1.7	2.21	11.1	as received	0.3546	AC	10.5	
RBH06	27.16	C42	Red/Brown SANDSTONE	100.4	218.3	*2.2	2.19	10.9	as received	0.3535	AC	10.7	
RBH06	29.00	C44	Red/Brown SANDSTONE	100.3	203.6	*2	2.27	10.7	as received	0.3546	AC	9.6	
RBH06	30.21	C45	Red/Brown SANDSTONE	100.7	196.9	*2	2.31	9.4	as received	0.3514	AC	26.0	
RBH06	31.34	C46	Red/Brown SANDSTONE	100.7	240.7	*2.4	2.33	7.4	as received	0.3519	AC	14.3	
RBH06	35.73	C48	Red/Brown SANDSTONE	100.1	183.9	*1.8	2.38	8.1	as received	0.3558	AC	13.7	
RBH06	38.00	C50	Red/Brown SANDSTONE	99.9	250.5	2.5	2.35	8.9	as received	0.3575	AC	20.8	
RBH06	41.47	C52	Red/Brown SANDSTONE	101.0	298.6	3	2.33	8.8	as received	0.3497	AC	25.0	

Notes 1 ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS

*Denotes length diameter ratio outside ISRM specification

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

Mode of failure :

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

S - Single shear MS - multiple shear

above notes apply unless annotated otherwise in the remarks

AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007**Method of Test:** International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Site: St John's Masterplan

Job Number: 42206A

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
BH04B	8.5	C1	Red/Brown SANDSTONE As received	D	PL	YES	44.7	99.6	99.6	95.6	0.9	99.6	0.09	0.12	
BH04B	8.5	C1	Red/Brown SANDSTONE As received	A	PD	YES		101.3	46.9	41.9	1.8	77.8	0.30	0.36	
BH04B	10.77	C4	Red/Brown SANDSTONE As received	D	PL	YES	52.1	99.0	99.0	96.0	0.1	99.0	0.01	0.02	
BH04B	10.77	C4	Red/Brown SANDSTONE As received	A	PD	YES		99.1	63.0	59.0	0.9	89.1	0.11	0.15	
BH04B	12.31	C8	Red/Brown SANDSTONE As received	D	PL	YES	50.1	101.0	101.0	99.0	0.7	101.0	0.07	0.10	
BH04B	12.31	C8	Red/Brown SANDSTONE As received	A	PD	YES		100.7	49.7	46.7	1.2	79.8	0.18	0.23	
BH04B	14.1	C12	Red/Brown SANDSTONE As received	D	PL	YES	52.2	100.5	100.5	97.5	0.9	100.5	0.09	0.12	
BH04B	14.1	C12	Red/Brown SANDSTONE As received	A	PD	YES		100.6	44.4	38.4	1.6	75.4	0.28	0.34	
BH04B	16	C16	Red/Brown SANDSTONE As received	D	PL	YES	81.9	100.6	100.6	95.6	0.8	100.6	0.07	0.10	
BH04B	16	C16	Red/Brown SANDSTONE As received	A	PD	YES		100.4	75.6	68.6	1.9	98.3	0.20	0.27	
BH04B	17	C17	Red/Brown SANDSTONE As received	D	PL	YES	82.3	101.1	101.1	96.1	1.0	101.1	0.09	0.13	
BH04B	17	C17	Red/Brown SANDSTONE As received	A	PD	YES		101.2	74.3	41.3	2.4	97.8	0.25	0.33	
BH04B	19	C19	Red/Brown SANDSTONE As received	D	PL	YES	100.9	101.5	101.5	96.5	0.8	101.5	0.08	0.11	
BH04B	19	C19	Red/Brown SANDSTONE As received	A	PD	YES		101.5	90.4	83.4	0.5	108.1	0.04	0.06	
BH04B	21.55	C23	Red/Brown SANDSTONE As received	D	PL	YES	51.8	100.7	100.7	98.7	1.4	100.7	0.14	0.19	
BH04B	21.55	C23	Red/Brown SANDSTONE As received	A	PD	YES		100.6	70.1	62.1	2.1	94.7	0.24	0.32	
BH04B	23.14	C24	Red/Brown SANDSTONE As received	D	PL	YES	64.9	100.7	100.7	96.7	0.3	100.7	0.03	0.04	
BH04B	23.14	C24	Red/Brown SANDSTONE As received	A	PD	YES		100.3	109.6	91.6	0.2	118.3	0.01	0.02	
BH04B	24.04	C25	Red/Brown SANDSTONE As received	D	PL	YES	76.0	100.4	100.4	96.4	1.2	100.4	0.12	0.16	
BH04B	24.04	C25	Red/Brown SANDSTONE As received	A	PD	YES		101.4	74.0	58.0	2.4	97.7	0.25	0.33	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

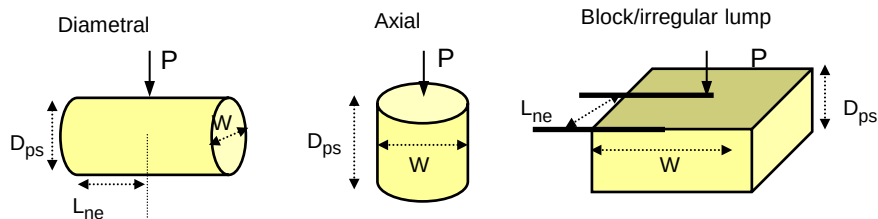
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Site: St John's Masterplan

Job Number: 42206A

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH06	8	C10	Red/Brown SANDSTONE As received	D	PL	YES	46.5	98.9	98.9	95.9	0.4	98.9	0.04	0.05	
RBH06	8	C10	Red/Brown SANDSTONE As received	A	PD	YES		98.2	57.7	53.7	0.6	84.9	0.08	0.10	
RBH06	9.63	C11	Red/Brown SANDSTONE As received	D	PL	YES	47.2	98.8	98.8	92.8	0.2	98.8	0.03	0.03	
RBH06	9.63	C11	Red/Brown SANDSTONE As received	A	PD	YES		98.0	55.7	51.7	0.7	83.4	0.10	0.13	
RBH06	11.29	C13	Red/Brown SANDSTONE As received	D	PL	YES	53.2	101.3	101.3	97.3	0.3	101.3	0.03	0.04	
RBH06	11.29	C13	Red/Brown SANDSTONE As received	A	PD	YES		101.3	82.0	70.0	0.7	102.8	0.07	0.09	
RBH06	13	C16	Red/Brown SANDSTONE As received	D	PL	YES	49.9	100.4	100.4	97.4	0.4	100.4	0.04	0.05	
RBH06	13	C16	Red/Brown SANDSTONE As received	A	PD	YES		100.2	52.5	45.5	1.1	81.8	0.17	0.21	
RBH06	14.17	C19	Red/Brown SANDSTONE As received	A	PD	YES		99.6	58.3	54.3	0.2	86.0	0.03	0.04	
RBH06	16.55	C22	Red/Brown SANDSTONE As received	D	PL	YES	40.5	99.5	99.5	96.5	0.4	99.5	0.04	0.06	
RBH06	16.55	C22	Red/Brown SANDSTONE As received	A	PD	YES		98.6	47.6	43.6	0.8	77.3	0.14	0.17	
RBH06	18.06	C25	Red/Brown SANDSTONE As received	D	PL	YES	50.0	95.8	95.8	91.8	0.2	95.8	0.03	0.03	
RBH06	18.06	C25	Red/Brown SANDSTONE As received	A	PD	YES		98.9	57.2	50.2	0.9	84.8	0.12	0.16	
RBH06	20.21	C29	Red/Brown SANDSTONE As received	D	PL	YES	55.7	99.6	99.6	96.6	0.7	99.6	0.07	0.10	
RBH06	20.21	C29	Red/Brown SANDSTONE As received	A	PD	YES		100.3	53.7	49.7	1.3	82.8	0.19	0.23	
RBH06	21	C30	Red/Brown SANDSTONE As received	D	PL	YES	83.4	100.8	100.8	98.8	1.0	100.8	0.10	0.14	
RBH06	21	C30	Red/Brown SANDSTONE As received	A	PD	YES		100.9	79.4	68.4	3.0	101.0	0.29	0.40	
RBH06	23.6	C37	Red/Brown SANDSTONE As received	D	PL	YES	83.7	100.1	100.1	97.1	0.6	100.1	0.06	0.08	
RBH06	23.6	C37	Red/Brown SANDSTONE As received	A	PD	YES		100.1	72.5	63.5	1.6	96.1	0.18	0.24	
RBH06	25	C39	Red/Brown SANDSTONE As received	D	PL	YES	64.3	100.9	100.9	97.9	0.9	100.9	0.09	0.13	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

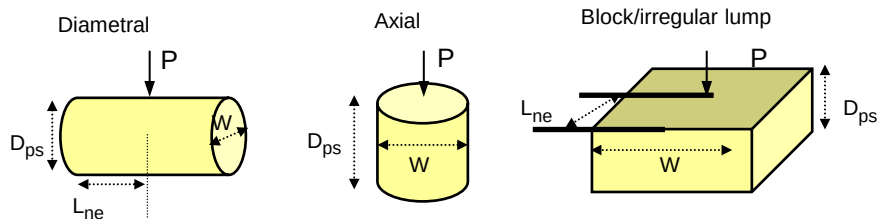
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Site: St John's Masterplan

Job Number: 42206A

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH06	25	C39	Red/Brown SANDSTONE As received	A	PD	YES		101.0	53.0	43.0	0.6	82.5	0.09	0.12	
RBH06	26.71	C41	Red/Brown SANDSTONE As received	D	PL	YES	63.7	100.4	100.4	99.4	0.7	100.4	0.07	0.09	
RBH06	26.71	C41	Red/Brown SANDSTONE As received	A	PD	YES		100.2	60.7	50.7	1.1	88.0	0.15	0.19	
RBH06	28.07	C43	Red/Brown SANDSTONE As received	D	PL	YES	78.3	100.5	100.5	97.5	0.4	100.5	0.04	0.05	
RBH06	28.07	C43	Red/Brown SANDSTONE As received	A	PD	YES		100.5	71.4	66.4	1.5	95.6	0.17	0.23	
RBH06	33.31	C47	Red/Brown SANDSTONE As received	D	PL	YES	89.7	99.9	99.9	96.9	0.9	99.9	0.09	0.13	
RBH06	33.31	C47	Red/Brown SANDSTONE As received	A	PD	YES		100.3	89.6	82.6	2.2	107.0	0.19	0.27	
RBH06	37	C49	Red/Brown SANDSTONE As received	D	PL	YES	87.3	99.8	99.8	96.8	0.9	99.8	0.09	0.13	
RBH06	37	C49	Red/Brown SANDSTONE As received	A	PD	YES		99.6	66.1	60.1	1.4	91.6	0.17	0.22	
RBH06	40.03	C51	Red/Brown SANDSTONE As received	D	PL	YES	74.1	100.4	100.4	98.4	1.7	100.4	0.17	0.23	
RBH06	40.03	C51	Red/Brown SANDSTONE As received	A	PD	YES		100.0	97.0	88.0	2.4	111.1	0.19	0.28	
RBH06	45	C54	Red/Brown SANDSTONE As received	D	PL	YES	87.5	100.7	100.7	98.7	1.4	100.7	0.13	0.18	
RBH06	45	C54	Red/Brown SANDSTONE As received	A	PD	YES		100.9	83.0	78.0	2.2	103.2	0.20	0.28	
RBH06	49.07	C56	Red/Brown SANDSTONE As received	D	PL	YES	74.9	100.8	100.8	98.8	0.5	100.8	0.04	0.06	
RBH06	49.07	C56	Red/Brown SANDSTONE As received	A	PD	YES		100.7	70.7	65.7	0.9	95.2	0.10	0.13	
RBH06	53.25	C58	Red/Brown SANDSTONE As received	D	PL	YES	57.5	100.8	100.8	95.8	1.0	100.8	0.10	0.14	
RBH06	53.25	C58	Red/Brown SANDSTONE As received	A	PD	YES		100.4	43.7	38.7	0.8	74.7	0.14	0.17	
RBH06	54.87	C59	Red/Brown SANDSTONE As received	D	PL	YES	65.3	100.5	100.5	97.5	0.7	100.5	0.07	0.10	
RBH06	54.87	C59	Red/Brown SANDSTONE As received	A	PD	YES		100.9	71.5	51.5	2.0	95.8	0.22	0.29	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

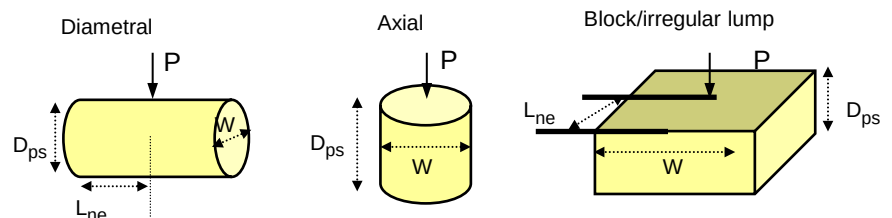
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, $F = (De/50)0.45$ for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)



Test Report - 42206A / 2

Site: St John's Masterplan

Job Number: 42206A

Originating Client: Curtins Consulting

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Date: 20/08/2018

F.A.O.

Test Report - 42206B / 1

Site: St John's Masterplan

Job Number: 42206B

Originating Client: Curtins Consulting

Originating Reference: 42206

Date Sampled: 02/08/2018

Date Scheduled: 13/08/2018

Date Testing Started: 17/08/2018

Date Testing Finished: 29/08/2018

Remarks:

Authorised By:



Tim Robinson
Quality Technician

Date: 30/08/2018

**Site:** St John's Masterplan**Job Number:** 42206B**Client:** Curtins Consulting**Page:** 2**ROCK INDEX TESTS - SUMMARY OF RESULTS**

Hole No.	Depth m	Sample	Rock description / Rock type	Natural Water Content ¹ %	Caliper ²		Buoyancy ³		Natural Bulk density Mg/m ³	Remarks
					Dry density Mg/m ³	Porosity %	Dry density Mg/m ³	Porosity %		
BH02	13.16	C23	Red SANDSTONE	12.0			2.05	24.3	2.30	
BH02	18.19	C28	Red SANDSTONE	11.2			2.05	23.5	2.27	
BH02	24.30	C38	Red SANDSTONE	9.5			2.04	23.1	2.23	
BH03	11.19	C19	Red SANDSTONE	10.5			1.98	24.1	2.19	
BH03	16.98	C23	Red SANDSTONE	10.6			2.00	23.3	2.21	
BH03	24.38	C30	Red SANDSTONE	11.2			1.91	27.3	2.12	
RBH05	10.28	C19	Red SANDSTONE	9.9			2.05	22.6	2.25	
RBH05	16.17	C28	Red SANDSTONE	13.6			1.88	29.4	2.13	
RBH05	22.00	C37	Red SANDSTONE	12.4			1.91	27.6	2.15	
RBH05	28.18	C43	Red SANDSTONE	7.9			2.06	21.7	2.23	
RBH05	32.19	C47	Red SANDSTONE	8.1			2.01	21.4	2.17	
RBH05	36.38	C50	Red SANDSTONE	10.9			2.13	18.9	2.37	
RBH05	39.50	C52	Red SANDSTONE	11.0			1.96	25.6	2.17	

Notes 1. ISRM p87 test 1, water content at 105 ± 3 oC, specimen as received at the laboratory 3. ISRM p88 test 3, Porosity/density determination using saturation and buoyancy
2. ISRM p87 test 2, Porosity/density determination using saturation and caliper 2/3. pore volume determined by water saturation

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.

Part 1.1 Suggested method for determination of the water content of a rock sample

Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007.

Part 1.1 Suggested method for determination of the water content of a rock sample

**Site:** St John's Masterplan**Job Number:** 42206B**Client:** Curtins Consulting**Page:** 3**UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS**

Hole No.	Depth m	Sample	Rock Type	Specimen Dimensions ²			Bulk Density ² Mg/m ³	Water Content 1 %	Uniaxial Compression ³				Remarks
				Dia. mm	Length mm	H/D			Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
BH02	13.16	C23	Red/Brown SANDSTONE	99.2	60.4	*0.6	2.19	11.6	as received	0.3623	AC	7.4	
BH02	17.13	C27	Red/Brown SANDSTONE	100.7	69.1	*0.7	2.30	8.4	as received	0.3629	AC	21.7	
BH02	18.19	C28	Red/Brown SANDSTONE	100.4	83.4	*0.8	2.21	11.2	as received	0.3537	AC	12.0	
BH02	21.00	C31	Red/Brown SANDSTONE	100.2	201.0	*2	2.22	11.7	as received	0.3552	S	8.4	
BH02	22.56	C37	Red/Brown SANDSTONE	100.3	218.1	*2.2	2.27	10.5	as received	0.3543	S	8.7	
BH02	24.30	C38	Red/Brown SANDSTONE	101.8	259.6	2.6	2.26	9.5	as received	0.3442	AC	7.3	
BH03	10.15	C18	Red/Brown SANDSTONE	100.0	94.3	*0.9	2.24	10.1	as received	0.3566	AC	14.7	
BH03	12.28	C20	Red/Brown SANDSTONE	100.7	154.2	*1.5	2.22	10.8	as received	0.3516	AC	14.7	
BH03	13.16	C20	Red/Brown SANDSTONE	100.7	199.4	*2	2.27	11.1	as received	0.3519	S	17.2	
BH03	18.29	C24	Red/Brown SANDSTONE	100.3	149.6	*1.5	2.32	9.4	as received	0.3544	AC	23.9	
BH03	19.06	C25	Red/Brown SANDSTONE	100.6	192.3	*1.9	2.31	10.3	as received	0.3523	AC	14.5	
BH03	20.89	C27	Red/Brown SANDSTONE	100.5	263.4	2.6	2.31	10.2	as received	0.3530	S	12.6	
BH03	23.01	C29	Red/Brown SANDSTONE	101.3	274.7	2.7	2.18	11.9	as received	0.3475	S	11.9	
BH03	24.38	C30	Red/Brown SANDSTONE	100.6	250.3	2.5	2.22	11.2	as received	0.3522	AC	14.6	
RBH05	12.57	C23	Red/Brown SANDSTONE	101.0	76.0	*0.8	2.24	9.9	as received	0.3492	AC	7.1	
RBH05	14.09	C24	Red/Brown SANDSTONE	100.4	118.1	*1.2	2.16	12.4	as received	0.3540	AC	6.5	
RBH05	16.17	C28	Red/Brown SANDSTONE	101.7	221.4	*2.2	2.14	12.3	as received	0.3447	S	10.6	
RBH05	19.10	C32	Red/Brown SANDSTONE	100.8	228.0	*2.3	2.36	7.7	as received	0.3510	S	13.1	
RBH05	22.00	C37	Red/Brown SANDSTONE	101.3	128.7	*1.3	2.19	37.7	as received	0.3476	AC	5.8	
RBH05	23.05	C38	Red/Brown SANDSTONE	99.7	131.2	*1.3	2.29	9.9	as received	0.3584	AC	10.6	
RBH05	24.61	C40	Red/Brown SANDSTONE	100.2	219.8	*2.2	2.34	8.5	as received	0.3554	AC	8.5	
RBH05	26.00	C41	Red/Brown SANDSTONE	100.7	244.9	*2.4	2.28	10.1	as received	0.3518	S	11.0	
RBH05	28.18	C43	Red/Brown SANDSTONE	100.8	168.4	*1.7	2.23	9.3	as received	0.3505	AC	7.0	

Notes 1 ISRM p87 test 1, water content at 105 ± 3 °C, specimen as tested for UCS

*Denotes length diameter ratio outside ISRM specification

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

Mode of failure :

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

S - Single shear MS - multiple shear

above notes apply unless annotated otherwise in the remarks

AC - Axial cleavage F - Fragmented

Method of Preparation: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007**Method of Test:** International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

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Method of Test: International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007

Site: St John's Masterplan

Job Number: 42206B

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
BH02	8.43	C20	Red/Brown SANDSTONE As received	D	PL	YES	39.5	100.1	100.1	98.1	0.2	100.1	0.02	0.03	
BH02	8.43	C20	Red/Brown SANDSTONE As received	A	PD	YES		101.3	69.5	59.5	0.6	94.6	0.07	0.09	
BH02	10.1	C21	Red/Brown SANDSTONE As received	A	PD	YES		100.3	57.2	49.2	0.3	85.5	0.05	0.06	
BH02	11.91	C22	Red/Brown SANDSTONE As received	D	PL	YES	34.7	98.9	98.9	95.9	0.1	98.9	0.01	0.01	
BH02	11.91	C22	Red/Brown SANDSTONE As received	A	PD	YES		98.3	81.3	75.3	0.4	100.9	0.04	0.05	
BH02	14.13	C34	Red/Brown SANDSTONE As received	D	PL	YES	39.9	99.9	99.9	96.9	1.0	99.9	0.10	0.13	
BH02	14.13	C34	Red/Brown SANDSTONE As received	A	PD	YES		98.7	98.8	86.8	1.3	111.4	0.10	0.15	
BH02	15.07	C25	Red/Brown SANDSTONE As received	D	PL	YES		100.7	100.7	94.7	1.6	100.7	0.16	0.21	
BH02	16.22	C26	Red/Brown SANDSTONE As received	D	PL	YES	84.3	99.7	99.7	90.7	0.3	99.7	0.03	0.04	
BH02	16.22	C26	Red/Brown SANDSTONE As received	A	PD	YES		99.6	86.9	69.9	0.3	105.0	0.03	0.04	
BH02	19	C29	Red/Brown SANDSTONE As received	D	PL	YES	41.5	100.9	100.9	98.9	0.3	100.9	0.03	0.04	
BH02	19	C29	Red/Brown SANDSTONE As received	A	PD	YES		100.5	46.5	44.5	0.5	77.2	0.08	0.09	
BH02	20	C30	Red/Brown SANDSTONE As received	D	PL	YES	40.1	99.2	99.2	97.2	0.3	99.2	0.03	0.04	
BH02	20	C30	Red/Brown SANDSTONE As received	A	PD	YES		99.2	49.2	44.2	0.5	78.8	0.07	0.09	
BH02	22	C36	Red/Brown SANDSTONE As received	D	PL	YES	46.1	98.9	98.9	94.9	0.4	98.9	0.04	0.05	
BH02	22	C36	Red/Brown SANDSTONE As received	A	PD	YES		99.1	53.2	47.2	0.3	81.9	0.04	0.05	
BH02	23.83	C39	Red/Brown SANDSTONE As received	D	PL	YES	37.7	99.9	99.9	95.9	0.3	99.9	0.03	0.05	
BH02	23.83	C39	Red/Brown SANDSTONE As received	A	PD	YES		100.0	38.8	33.8	0.6	70.3	0.13	0.15	
BH03	8.52	C16	Red/Brown SANDSTONE As received	D	PL	YES	70.2	100.8	100.8	97.8	0.7	100.8	0.07	0.10	
BH03	8.52	C16	Red/Brown SANDSTONE As received	A	PD	YES		98.8	58.9	64.9	1.2	86.1	0.16	0.20	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction

PL - Parallel to planes of weakness

PD - Perpendicular to planes of weakness

U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

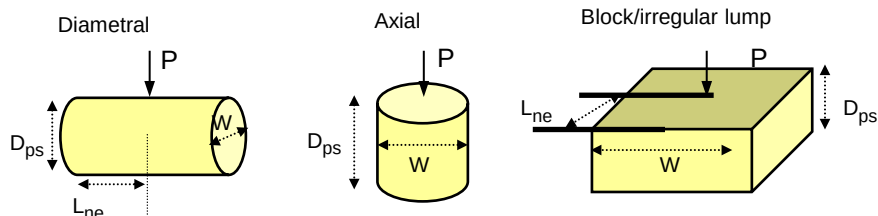
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Site: St John's Masterplan

Job Number: 42206B

Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
BH03	9.56	C17	Red/Brown SANDSTONE As received	D	PL	YES	75.8	99.9	99.9	96.9	0.4	99.9	0.04	0.05	
BH03	9.56	C17	Red/Brown SANDSTONE As received	A	PD	YES		98.7	70.9	62.9	1.0	94.4	0.12	0.15	
BH03	11.19	C19	Red/Brown SANDSTONE As received	D	PL	YES	47.0	100.1	100.1	98.1	0.4	100.1	0.04	0.05	
BH03	11.19	C19	Red/Brown SANDSTONE As received	A	PD	YES		100.5	55.2	51.2	0.9	84.1	0.13	0.17	
BH03	14.03	C21	Red/Brown SANDSTONE As received	A	PD	YES		97.0	68.2	62.2	1.9	91.7	0.23	0.30	
BH03	16.08	C22	Red/Brown SANDSTONE As received	D	PL	YES	65.6	100.0	100.0	96.0	1.4	100.0	0.14	0.19	
BH03	16.08	C22	Red/Brown SANDSTONE As received	A	PD	YES		99.5	62.3	55.3	1.4	88.8	0.18	0.23	
BH03	16.98	C23	Red/Brown SANDSTONE As received	D	PL	YES	60.4	100.8	100.8	98.8	1.0	100.8	0.09	0.13	
BH03	16.98	C23	Red/Brown SANDSTONE As received	A	PD	YES		100.2	58.6	53.6	2.1	86.5	0.28	0.35	
BH03	19.9	C26	Red/Brown SANDSTONE As received	D	PL	YES	65.5	100.4	100.4	100.4	1.2	100.4	0.12	0.16	
BH03	19.9	C26	Red/Brown SANDSTONE As received	A	PD	YES		100.7	70.1	70.1	2.4	94.7	0.26	0.35	
BH03	21.83	C28	Red/Brown SANDSTONE As received	D	PL	YES	98.7	101.1	101.1	101.1	1.2	101.1	0.12	0.16	
BH03	21.83	C28	Red/Brown SANDSTONE As received	A	PD	YES		101.0	107.8	107.8	3.0	117.7	0.22	0.32	
BH03	24.83	C30	Red/Brown SANDSTONE As received	D	PL	YES	49.2	100.3	100.3	97.3	0.8	100.3	0.08	0.10	
BH03	24.83	C30	Red/Brown SANDSTONE As received	A	PD	YES		100.4	61.2	55.2	3.5	88.5	0.45	0.58	
RBH05	8.54	C16	Red/Brown SANDSTONE As received	D	PL	YES	44.7	100.4	100.4	96.4	0.6	100.4	0.06	0.09	
RBH05	8.54	C16	Red/Brown SANDSTONE As received	A	PD	YES		100.7	79.8	61.8	0.8	101.2	0.08	0.11	
RBH05	9.51	C17	Red/Brown SANDSTONE As received	A	PD	YES		99.8	58.7	53.7	0.9	86.3	0.12	0.15	
RBH05	10.28	C19	Red/Brown SANDSTONE As received	D	PL	YES	37.9	100.8	100.8	96.8	0.9	100.8	0.08	0.11	
RBH05	10.28	C19	Red/Brown SANDSTONE As received	A	PD	YES		100.8	35.8	20.8	1.0	67.8	0.22	0.25	

Test Type

D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction

PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

Dimensions

Dps - Distance between platens (platen separation)

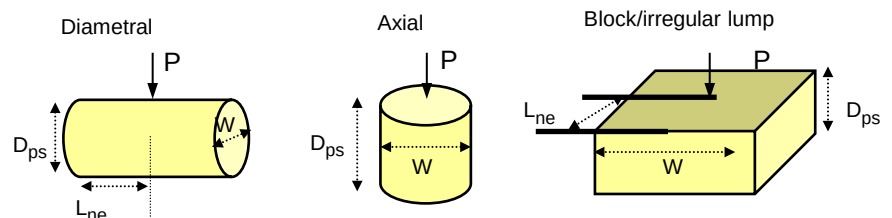
Dps' - at failure (see ISRM note 6)

Lne - Length from platens to nearest free end

W - Width of shortest dimension perpendicular to load, P

Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM


Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Site: St John's Masterplan

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Client: Curtins Consulting

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Point Load Strength Index Tests Summary of Results

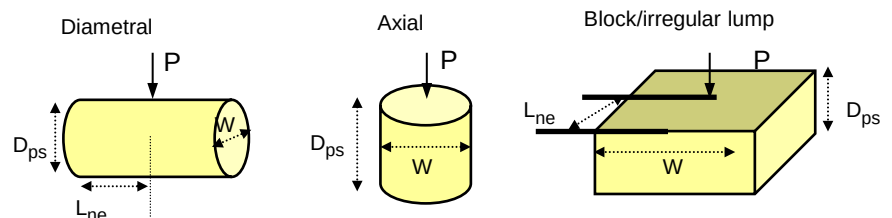
Borehole No.	Depth m	Sample	Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P kN	Equivalent diameter, De mm	Point Load Strength Index		Remarks (including water content if measured)
				Type (D, A, I, B)	Direction (PL, PD or U)		Lne mm	W mm	Dps mm	Dps' mm			Is MPa	Is (50) MPa	
RBH05	11.37	C20	Red/Brown SANDSTONE As received	A	PD	YES		95.4	124.6	117.6	1.1	123.0	0.08	0.11	
RBH05	12.05	C21	Red/Brown SANDSTONE As received	D	PL	YES	61.8	96.6	96.6	93.6	0.1	96.6	0.01	0.02	
RBH05	14.93	C26	Red/Brown SANDSTONE As received	D	PL	YES	34.3	101.7	101.7	97.7	0.5	101.7	0.05	0.06	
RBH05	14.93	C26	Red/Brown SANDSTONE As received	A	PD	YES		102.0	52.2	50.2	0.4	82.3	0.06	0.08	
RBH05	17.77	C30	Red/Brown SANDSTONE As received	D	PL	YES	94.1	101.1	101.1	97.1	0.7	101.1	0.07	0.09	
RBH05	17.77	C30	Red/Brown SANDSTONE As received	A	PD	YES		101.0	116.0	110.0	1.3	122.2	0.09	0.13	
RBH05	20.06	C34	Red/Brown SANDSTONE As received	D	PL	YES	44.0	100.3	100.3	98.3	0.3	100.3	0.03	0.05	
RBH05	20.06	C34	Red/Brown SANDSTONE As received	A	PD	YES		101.4	62.8	58.8	1.7	90.0	0.20	0.27	
RBH05	21	C35	Red/Brown SANDSTONE As received	A	PD	YES		100.2	63.3	60.3	0.5	89.8	0.06	0.08	
RBH05	23.9	C39	Red/Brown SANDSTONE As received	D	PL	YES	43.0	100.4	100.4	96.4	0.6	100.4	0.06	0.08	
RBH05	23.9	C39	Red/Brown SANDSTONE As received	A	PD	YES		100.5	55.1	49.1	0.7	83.9	0.10	0.12	
RBH05	26.88	C42	Red/Brown SANDSTONE As received	D	PL	YES	57.2	100.3	100.3	98.3	0.9	100.3	0.09	0.12	
RBH05	26.88	C42	Red/Brown SANDSTONE As received	A	PD	YES		100.6	55.5	50.5	1.2	84.3	0.17	0.22	
RBH05	28.9	C44	Red/Brown SANDSTONE As received	A	PD	YES		101.0	67.7	22.7	0.3	93.3	0.04	0.05	
RBH05	29.88	C45	Red/Brown SANDSTONE As received	D	PL	YES	47.9	100.4	100.4	97.4	1.0	100.4	0.10	0.13	
RBH05	29.88	C45	Red/Brown SANDSTONE As received	A	PD	YES		100.6	51.8	46.8	1.1	81.5	0.16	0.20	
RBH05	32.19	C47	Red/Brown SANDSTONE As received	D	PL	YES	42.3	99.7	99.7	95.7	0.3	99.7	0.03	0.04	
RBH05	32.19	C47	Red/Brown SANDSTONE As received	A	PD	YES		99.9	57.4	52.4	1.1	85.4	0.15	0.20	
RBH05	34	C48	Red/Brown SANDSTONE As received	D	PL	YES	46.4	101.2	101.2	99.2	1.4	101.2	0.14	0.19	
RBH05	34	C48	Red/Brown SANDSTONE As received	A	PD	YES		100.8	52.9	49.9	2.0	82.4	0.30	0.37	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block

Direction
PL - Parallel to planes of weakness
PD - Perpendicular to planes of weakness
U - Unknown or random

Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)0.45 for all tests.

Detailed legend for test and dimensions, based on ISRM



Method of Preparation: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

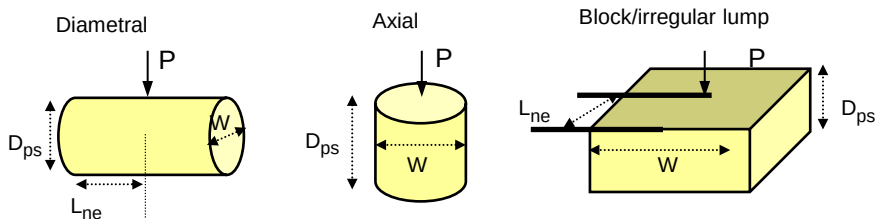
Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)

Job Number: 42206B

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[illegible]

Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P
Size factor, F = (De/50)^{0.45} for all tests.



Method of Test: ISRM 2007 Suggested method for point load strength index (pages 125 - 132)



Test Report - 42206B / 1

Site: St John's Masterplan

Job Number: 42206B

Originating Client: Curtins Consulting

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Date: 30/08/2018

INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Sample details				Indirect Tensile Strength test (LF0879C (1000kN) compression frame used)											
Borehole Ref.	Sample Ref.	Depth (m)	Description	D. Tested	Sample Diameter (mm)	Sample Width (mm)	Degree of Saturation (%)	Water Content (%)	Specific Gravity* (Mg/m³)	Stress Rate (N/s)	Test Duration (min:sec)	Failure Sketch	Failure Load (kN)	Tensile Strength (MPa)	Remarks
BH02	33	13.30-13.42	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	99.60	50.00	81.9	12.0	2.72 (a)	200	00:14		2.90	0.37	
BH03	34	16.34-16.48	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.20	48.90	82.6	11.4	2.72 (a)	200	00:21		4.10	0.532	
BH04B	3	9.82-9.90	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	98.50	50.20	80.3	11.6	2.72 (a)	200	00:25		5.00	0.643	
RBH02		13.85-14.00	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.90	50.90	92.6	10.5	2.72 (a)	200	00:19		3.80	0.471	
RBH03		15.11-15.30	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	101.30	50.50	95.4	6.9	2.72 (a)	200	00:36		7.30	0.908	
RBH04		16.92-17.34	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	101.40	50.90	90.5	7.1	2.72 (a)	200	00:45		8.90	1.1	
RBH05	18	10.00-10.10	Very weak reddish brown fine grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	99.90	49.80	75.4	9.2	2.72 (a)	200	00:16		3.30	0.422	
RBH05	29	17.38-17.59	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.50	49.00	81.9	12.0	2.72 (a)	200	00:23		4.60	0.594	
RBH06	17	13.82	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.10	50.30	92.4	11.6	2.72 (a)	200	00:20		3.90	0.493	
RBH06	33	21.80-21.89	Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered	13/08/18	100.30	51.20	91.1	12.3	2.72 (a)	200	00:35		6.90	0.855	

* Specific Gravity: (a) assumed or (m) measured/supplied by client.

* Load rate: 200 N/s

Checked and Approved by  C Clergeaud (Snr. Geologist) Date: 15/08/2018	Project Number: GEO / 27859 Project Name: ST JOHNS MASTERPLAN 42206	
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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: BH02
 Sample Ref.: 33
 Depth (m): 13.30-13.42

Description:
 Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

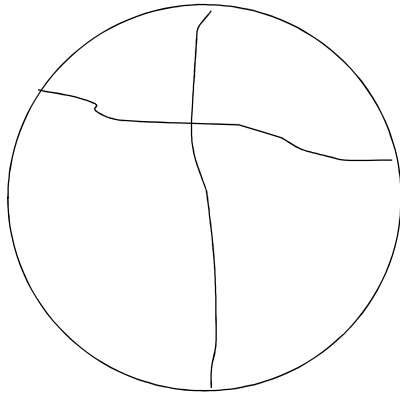
Diameter	99.60 mm
Thickness	50.00 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.18 Mg/m ³
Dry Density	1.95 Mg/m ³
Water Content	12.0 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	81.9 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:14 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Wedge fracture



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**2.90 kN****Tensile Strength****0.37 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: BH03
 Sample Ref.: 34
 Depth (m): 16.34-16.48

Description:
 Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

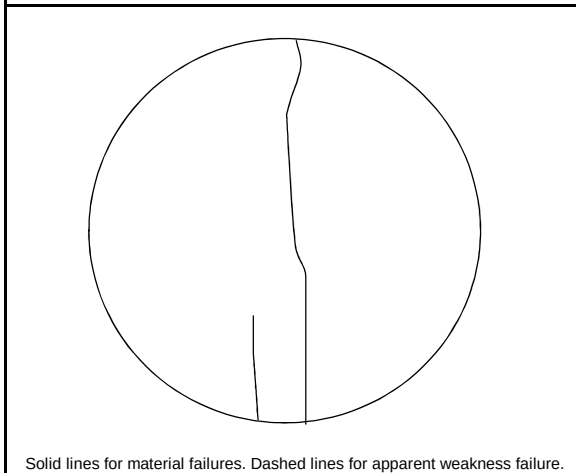
Diameter	100.20 mm
Thickness	48.90 mm
Thickness / Diameter Ratio	0.49
Bulk Density	2.20 Mg/m ³
Dry Density	1.98 Mg/m ³
Water Content	11.4 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	82.6 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:21 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**4.10 kN****Tensile Strength****0.532 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: BH04B
 Sample Ref.: 3
 Depth (m): 9.82-9.90

Description:

Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

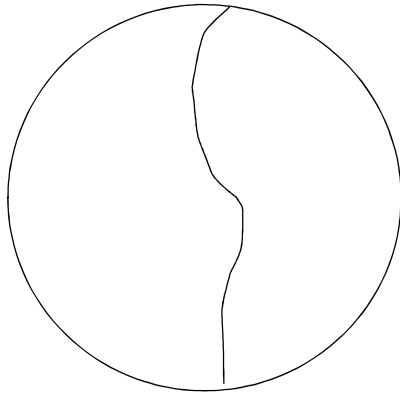
Diameter	98.50 mm
Thickness	50.20 mm
Thickness / Diameter Ratio	0.51
Bulk Density	2.18 Mg/m ³
Dry Density	1.95 Mg/m ³
Water Content	11.6 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	80.3 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:25 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**5.00 kN****Tensile Strength****0.643 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH02
 Sample Ref.:
 Depth (m): 13.85-14.00

Description:
 Very weak reddish brown fine grained SANDSTONE. High reaction to HCl.
 Moderately weathered

Sample Details

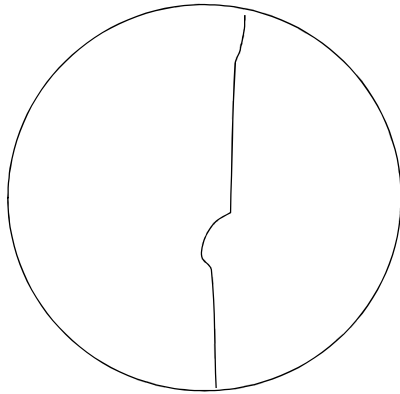
Diameter	100.90 mm
Thickness	50.90 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.30 Mg/m ³
Dry Density	2.08 Mg/m ³
Water Content	10.5 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	92.6 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:19 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**3.80 kN****Tensile Strength****0.471 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

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C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH03
 Sample Ref.:
 Depth (m): 15.11-15.30

Description:
 Very weak reddish brown fine grained SANDSTONE. High reaction to HCl.
 Moderately weathered

Sample Details

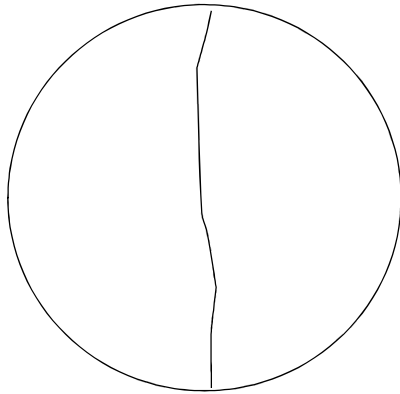
Diameter	101.30 mm
Thickness	50.50 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.43 Mg/m ³
Dry Density	2.27 Mg/m ³
Water Content	6.9 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	95.4 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:36 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**7.30 kN****Tensile Strength****0.908 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

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Project Name:

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH04
 Sample Ref.:
 Depth (m): 16.92-17.34

Description:
 Very weak reddish brown fine grained SANDSTONE. High reaction to HCl.
 Moderately weathered

Sample Details

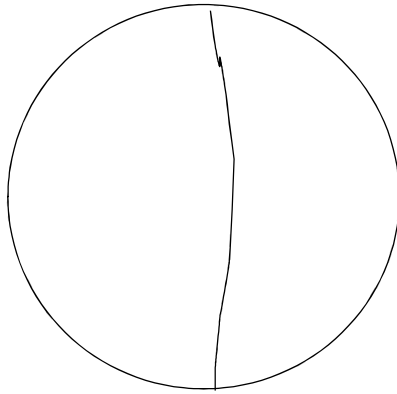
Diameter	101.40 mm
Thickness	50.90 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.40 Mg/m ³
Dry Density	2.24 Mg/m ³
Water Content	7.1 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	90.5 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:45 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**8.90 kN****Tensile Strength****1.1 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH05
 Sample Ref.: 18
 Depth (m): 10.00-10.10

Description:
 Very weak reddish brown fine grained SANDSTONE. High reaction to HCl.
 Moderately weathered

Sample Details

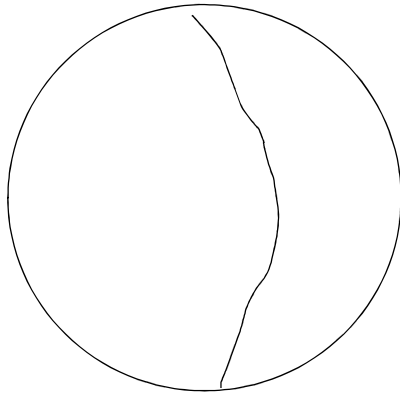
Diameter	99.90 mm
Thickness	49.80 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.23 Mg/m ³
Dry Density	2.04 Mg/m ³
Water Content	9.2 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	75.4 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:16 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Curved Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**3.30 kN****Tensile Strength****0.422 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH05
 Sample Ref.: 29
 Depth (m): 17.38-17.59

Description:
 Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

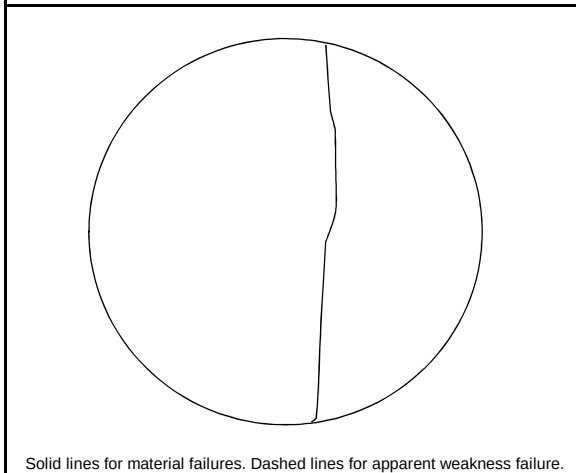
Diameter	100.50 mm
Thickness	49.00 mm
Thickness / Diameter Ratio	0.49
Bulk Density	2.18 Mg/m ³
Dry Density	1.94 Mg/m ³
Water Content	12.0 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	81.9 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:23 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**4.60 kN****Tensile Strength****0.594 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH06
 Sample Ref.: 17
 Depth (m): 13.82

Description:
 Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

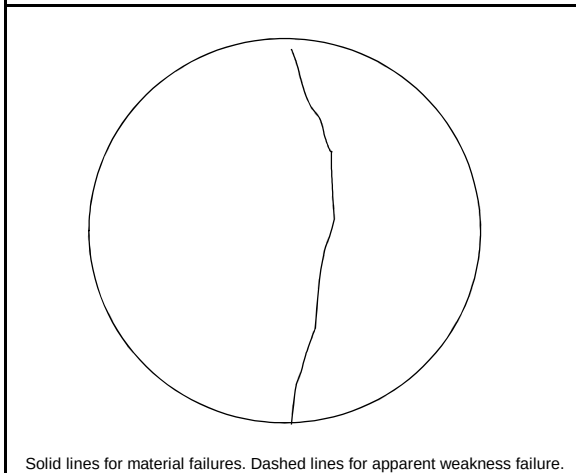
Diameter	100.10 mm
Thickness	50.30 mm
Thickness / Diameter Ratio	0.50
Bulk Density	2.26 Mg/m ³
Dry Density	2.03 Mg/m ³
Water Content	11.6 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	92.4 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:20 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Curved Split



Date tested: 13/08/2018

Failure Load**3.90 kN****Tensile Strength****0.493 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
42206

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INDIRECT TENSILE STRENGTH BY THE BRAZIL TEST

Borehole Ref.: RBH06
 Sample Ref.: 33
 Depth (m): 21.80-21.89

Description:
 Very weak reddish brown fine to medium grained SANDSTONE. High reaction to HCl. Moderately weathered

Sample Details

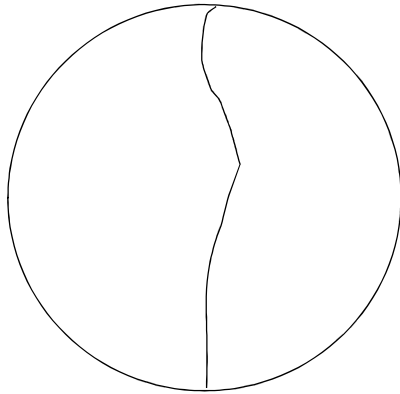
Diameter	100.30 mm
Thickness	51.20 mm
Thickness / Diameter Ratio	0.51
Bulk Density	2.23 Mg/m ³
Dry Density	1.99 Mg/m ³
Water Content	12.3 %
Specific Gravity (Assumed)	2.72 Mg/m ³
Degree of Saturation	91.1 %

Test Results

Stress Rate	0.20 kN/s
Test Duration	00:35 min:sec
Angle of loading with respect to anisotropy	90 °

Failure Sketch

Mode of failure: Axial Split



Solid lines for material failures. Dashed lines for apparent weakness failure.
 LF0879C (1000kN) compression frame and steel loading jaws used

Date tested: 13/08/2018

Failure Load**6.90 kN****Tensile Strength****0.855 MPa**

Note: The dimensional requirements of Flatness (<0.25 mm), Perpendicularity (to within 0.25°) and irregularities across thickness (< 0.025 mm) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 15/08/2018

Project Number:

GEO / 27859

Project Name:

ST JOSEPH'S MASTERPLAN
42206

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: BH02
 Sample Ref.: 32
 Depth (m): 11.70-11.81

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

Diameter	53.60 mm
Height	108.30 mm
Bulk Density	2.02 Mg/m ³
Dry Density	1.96 Mg/m ³
Water Content	3.2 %

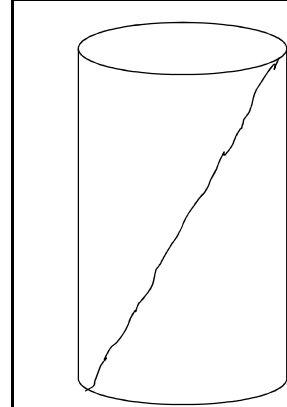
Degree of Saturation: 22.7 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	19.7 MPa
2.00 MPa	26.5 MPa
3.00 MPa	31.3 MPa
4.00 MPa	36.7 MPa
6.00 MPa	45.1 MPa
8.00 MPa	54 MPa

LF0879C (1000kN) compression frame used

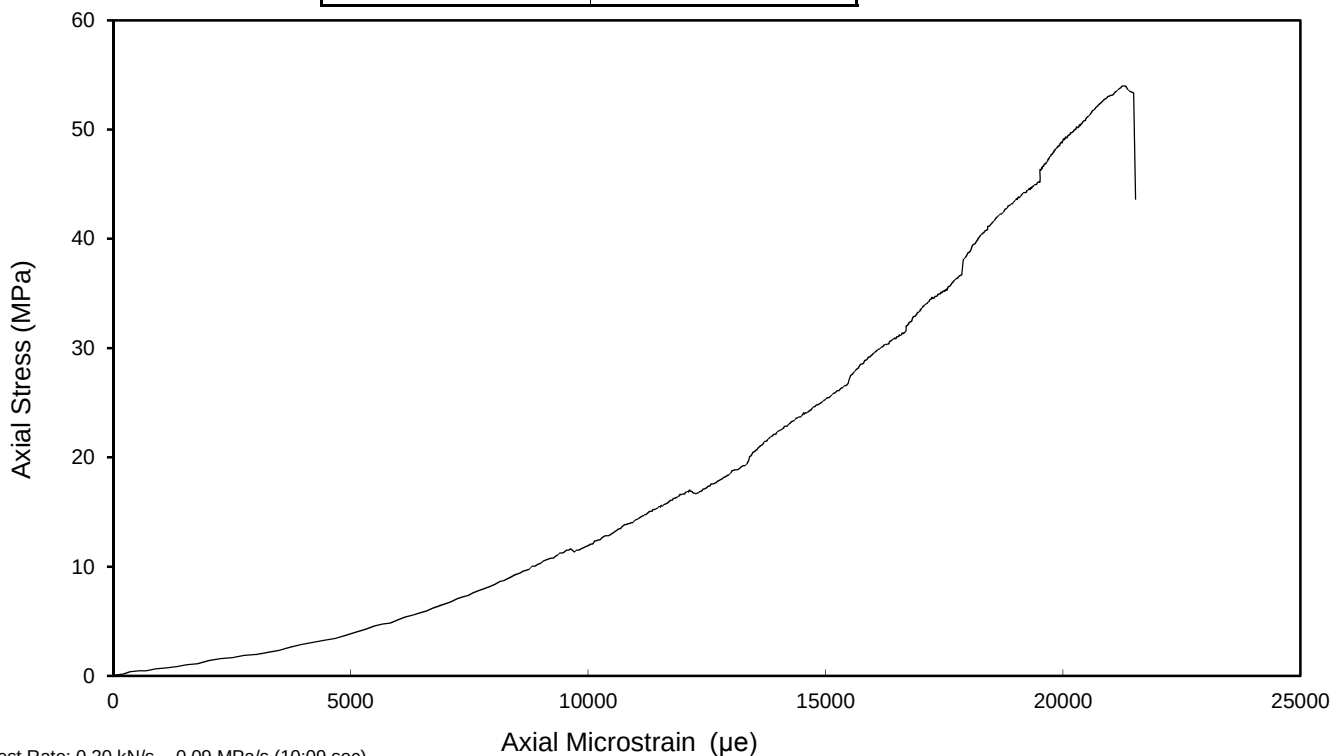
Failure Sketch



Date tested: 22/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Test Rate: 0.20 kN/s - 0.09 MPa/s (10:09 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 22-08-18

Borehole Ref.	BH02	BH02	BH02	BH02	BH02	BH02
Sample Ref.	32	32	32	32	32	32
Depth (m)	11.70-11.81	11.70-11.81	11.70-11.81	11.70-11.81	11.70-11.81	11.70-11.81
Diameter (mm)	53.60	53.60	53.60	53.60	53.60	53.60
Height (mm)	108.30	108.30	108.30	108.30	108.30	108.30
Bulk Density (Mg/m ³)	2.02	2.02	2.02	2.02	2.02	2.02
Dry Density (Mg/m ³)	1.96	1.96	1.96	1.96	1.96	1.96
Water Content (%)	3.2	3.2	3.2	3.2	3.2	3.2

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	19.70	26.50	31.30	36.70	45.10	54.00

Gradient of Slope, m

4.788

Internal Friction Angle, ϕ

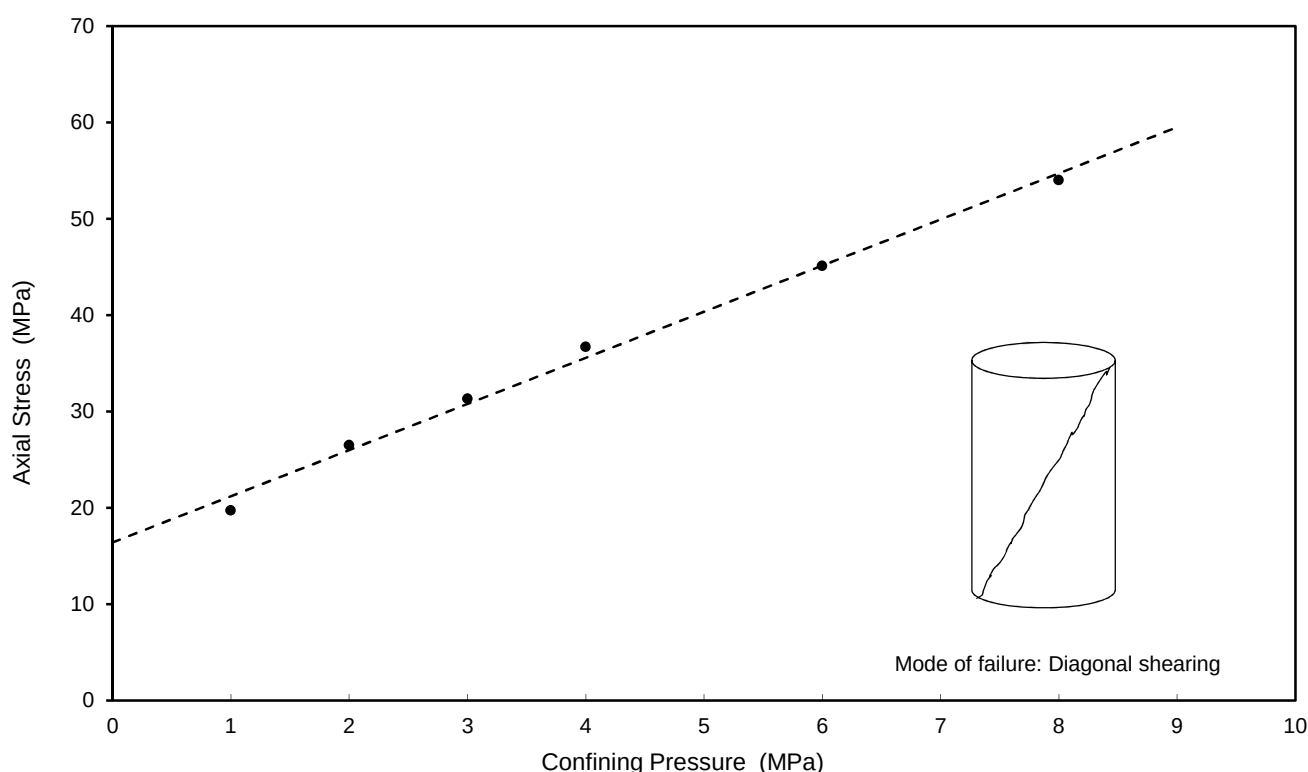
40.9 °

Ordinate of Slope, b

16 MPa

Apparent Cohesion, c

4 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: BH03
 Sample Ref.: 32
 Depth (m): 12.50-12.69

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE. Slightly to moderately weathered

Diameter	53.60 mm
Height	108.40 mm
Bulk Density	2.19 Mg/m ³
Dry Density	2.14 Mg/m ³
Water Content	2.7 %

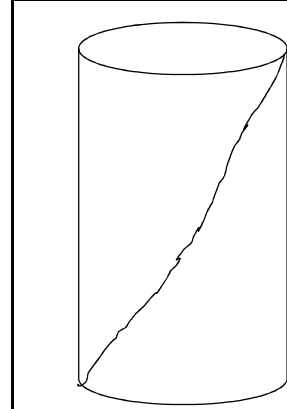
Degree of Saturation: 26.3 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	30.1 MPa
2.00 MPa	33.7 MPa
3.00 MPa	37.1 MPa
4.00 MPa	41.2 MPa
6.00 MPa	49.9 MPa
8.00 MPa	58.1 MPa

LF0879C (1000kN) compression frame used

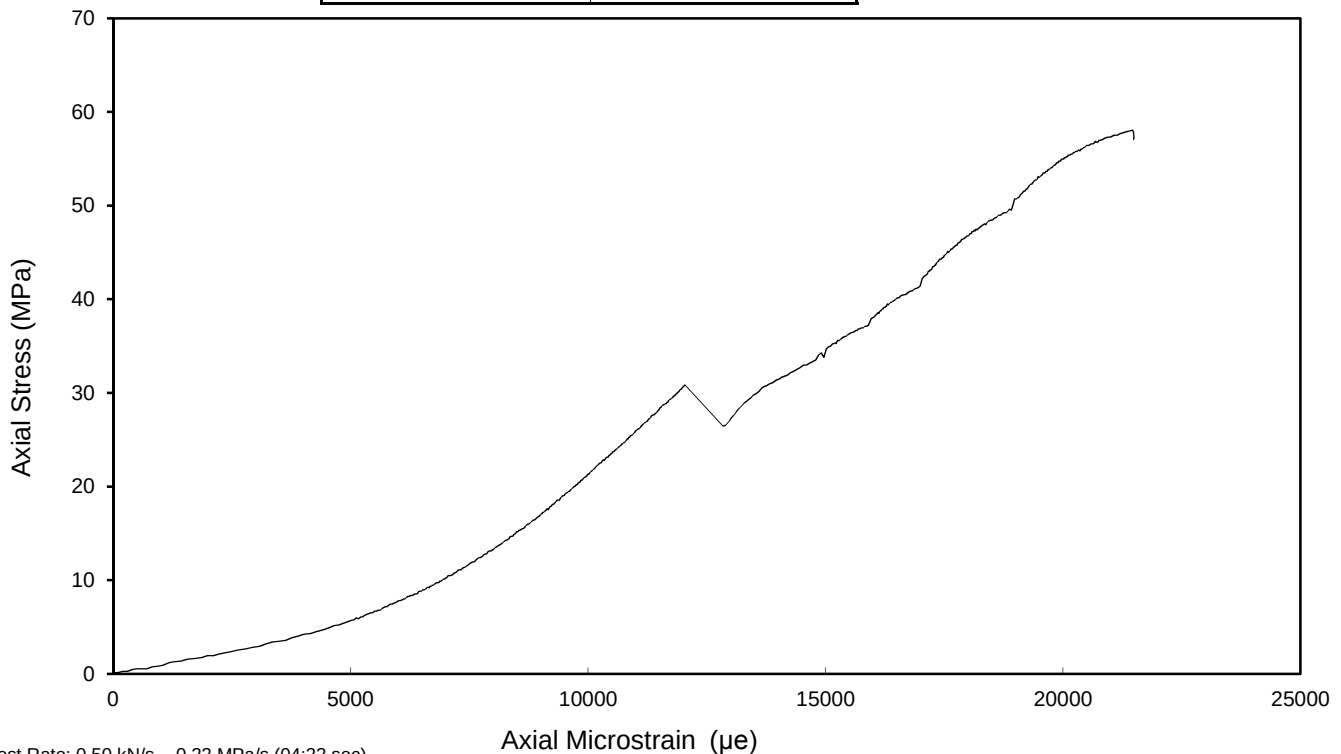
Failure Sketch



Date tested: 21/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Test Rate: 0.50 kN/s - 0.22 MPa/s (04:22 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Slightly to moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 21-08-18

Borehole Ref.	BH03	BH03	BH03	BH03	BH03	BH03
Sample Ref.	32	32	32	32	32	32
Depth (m)	12.50-12.69	12.50-12.69	12.50-12.69	12.50-12.69	12.50-12.69	12.50-12.69
Diameter (mm)	53.60	53.60	53.60	53.60	53.60	53.60
Height (mm)	108.40	108.40	108.40	108.40	108.40	108.40
Bulk Density (Mg/m ³)	2.19	2.19	2.19	2.19	2.19	2.19
Dry Density (Mg/m ³)	2.14	2.14	2.14	2.14	2.14	2.14
Water Content (%)	2.7	2.7	2.7	2.7	2.7	2.7

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	30.10	33.70	37.10	41.20	49.90	58.10

Gradient of Slope, m

4.041

Ordinate of Slope, b

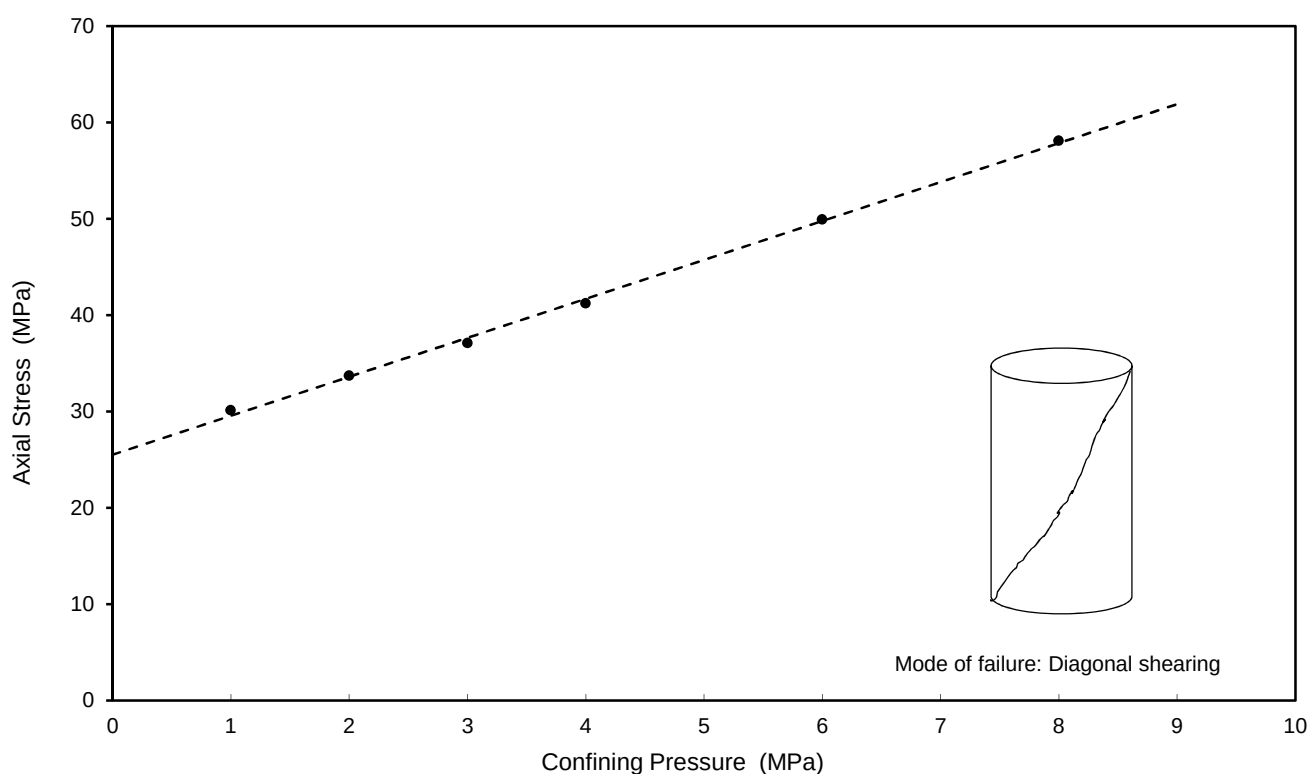
26 MPa

Internal Friction Angle, ϕ

37.1 °

Apparent Cohesion, c

6 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: BH04B
 Sample Ref.: 7
 Depth (m): 12.03-12.17

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

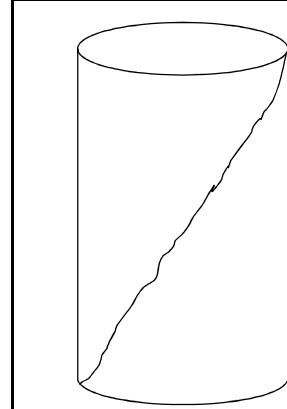
Diameter	54.00 mm
Height	108.20 mm
Bulk Density	2.01 Mg/m ³
Dry Density	1.96 Mg/m ³
Water Content	2.5 %

Degree of Saturation: 17.6 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	27.4 MPa
2.00 MPa	32 MPa
3.00 MPa	38.3 MPa
4.00 MPa	41.6 MPa
6.00 MPa	49.5 MPa
8.00 MPa	53.4 MPa

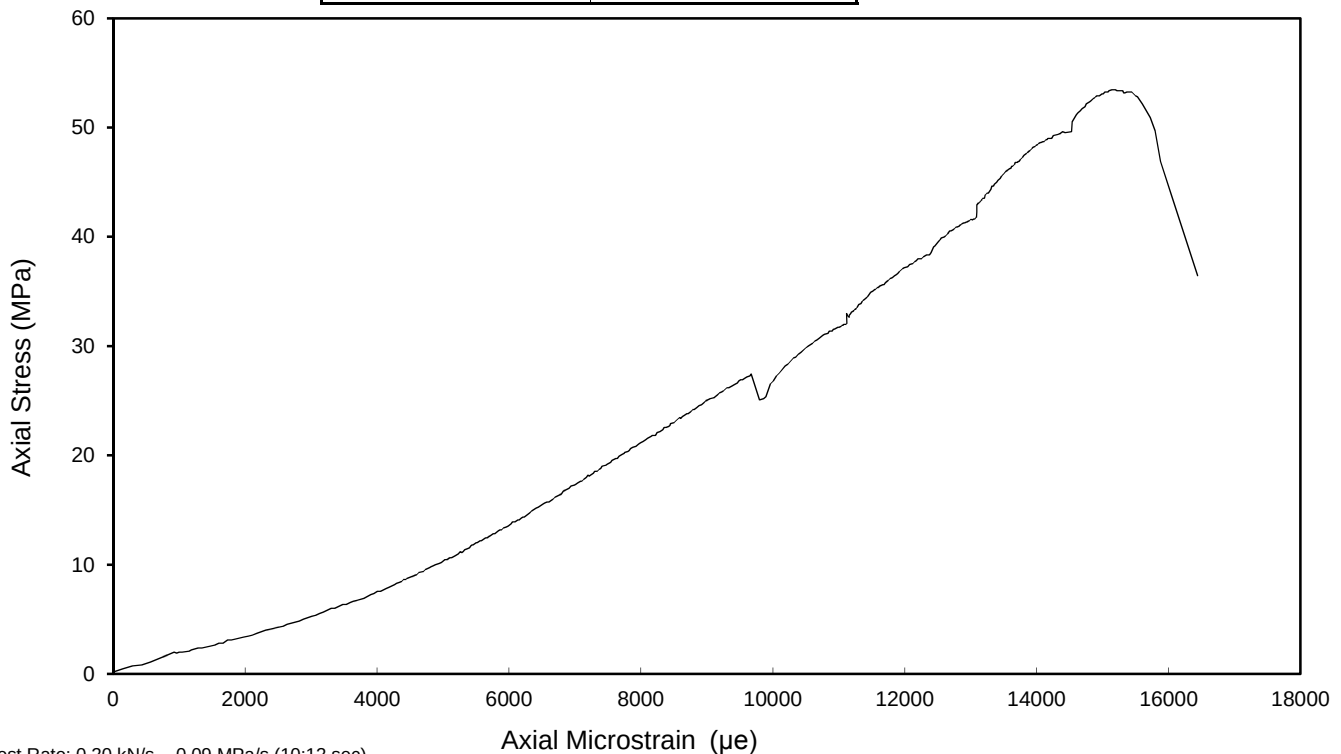
LF0879C (1000kN) compression frame used

Failure Sketch

Date tested: 22/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 22-08-18

Borehole Ref.	BH04B	BH04B	BH04B	BH04B	BH04B	BH04B
Sample Ref.	7	7	7	7	7	7
Depth (m)	12.03-12.17	12.03-12.17	12.03-12.17	12.03-12.17	12.03-12.17	12.03-12.17
Diameter (mm)	54.00	54.00	54.00	54.00	54.00	54.00
Height (mm)	108.20	108.20	108.20	108.20	108.20	108.20
Bulk Density (Mg/m ³)	2.01	2.01	2.01	2.01	2.01	2.01
Dry Density (Mg/m ³)	1.96	1.96	1.96	1.96	1.96	1.96
Water Content (%)	2.5	2.5	2.5	2.5	2.5	2.5

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	27.40	32.00	38.30	41.60	49.50	53.40

Gradient of Slope, m

3.768

Internal Friction Angle, ϕ

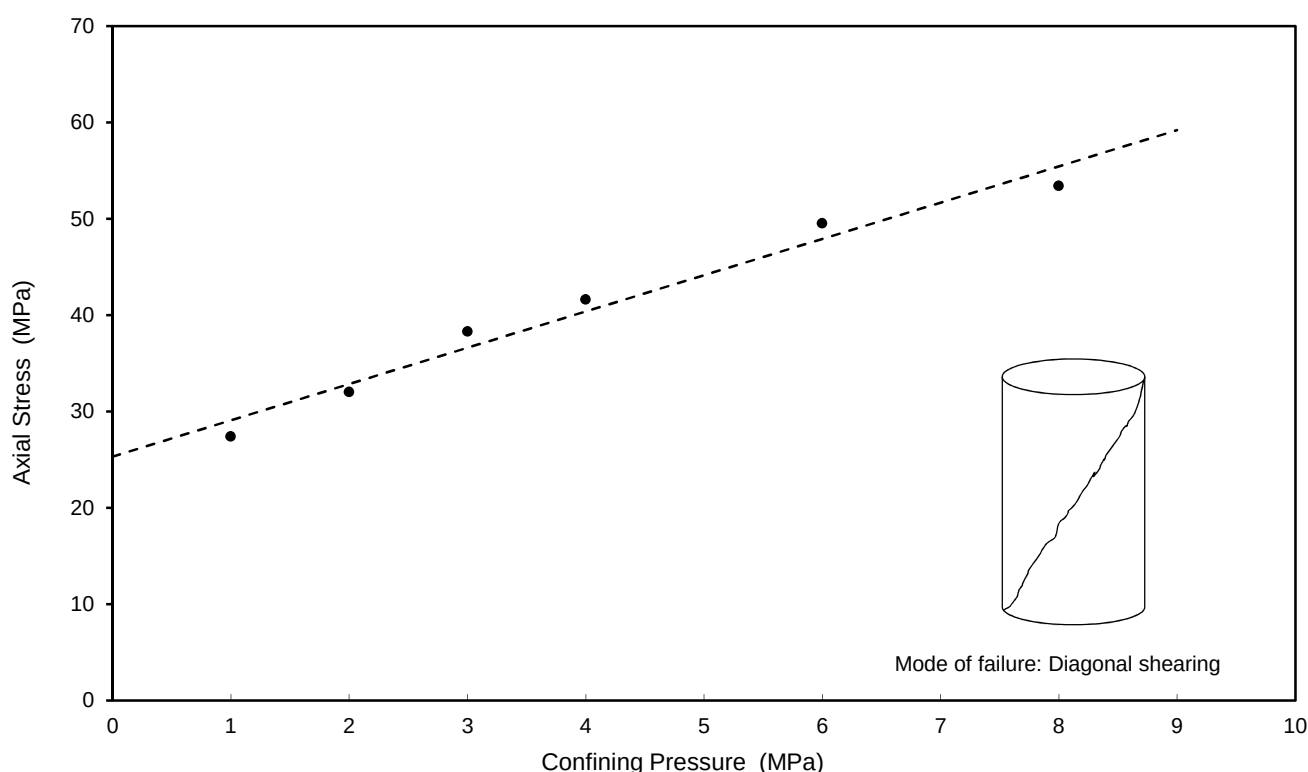
35.5 °

Ordinate of Slope, b

25 MPa

Apparent Cohesion, c

7 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: RBH03
 Sample Ref.:
 Depth (m): 11.00-11.20

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

Diameter	53.90 mm
Height	108.10 mm
Bulk Density	1.99 Mg/m ³
Dry Density	1.87 Mg/m ³
Water Content	6.5 %

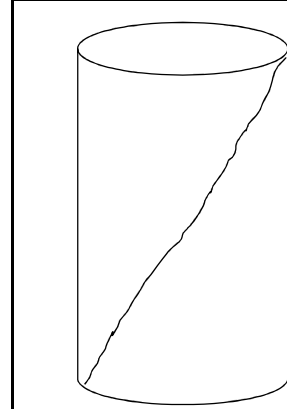
Degree of Saturation: 39.2 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	15.1 MPa
2.00 MPa	19.7 MPa
3.00 MPa	25.4 MPa
4.00 MPa	29.1 MPa
6.00 MPa	34.8 MPa
8.00 MPa	43.7 MPa

LF0879C (1000kN) compression frame used

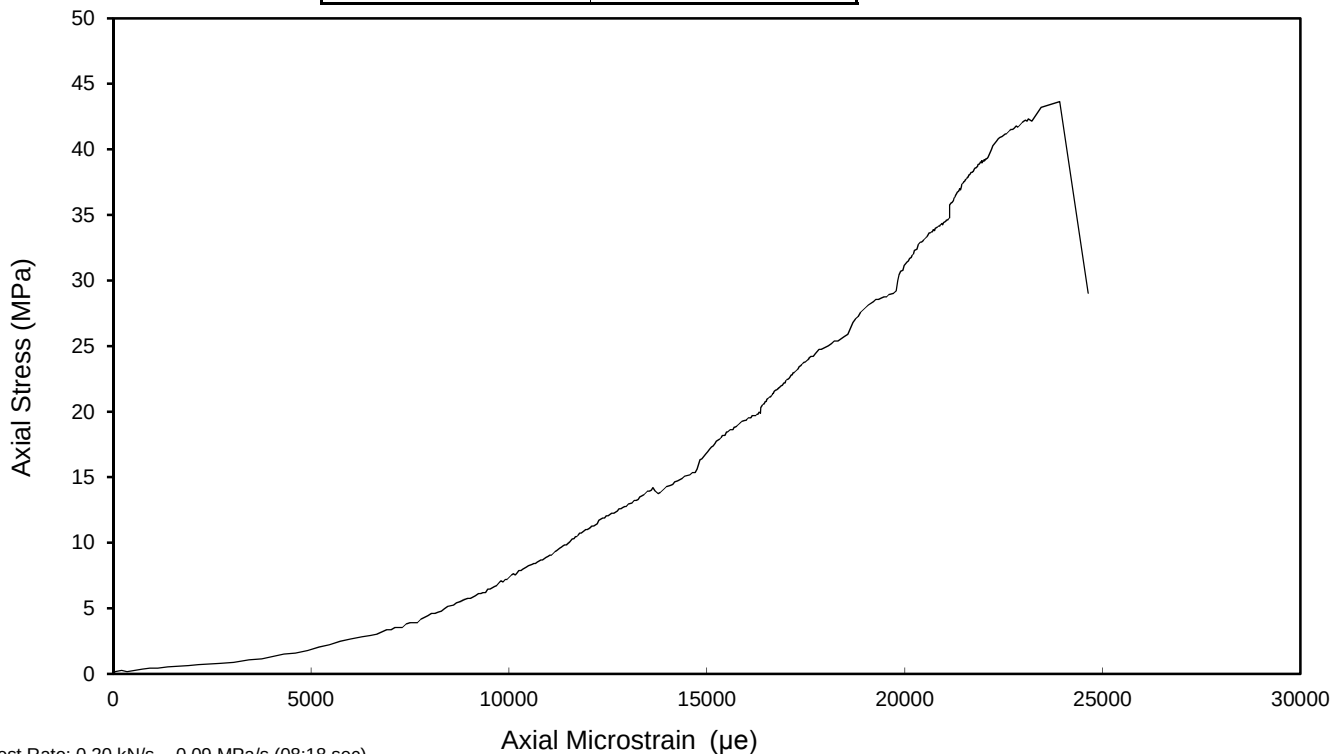
Failure Sketch



Date tested: 21/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Test Rate: 0.20 kN/s - 0.09 MPa/s (08:18 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 21-08-18

Borehole Ref.	RBH03	RBH03	RBH03	RBH03	RBH03	RBH03
Sample Ref.						
Depth (m)	11.00-11.20	11.00-11.20	11.00-11.20	11.00-11.20	11.00-11.20	11.00-11.20
Diameter (mm)	53.90	53.90	53.90	53.90	53.90	53.90
Height (mm)	108.10	108.10	108.10	108.10	108.10	108.10
Bulk Density (Mg/m ³)	1.99	1.99	1.99	1.99	1.99	1.99
Dry Density (Mg/m ³)	1.87	1.87	1.87	1.87	1.87	1.87
Water Content (%)	6.5	6.5	6.5	6.5	6.5	6.5

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	15.10	19.70	25.40	29.10	34.80	43.70

Gradient of Slope, m

3.950

Internal Friction Angle, ϕ

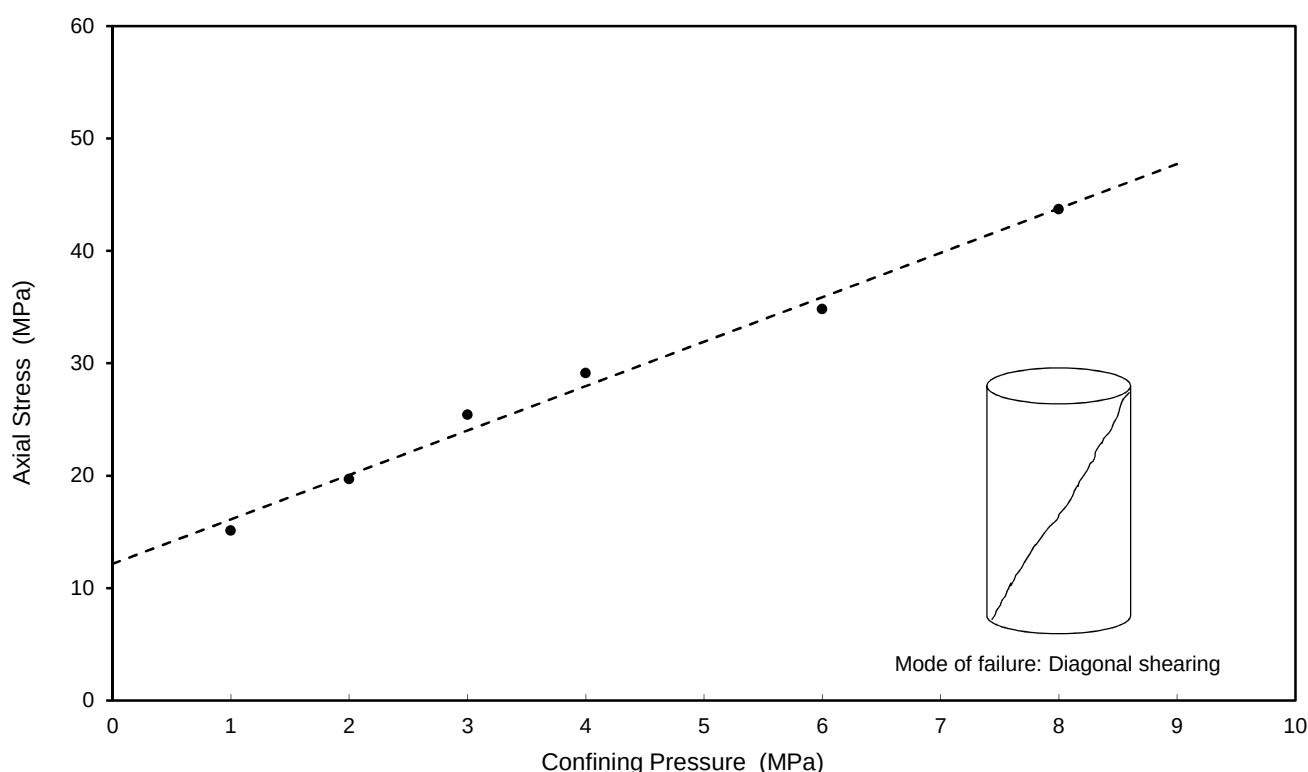
36.6 °

Ordinate of Slope, b

12 MPa

Apparent Cohesion, c

3 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: RBH04
 Sample Ref.:
 Depth (m): 16.29-16.50

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

Diameter	53.80 mm
Height	107.88 mm
Bulk Density	2.05 Mg/m ³
Dry Density	1.90 Mg/m ³
Water Content	7.9 %

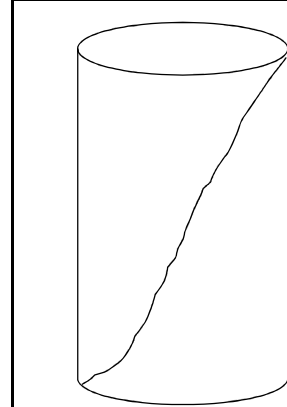
Degree of Saturation: 49.8 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	20.4 MPa
2.00 MPa	21.4 MPa
3.00 MPa	22.7 MPa
4.00 MPa	24.8 MPa
6.00 MPa	29.1 MPa
8.00 MPa	34.8 MPa

LF0879C (1000kN) compression frame used

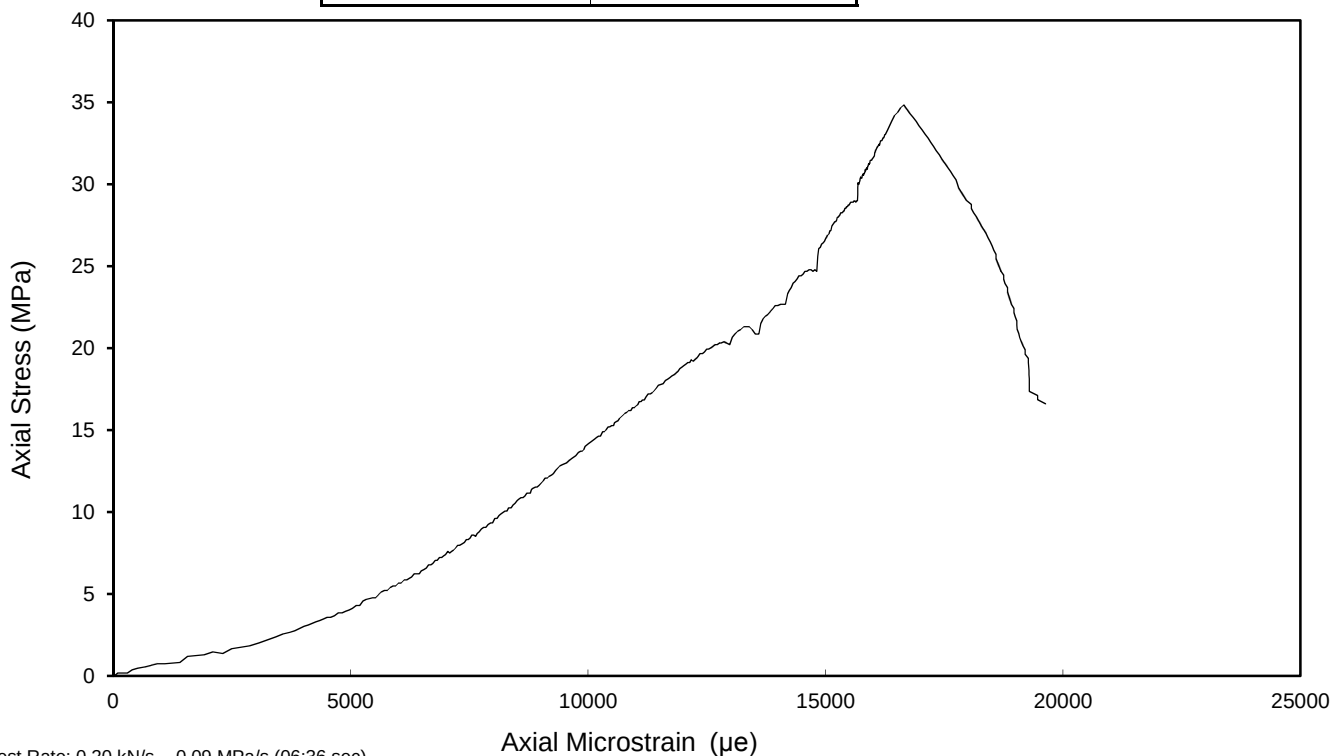
Failure Sketch



Date tested: 21/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Test Rate: 0.20 kN/s - 0.09 MPa/s (06:36 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 21-08-18

Borehole Ref.	RBH04	RBH04	RBH04	RBH04	RBH04	RBH04
Sample Ref.						
Depth (m)	16.29-16.50	16.29-16.50	16.29-16.50	16.29-16.50	16.29-16.50	16.29-16.50
Diameter (mm)	53.80	53.80	53.80	53.80	53.80	53.80
Height (mm)	107.88	107.88	107.88	107.88	107.88	107.88
Bulk Density (Mg/m ³)	2.05	2.05	2.05	2.05	2.05	2.05
Dry Density (Mg/m ³)	1.90	1.90	1.90	1.90	1.90	1.90
Water Content (%)	7.9	7.9	7.9	7.9	7.9	7.9

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	20.40	21.40	22.70	24.80	29.10	34.80

Gradient of Slope, m

2.079

Internal Friction Angle, ϕ

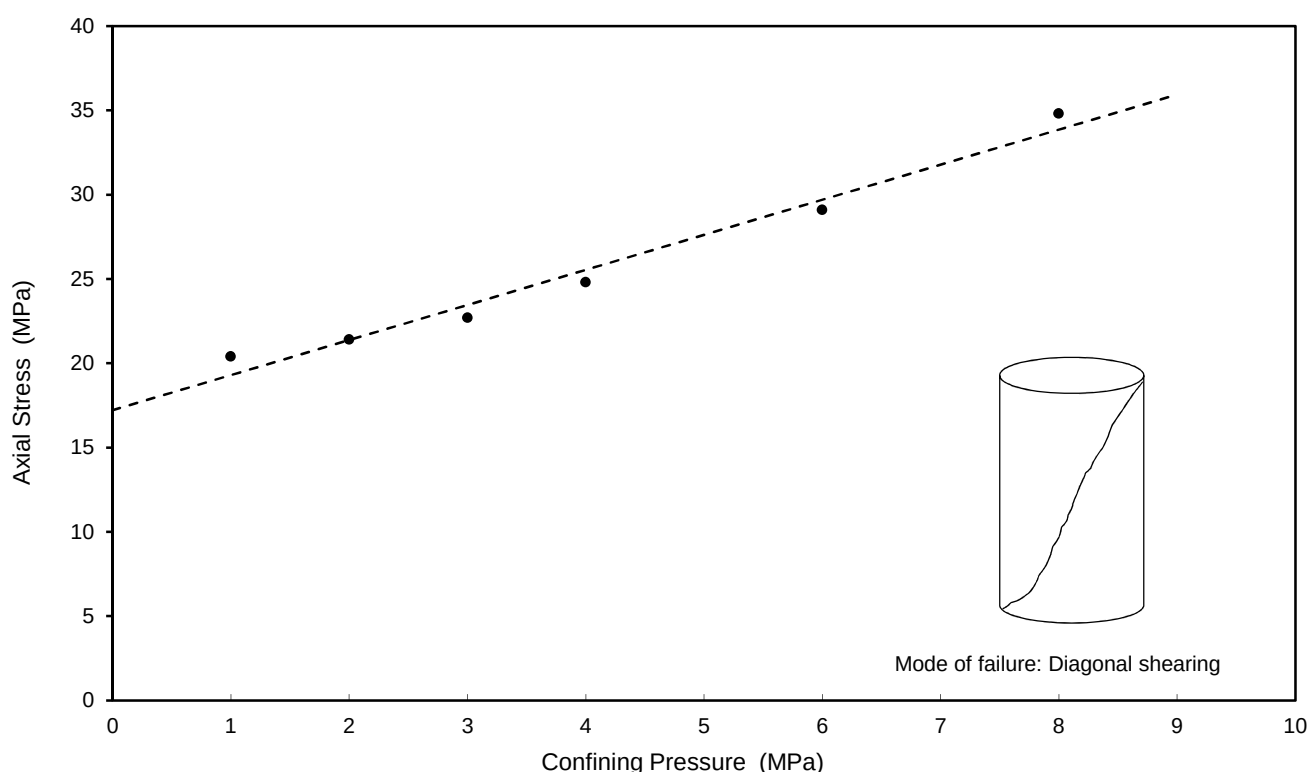
20.5 °

Ordinate of Slope, b

17 MPa

Apparent Cohesion, c

6 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: RBH05
 Sample Ref.: 27
 Depth (m): 15.91-16.00

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

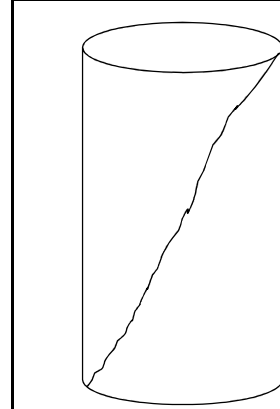
Diameter	37.80 mm
Height	79.70 mm
Bulk Density	2.01 Mg/m ³
Dry Density	1.92 Mg/m ³
Water Content	4.9 %

Degree of Saturation: 31.6 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	20.1 MPa
2.00 MPa	28.5 MPa
3.00 MPa	34.3 MPa
4.00 MPa	36.9 MPa
6.00 MPa	44.6 MPa
8.00 MPa	46.7 MPa

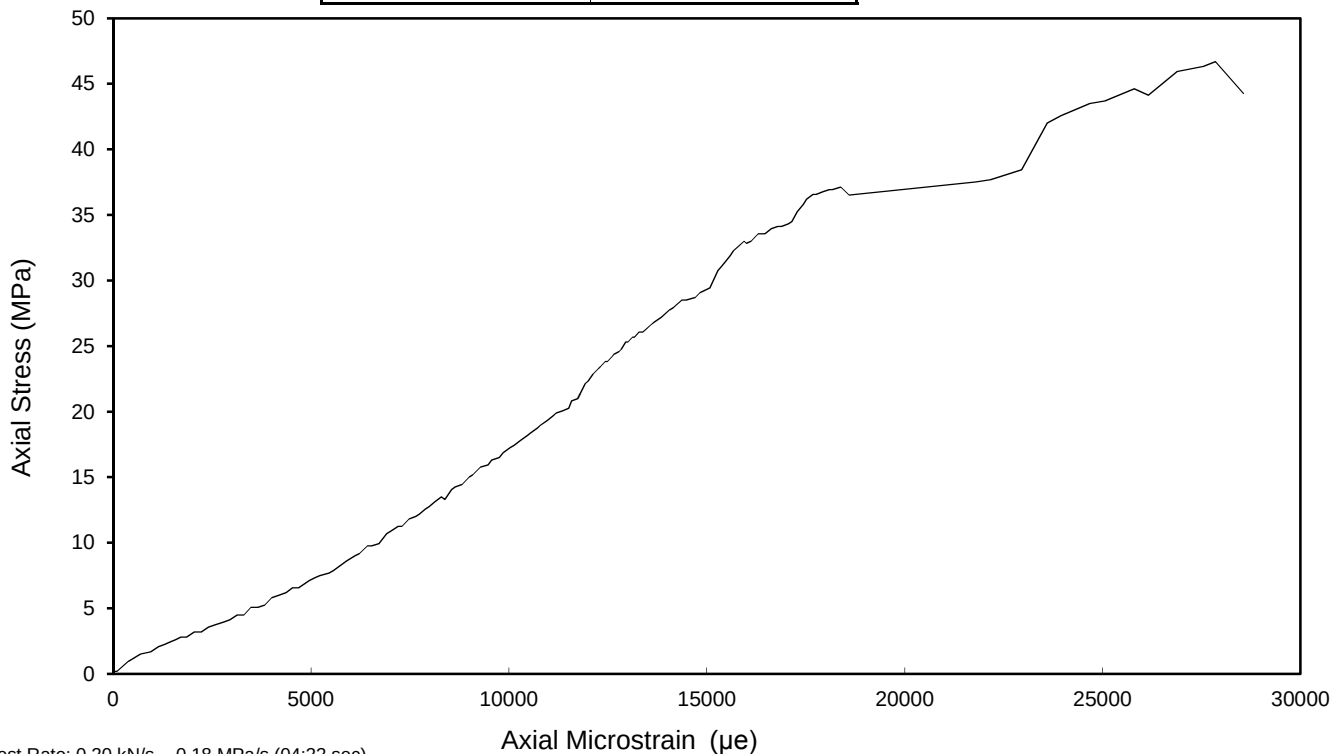
LF0879C (1000kN) compression frame used

Failure Sketch

Date tested: 21/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Test Rate: 0.20 kN/s - 0.18 MPa/s (04:22 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 21-08-18

Borehole Ref.	RBH05	RBH05	RBH05	RBH05	RBH05	RBH05
Sample Ref.	27	27	27	27	27	27
Depth (m)	15.91-16.00	15.91-16.00	15.91-16.00	15.91-16.00	15.91-16.00	15.91-16.00
Diameter (mm)	37.80	37.80	37.80	37.80	37.80	37.80
Height (mm)	79.70	79.70	79.70	79.70	79.70	79.70
Bulk Density (Mg/m ³)	2.01	2.01	2.01	2.01	2.01	2.01
Dry Density (Mg/m ³)	1.92	1.92	1.92	1.92	1.92	1.92
Water Content (%)	4.9	4.9	4.9	4.9	4.9	4.9

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	20.10	28.50	34.30	36.90	44.60	46.70

Gradient of Slope, m

3.659

Ordinate of Slope, b

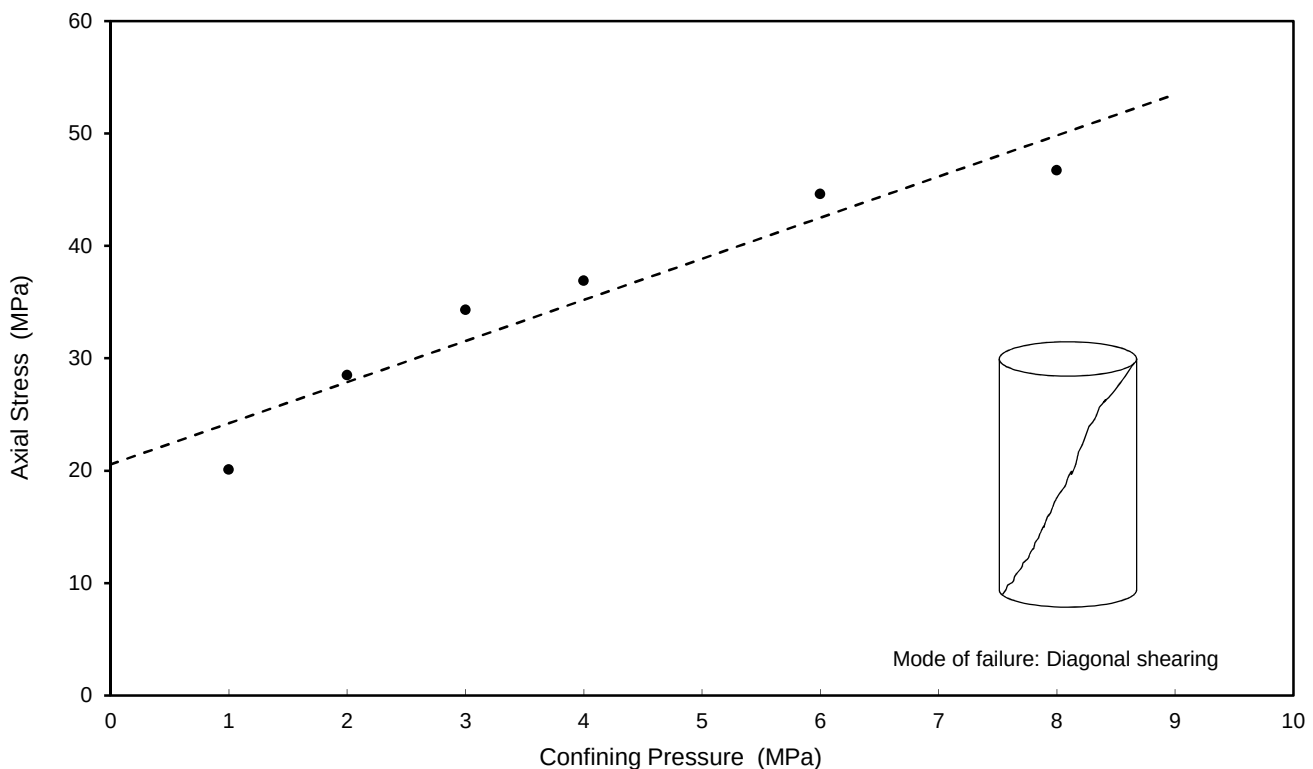
21 MPa

Internal Friction Angle, ϕ

34.8 °

Apparent Cohesion, c

5 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: RBH05
 Sample Ref.: 36
 Depth (m): 21.80-21.86

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

Diameter	37.80 mm
Height	76.10 mm
Bulk Density	1.96 Mg/m ³
Dry Density	1.87 Mg/m ³
Water Content	4.8 %

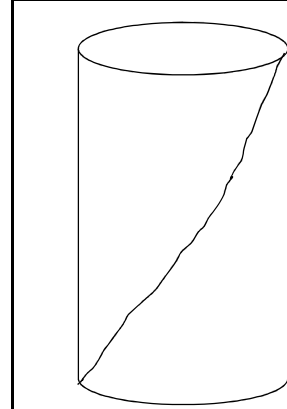
Degree of Saturation: 29.1 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	13.2 MPa
2.00 MPa	18.6 MPa
3.00 MPa	22 MPa
4.00 MPa	25.6 MPa
6.00 MPa	31.6 MPa
8.00 MPa	37.7 MPa

LF0879C (1000kN) compression frame used

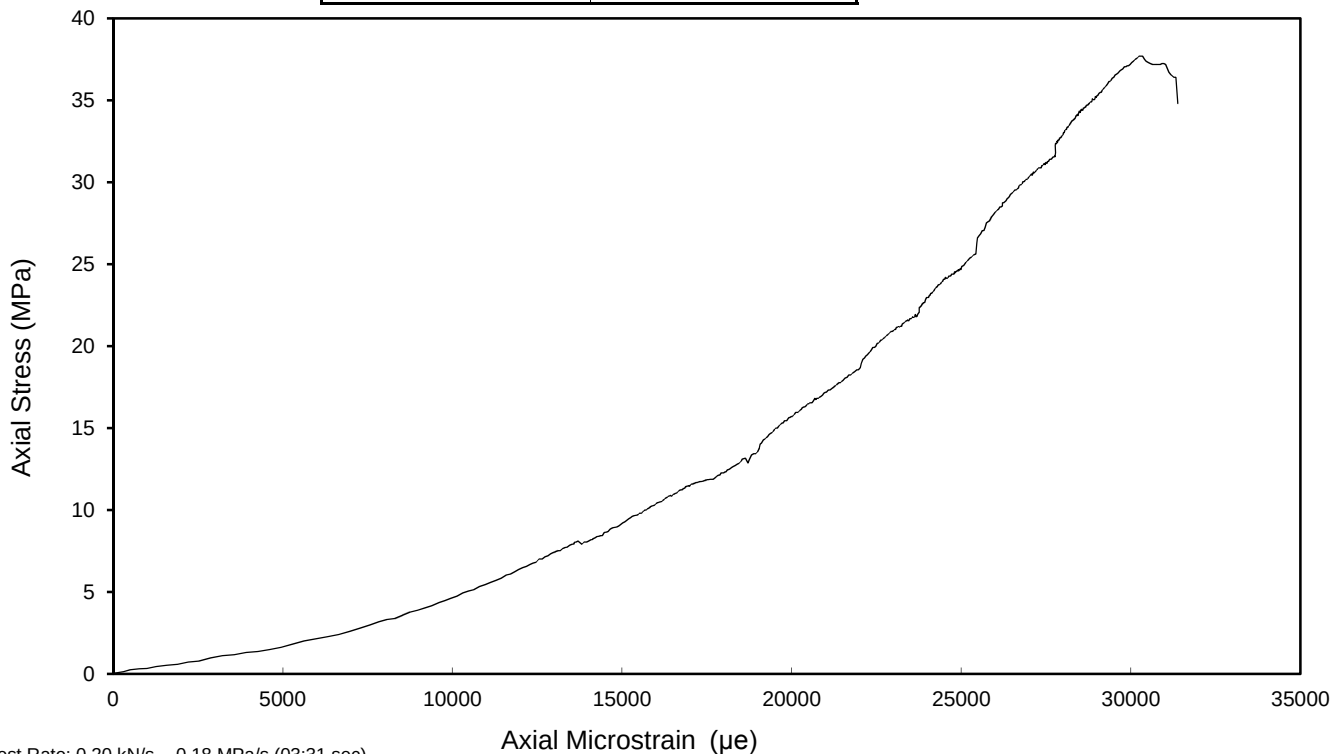
Failure Sketch



Date tested: 21/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type **C**



Test Rate: 0.20 kN/s - 0.18 MPa/s (03:31 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 21-08-18

Borehole Ref.	RBH05	RBH05	RBH05	RBH05	RBH05	RBH05
Sample Ref.	36	36	36	36	36	36
Depth (m)	21.80-21.86	21.80-21.86	21.80-21.86	21.80-21.86	21.80-21.86	21.80-21.86
Diameter (mm)	37.80	37.80	37.80	37.80	37.80	37.80
Height (mm)	76.10	76.10	76.10	76.10	76.10	76.10
Bulk Density (Mg/m ³)	1.96	1.96	1.96	1.96	1.96	1.96
Dry Density (Mg/m ³)	1.87	1.87	1.87	1.87	1.87	1.87
Water Content (%)	4.8	4.8	4.8	4.8	4.8	4.8

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	13.20	18.60	22.00	25.60	31.60	37.70

Gradient of Slope, m

3.388

Internal Friction Angle, ϕ

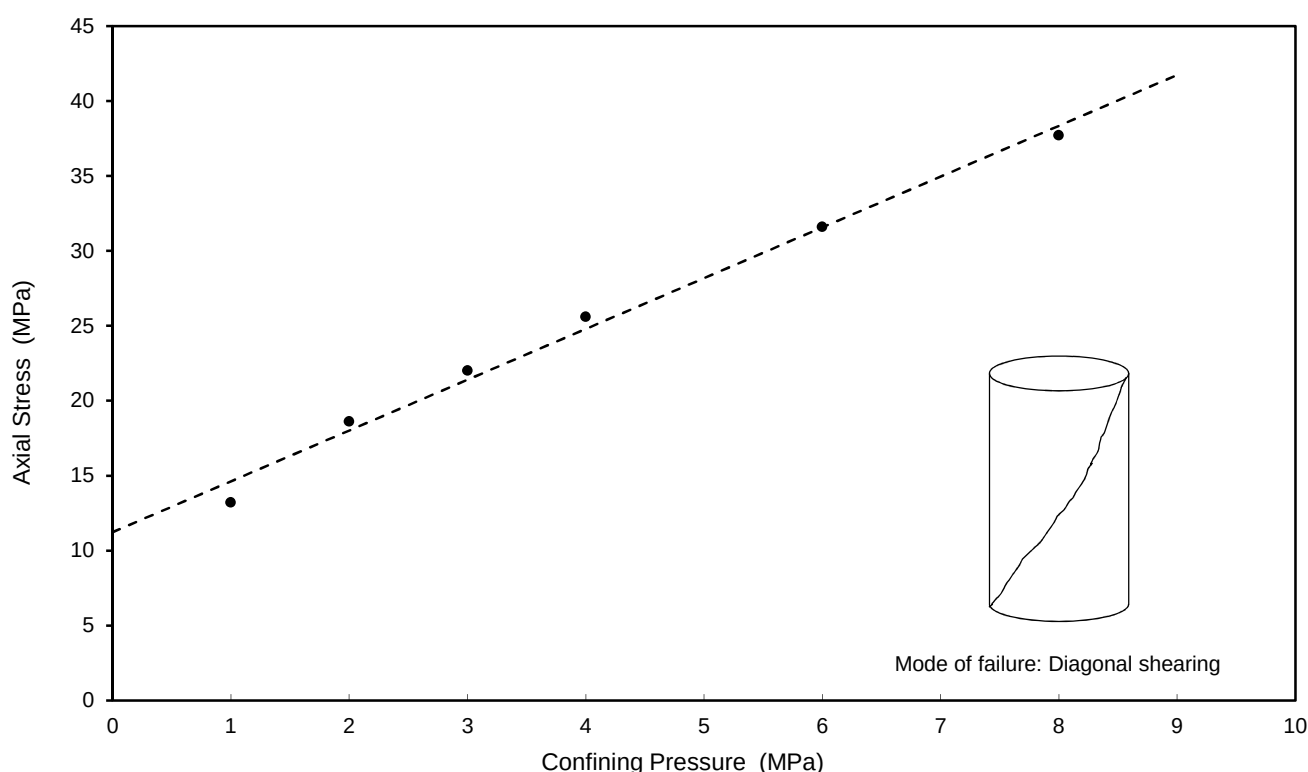
33.0 °

Ordinate of Slope, b

11 MPa

Apparent Cohesion, c

3 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

Strength of Rock Material in Triaxial Compression: Revised Version

Borehole Ref.: RBH06
 Sample Ref.: 26
 Depth (m): 18.16

Description:
 Medium strong orangish brown fine to medium grained SANDSTONE.
 Moderately weathered

Diameter	37.60 mm
Height	76.10 mm
Bulk Density	1.96 Mg/m ³
Dry Density	1.88 Mg/m ³
Water Content	4.4 %

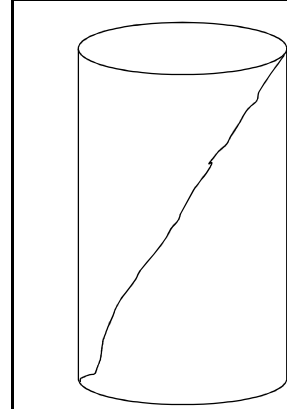
Degree of Saturation: 26.9 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Results

Confining Pressure	Axial Strength
1.00 MPa	22.6 MPa
2.00 MPa	29.5 MPa
3.00 MPa	33.7 MPa
4.00 MPa	36.4 MPa
6.00 MPa	40.4 MPa
8.00 MPa	45.7 MPa

LF0879C (1000kN) compression frame used

Failure Sketch

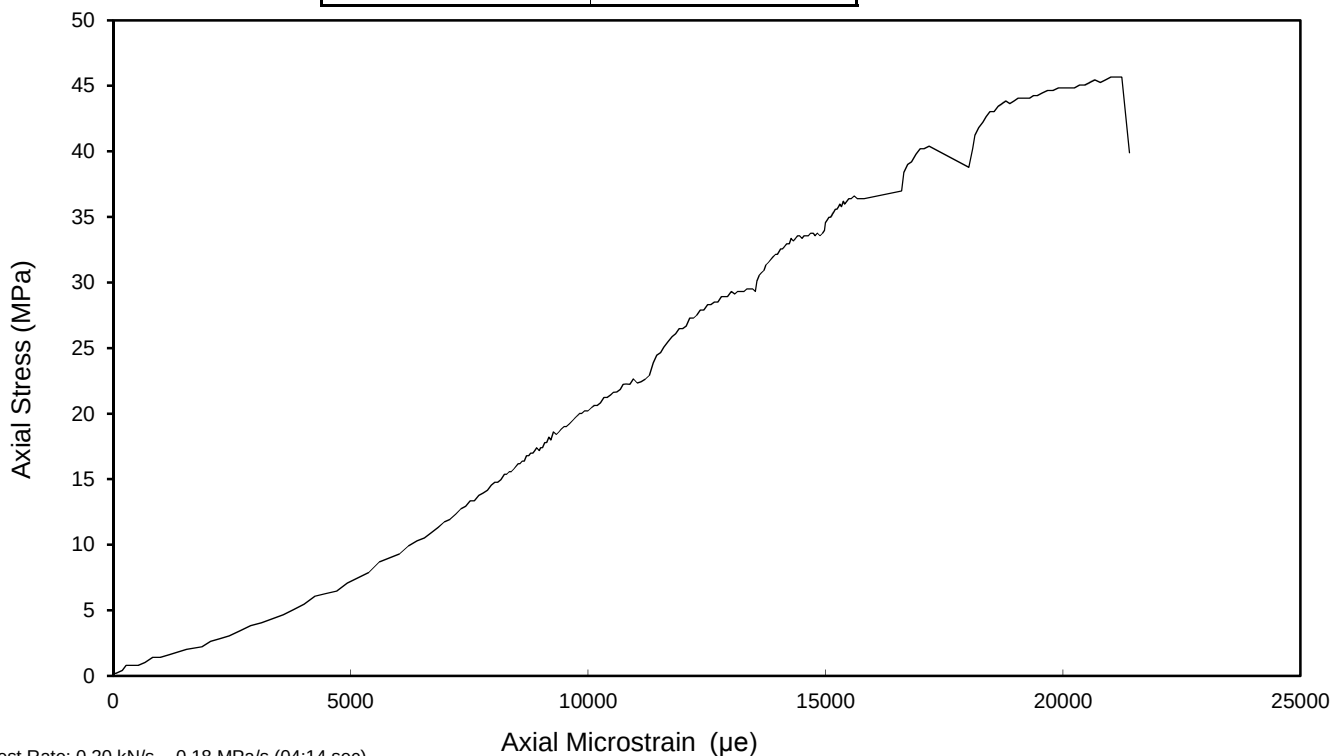


Date tested: 22/08/2018

Solid lines for material failures.
 Dashed lines for apparent weakness failure.

Sample type

C



Test Rate: 0.20 kN/s - 0.18 MPa/s (04:14 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are not met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

ST JOHN'S MASTERPLAN
 42206

GEOLABS®

Strength of Rock Materials in Triaxial Compression: Revised Version

Description: Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered

Test Type

Type II - Multiple failure state test

Date Tested: 22-08-18

Borehole Ref.	RBH06	RBH06	RBH06	RBH06	RBH06	RBH06
Sample Ref.	26	26	26	26	26	26
Depth (m)	18.16	18.16	18.16	18.16	18.16	18.16
Diameter (mm)	37.60	37.60	37.60	37.60	37.60	37.60
Height (mm)	76.10	76.10	76.10	76.10	76.10	76.10
Bulk Density (Mg/m ³)	1.96	1.96	1.96	1.96	1.96	1.96
Dry Density (Mg/m ³)	1.88	1.88	1.88	1.88	1.88	1.88
Water Content (%)	4.4	4.4	4.4	4.4	4.4	4.4

Confining Pressure (MPa)	1.00	2.00	3.00	4.00	6.00	8.00
Axial Strength (MPa)	22.60	29.50	33.70	36.40	40.40	45.70

Gradient of Slope, m

3.032

Internal Friction Angle, ϕ

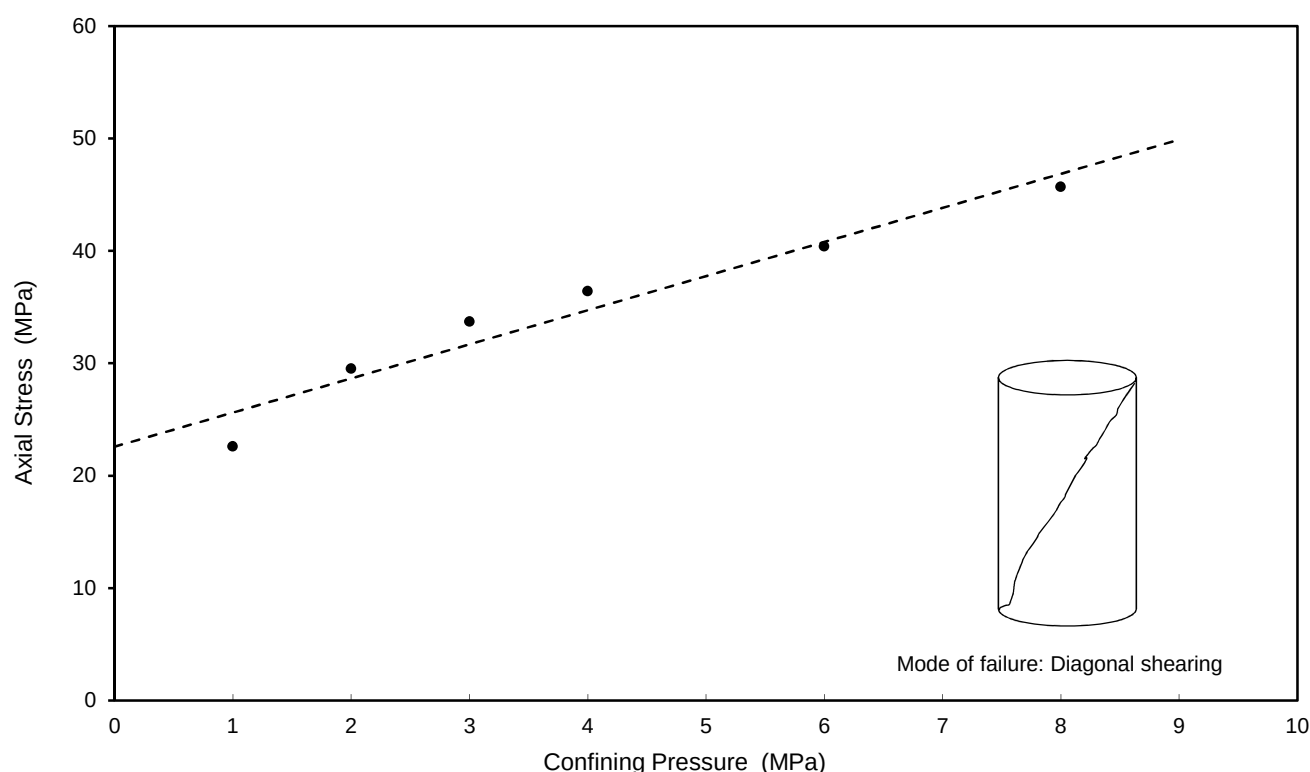
30.3 °

Ordinate of Slope, b

23 MPa

Apparent Cohesion, c

6 MPa



Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**ST JOHN'S MASTERPLAN
42206**

GEOLABS®

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: BH02
 Sample No: C39
 Depth (m): 10.68

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 2-4.
 Debris is abundant sand and fine to medium gravel.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number

1

Maximum Length

mm 93.2

Maximum Width

mm 55.2

Area

mm² 4612.0

Shearing Stage

Normal stress	<i>kPa</i>	500	1000	2500
---------------	------------	-----	------	------

Peak Conditions:

Rate of horizontal displacement	<i>mm/min</i>	0.1	0.1	0.1
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Maximum shear stress	<i>kPa</i>	352.8	538.9	1207.2
----------------------	------------	-------	-------	--------

Horizontal displacement at MSS	<i>mm</i>	6.3	11.6	21.7
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Residual Conditions:

Rate of horizontal displacement	<i>mm/min</i>	0.1	0.1	0.1
---------------------------------	---------------	-----	-----	-----

Residual shear stress	<i>kPa</i>	322.5	477.3	1113.8
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Final cumulative displacement	<i>mm</i>	38.9		
-------------------------------	-----------	------	--	--

Duration	<i>day(s)</i>	1
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Shear Strength Parameters

Maximum Condition:

Apparent Cohesion	<i>kPa</i>	124
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Angle of Shearing Resistance	<i>degrees</i>	23.5
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Residual Condition:

Apparent Cohesion	<i>kPa</i>	102
-------------------	------------	------------

Angle of Shearing Resistance	<i>degrees</i>	22.0
------------------------------	----------------	-------------

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 07/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS ^{3d}

ISRM Suggested Method

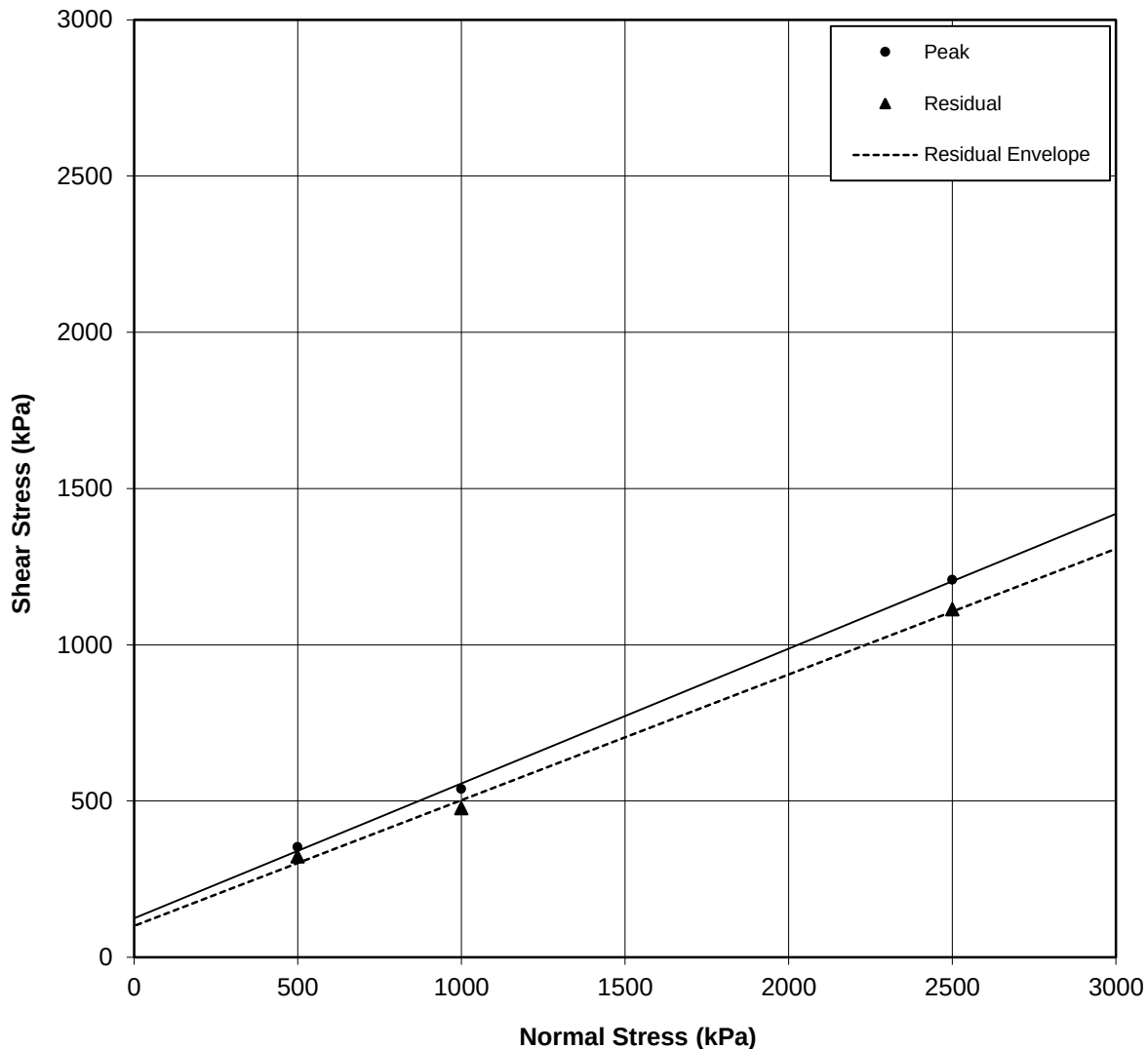
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: BH02
 Sample No: C39
 Depth (m): 10.68

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 2-4.
 Debris is abundant sand and fine to medium gravel.

Shear Stress v Normal Stress



Peak: $c' = 124$
 $\phi' = 23.5^\circ$

Residual: $c' = 102$
 $\phi' = 22^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 07/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS ³¹

ISRM Suggested Method

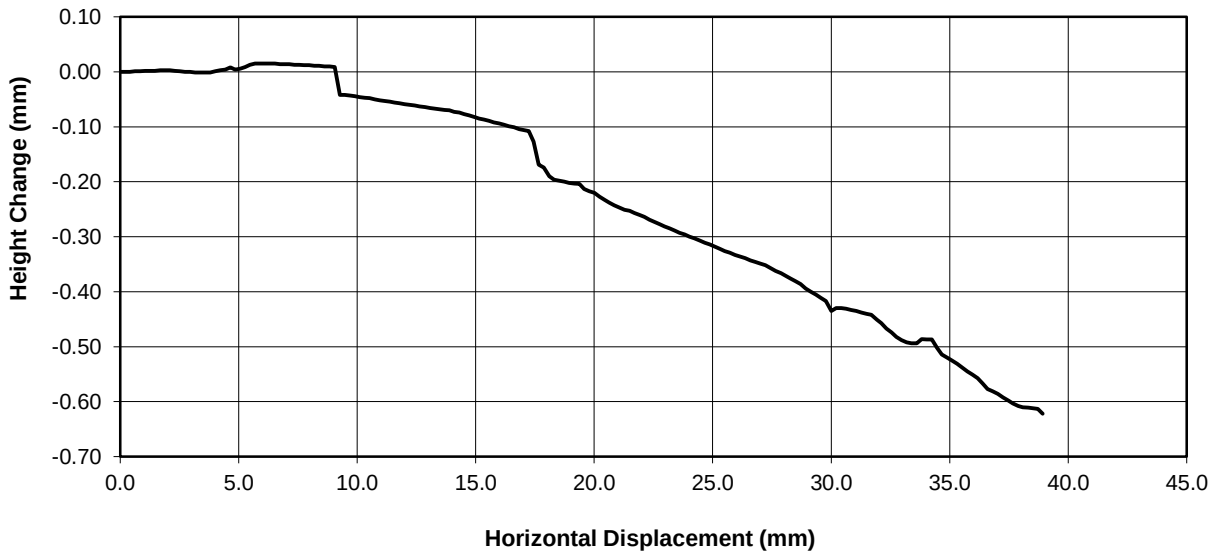
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

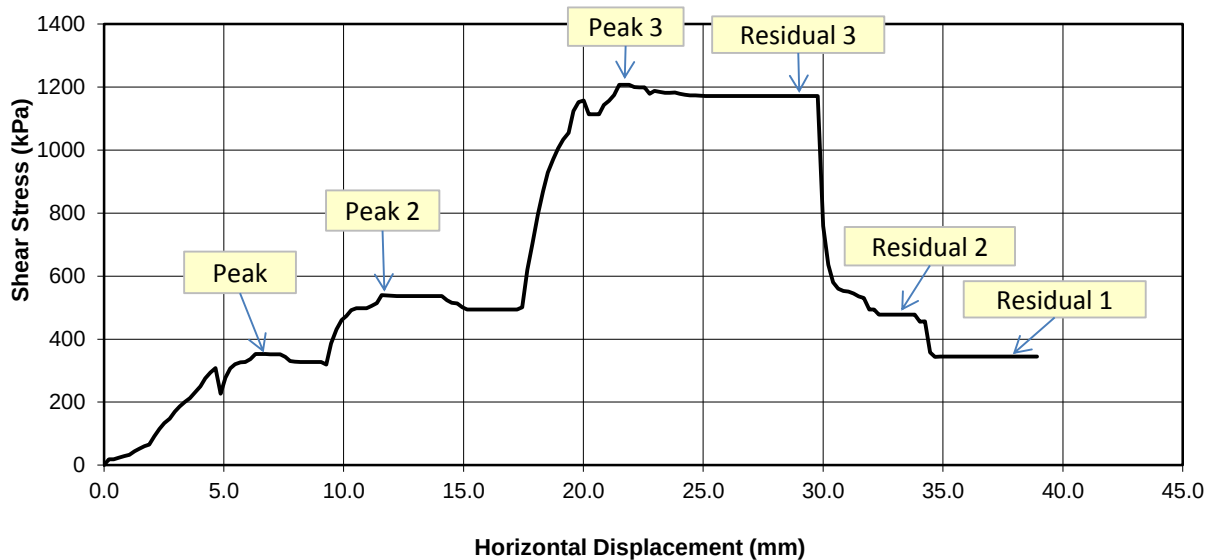
Borehole No: BH02
Sample No: C39
Depth (m): 10.68

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to medium gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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Date: 07/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method
Determination of Shear Strength by Direct Shear on Rock Sample
(large shearbox apparatus)

Borehole No: BH03
Sample No: C31
Depth (m): 11.53

Description:

Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material. Joint roughness coefficient = 10-12. Debris is fine to coarse sub-angular gravel and sand.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number

1

Maximum Length

mm 52.9

Maximum Width

mm 48.8

Area

mm² 2122.7

Shearing Stage

Normal stress

kPa 500 1000 2500

Peak Conditions:

Rate of horizontal displacement

mm/min 0.1 0.1 0.1

Maximum shear stress

kPa 705.2 1022.1 1747.3

Horizontal displacement at MSS

mm 4.7 6.0 9.7

Residual Conditions:

Rate of horizontal displacement

mm/min 0.1 0.1 0.1

Residual shear stress

kPa 445.1 608.2 911.0

Final cumulative displacement

mm 21.2

Duration

day(s) 1

Shear Strength Parameters

Maximum Condition:

Apparent Cohesion

kPa 475

Angle of Shearing Resistance

degrees 27.0

Residual Condition:

Apparent Cohesion

kPa 354

Angle of Shearing Resistance

degrees 12.5

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

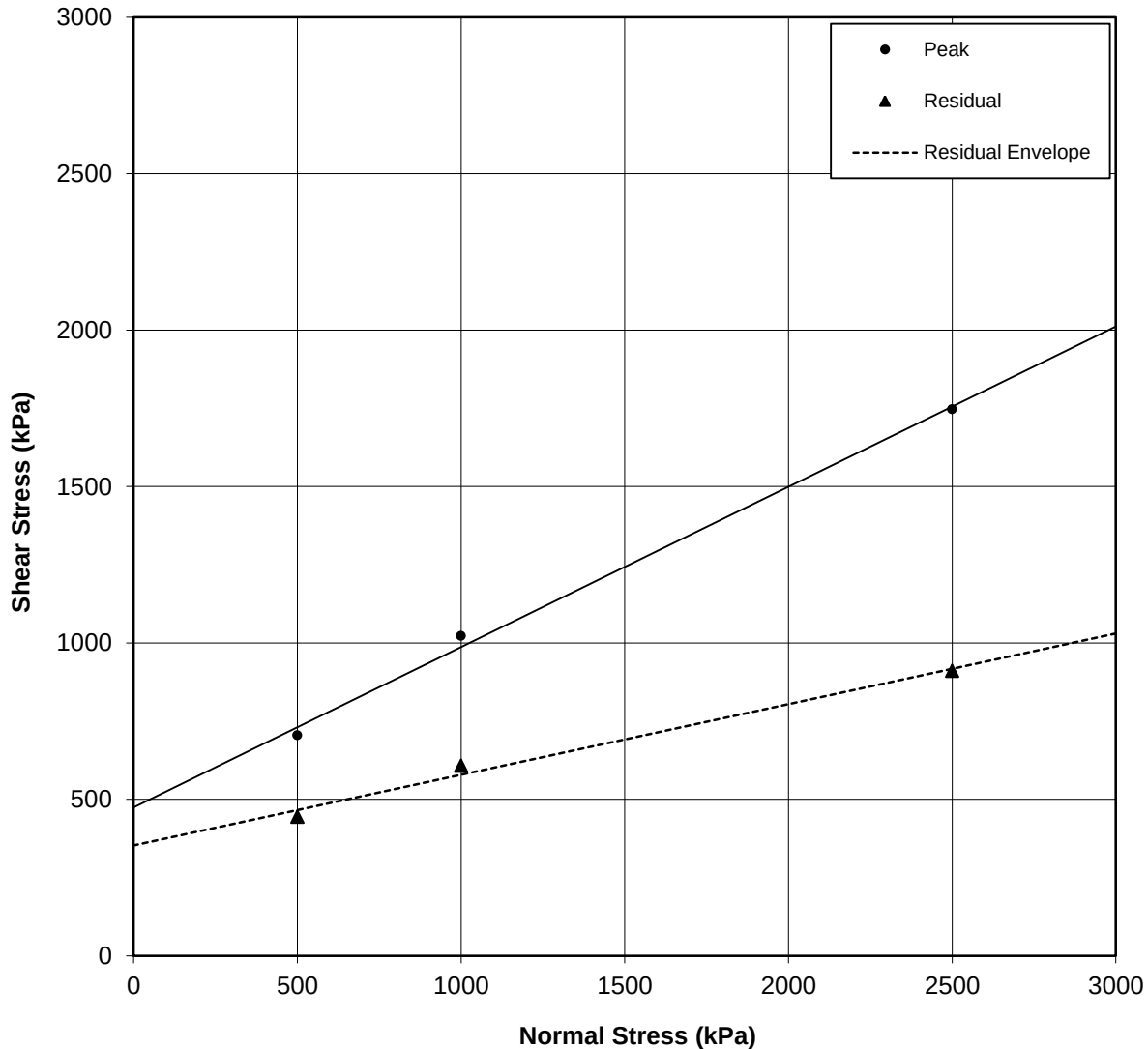
(large shearbox apparatus)

Borehole No: BH03
 Sample No: C31
 Depth (m): 11.53

Description:

Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material. Joint roughness coefficient = 10-12. Debris is fine to coarse sub-angular gravel and sand.

Shear Stress v Normal Stress



Peak: $c' = 475$
 $\phi' = 27^\circ$

Residual: $c' = 354$
 $\phi' = 12.5^\circ$

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S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

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Project Name:

**St John's Masterplan
 Project Ref: 42206**

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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

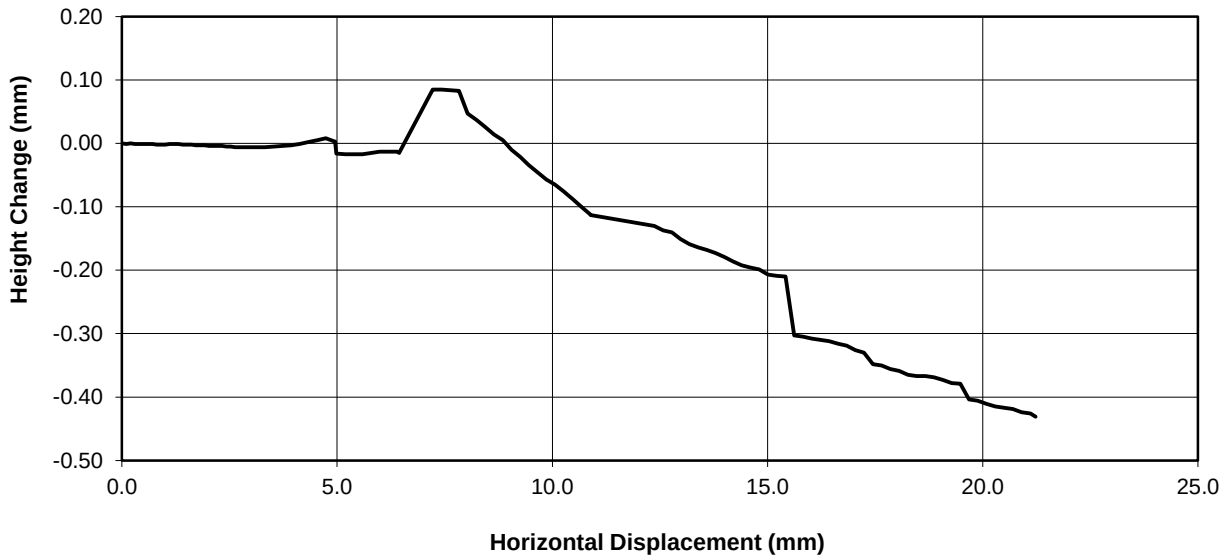
(large shearbox apparatus)

Borehole No: BH03
Sample No: C31
Depth (m): 11.53

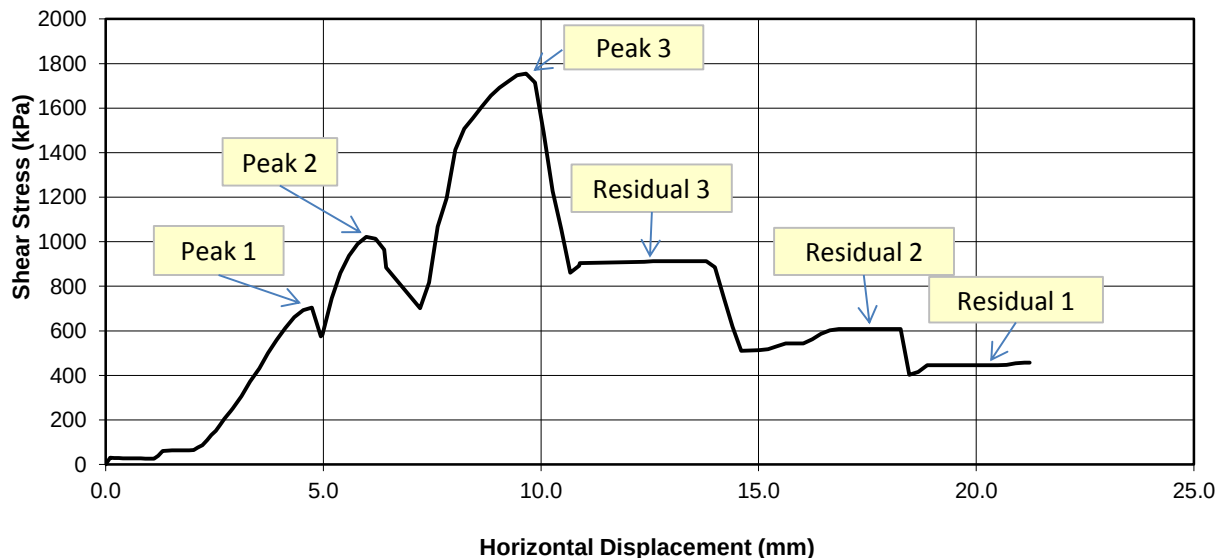
Description:

Medium strong orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material. Joint roughness coefficient = 10-12. Debris is fine to coarse sub-angular gravel and sand.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



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S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

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ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: BH04B
 Sample No: C13
 Depth (m): 14.50

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 6-8.
 Debris is negligible.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number

1

Maximum Length

mm 52.0

Maximum Width

mm 51.7

Area

mm² 2137.4

Shearing Stage

Normal stress	kPa	100	200	500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	118.0	215.6	515.0
Horizontal displacement at MSS	mm	1.5	4.1	11.9
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	95.0	171.6	428.6
Final cumulative displacement	mm	30.7		

Duration day(s) 1

Shear Strength Parameters

Maximum Condition:

Apparent Cohesion kPa 18
 Angle of Shearing Resistance degrees 45.0

Residual Condition:

Apparent Cohesion kPa 8
 Angle of Shearing Resistance degrees 40.0

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 03/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS

ISRM Suggested Method

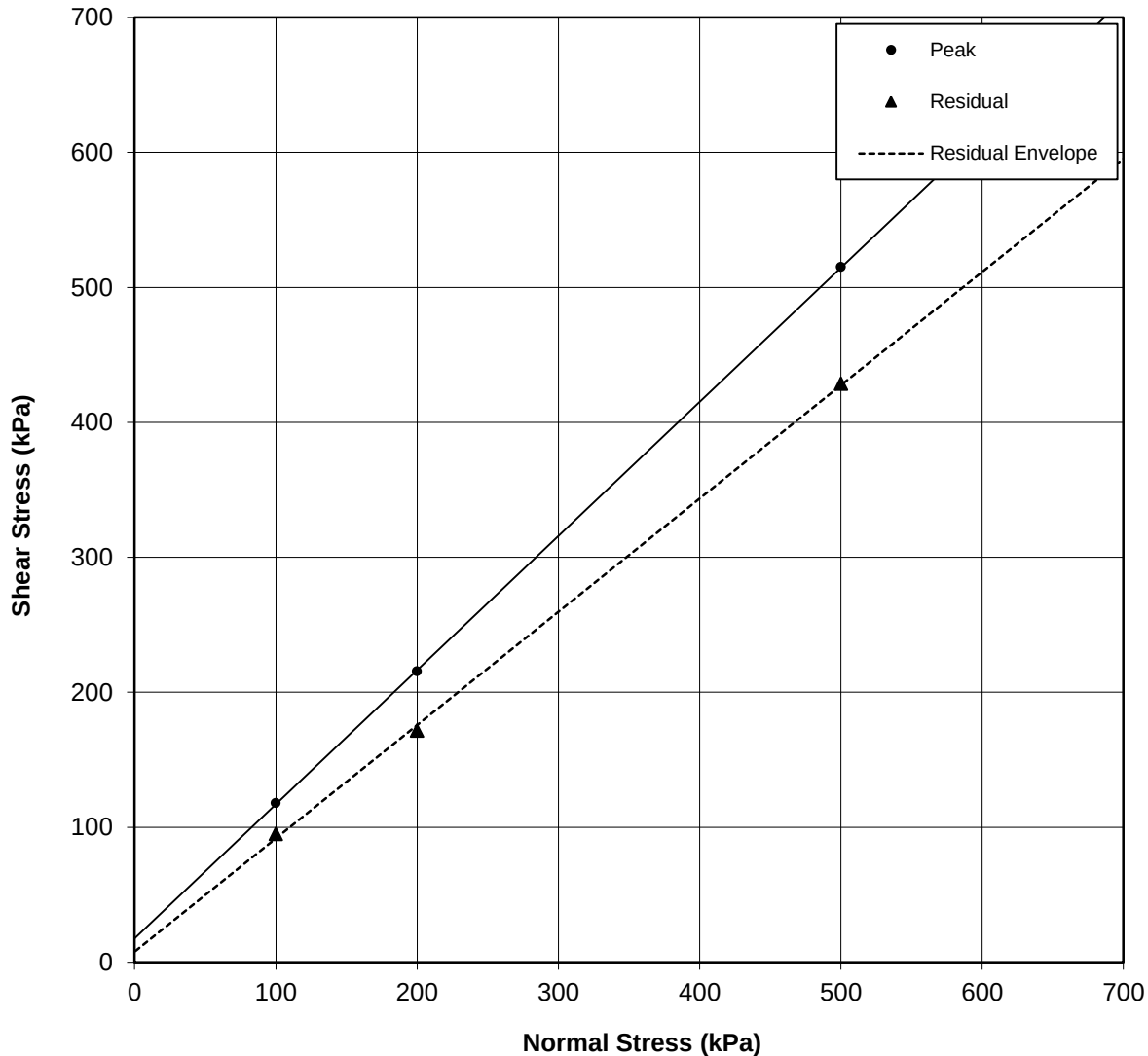
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: BH04B
 Sample No: C13
 Depth (m): 14.50

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 6-8.
 Debris is negligible.

Shear Stress v Normal Stress



Peak: $c' = 18$
 $\Phi' = 45^\circ$

Residual: $c' = 8$
 $\Phi' = 40^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 03/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

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ISRM Suggested Method

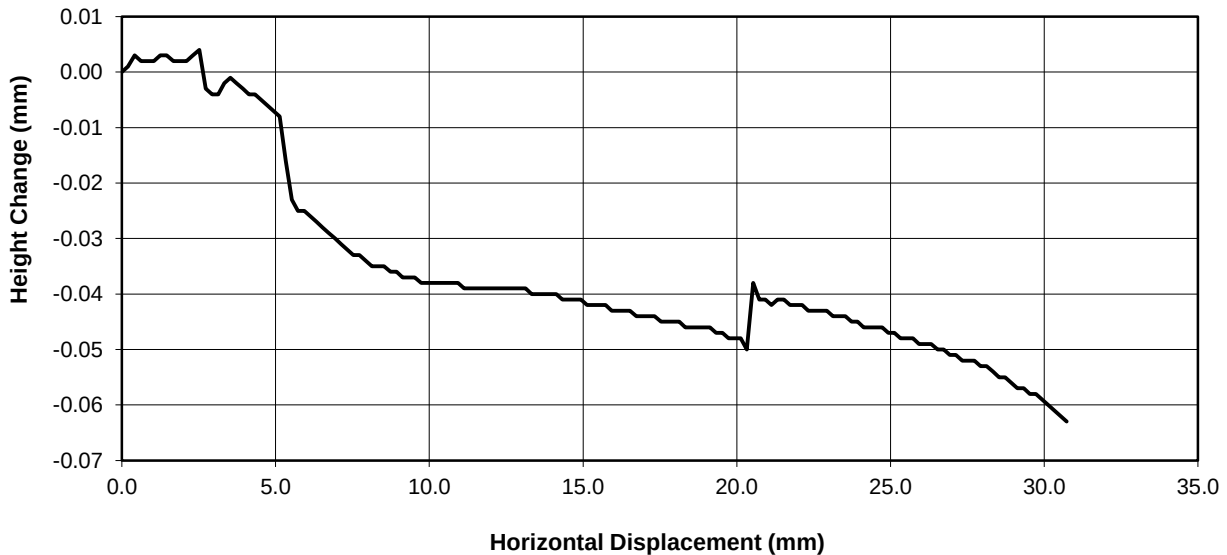
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

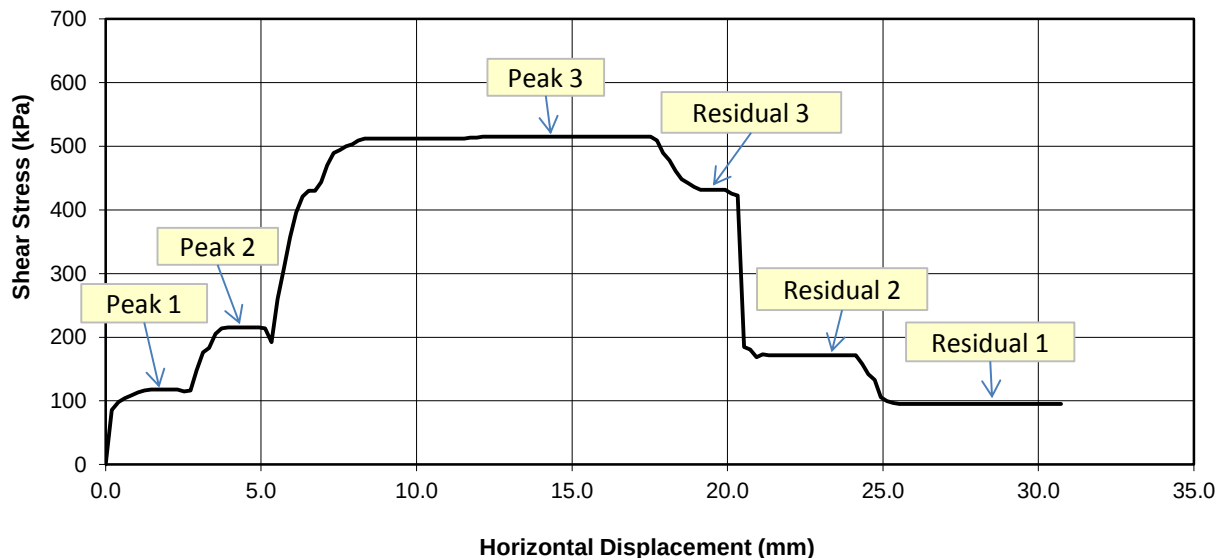
Borehole No: BH04B
Sample No: C13
Depth (m): 14.50

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is negligible.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 03/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method
Determination of Shear Strength by Direct Shear on Rock Sample
 (large shearbox apparatus)

Borehole No: RBH02
 Depth (m): 12.80

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 6-8.
 Debris is abundant sand and fine to coarse gravel.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number		1
Maximum Length	mm	51.2
Maximum Width	mm	38.6
Area	mm ²	1606.1

Shearing Stage

Normal stress	kPa	100	200	500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	110.1	186.9	425.5
Horizontal displacement at MSS	mm	2.0	8.1	12.4
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	77.5	140.7	314.0
Final cumulative displacement	mm	29.5		

Duration	day(s)	1
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Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	kPa	30
Angle of Shearing Resistance	degrees	38.5
Residual Condition:		
Apparent Cohesion	kPa	21
Angle of Shearing Resistance	degrees	30.5

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS

ISRM Suggested Method

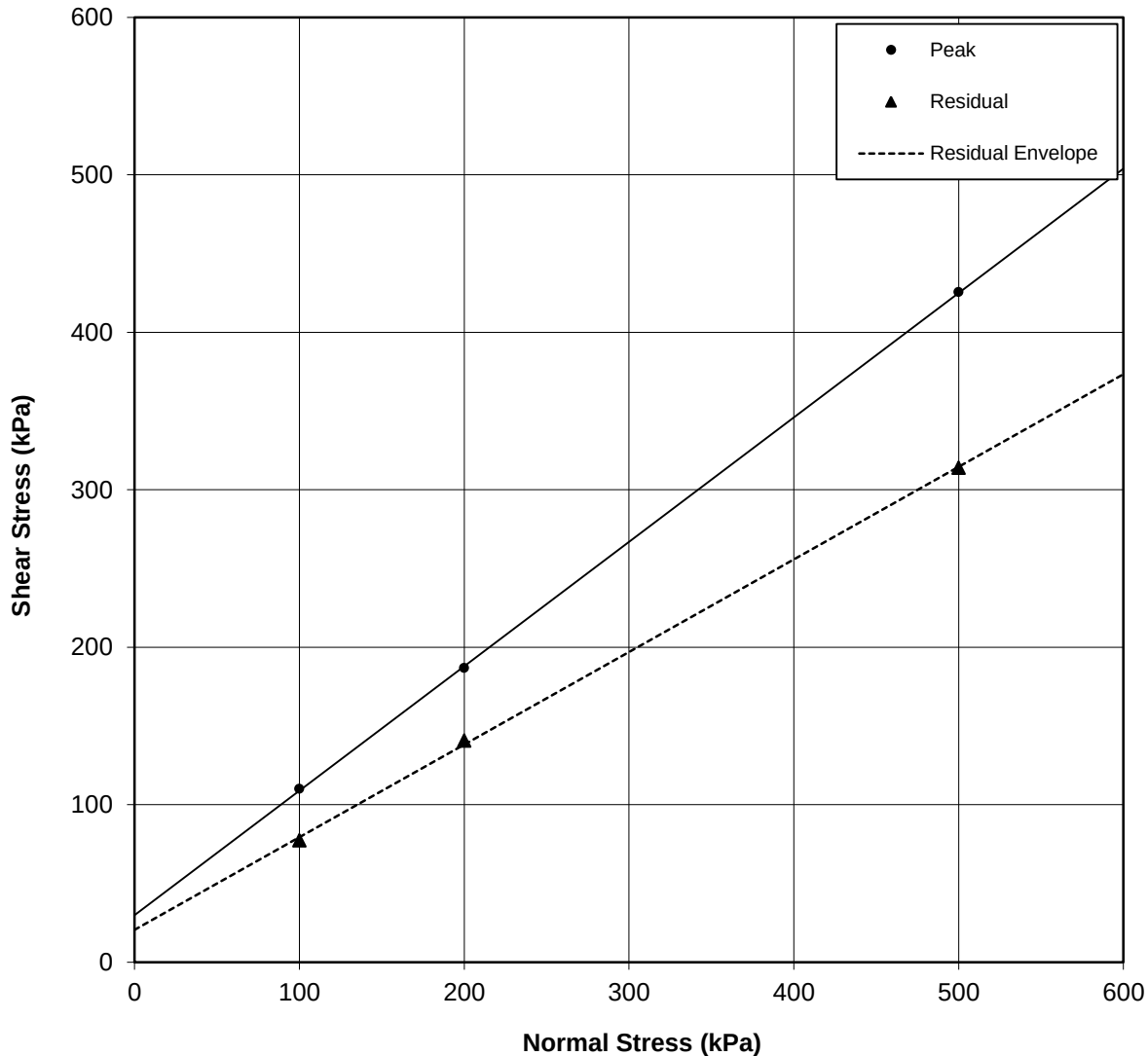
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH02
Depth (m): 12.80

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is abundant sand and fine to coarse gravel.

Shear Stress v Normal Stress



Peak: $c' = 30$
 $\phi' = 38.5^\circ$

Residual: $c' = 21$
 $\phi' = 30.5^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS ²¹

ISRM Suggested Method

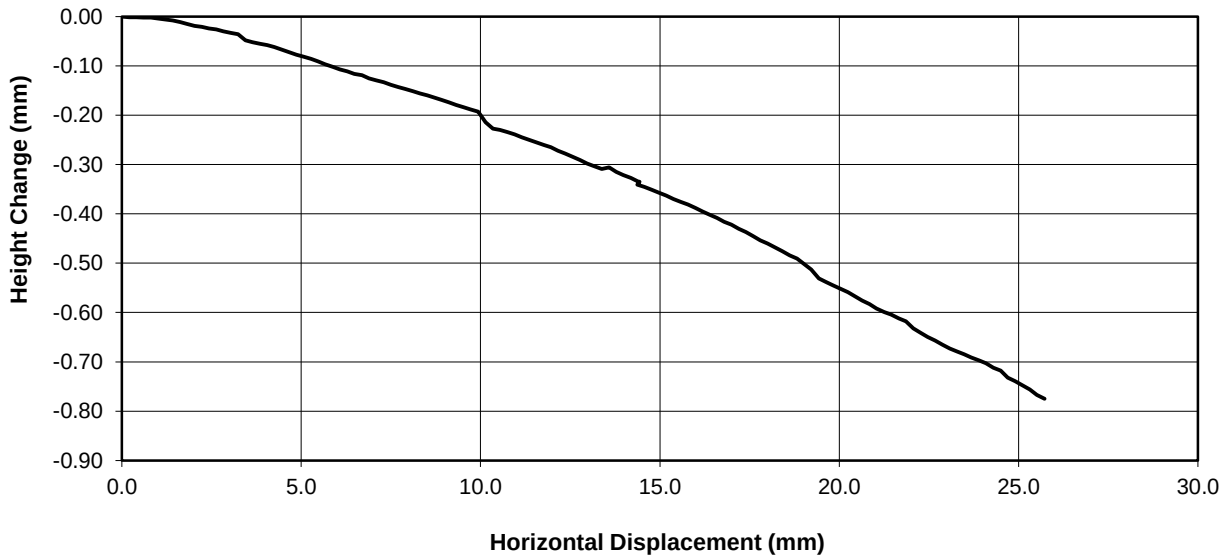
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

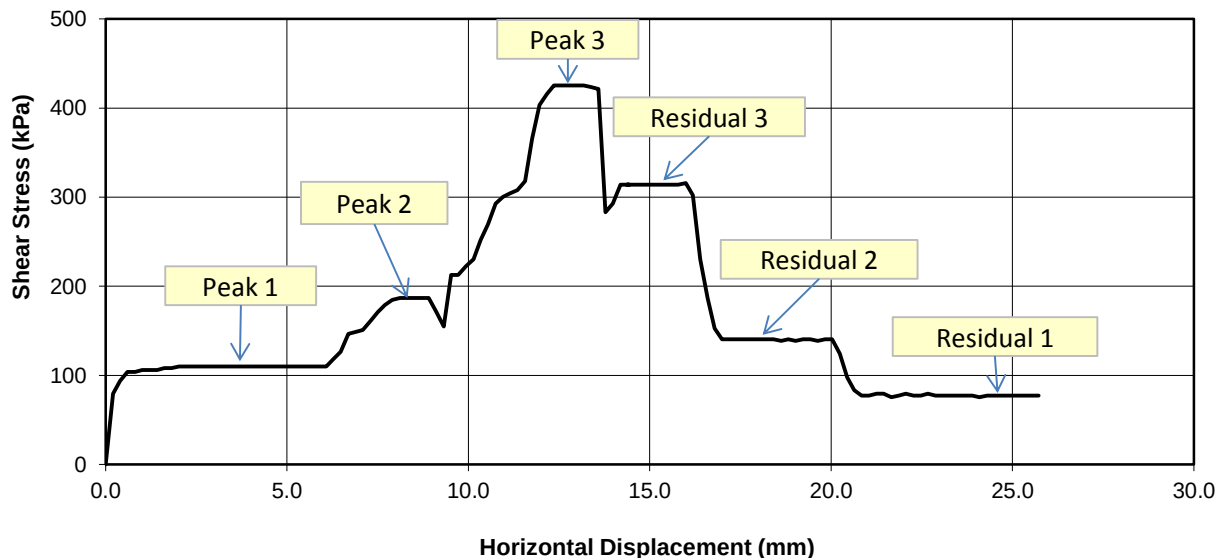
Borehole No: RBH02
Depth (m): 12.80

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is abundant sand and fine to coarse gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH03
Depth (m): 17.06

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is sand and fine to medium sub-angular gravel.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number		1
Maximum Length	mm	49.8
Maximum Width	mm	47.2
Area	mm ²	1908.4

Shearing Stage

Normal stress	kPa	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	674.9	841.0	1277.5
Horizontal displacement at MSS	mm	5.9	7.7	11.1
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	383.2	455.0	671.5
Final cumulative displacement	mm	25.3		

Duration	day(s)	1
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Shear Strength Parameters

Maximum Condition:

Apparent Cohesion	kPa	533
Angle of Shearing Resistance	degrees	16.5

Residual Condition:

Apparent Cohesion	kPa	311
Angle of Shearing Resistance	degrees	8.0

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

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ISRM Suggested Method

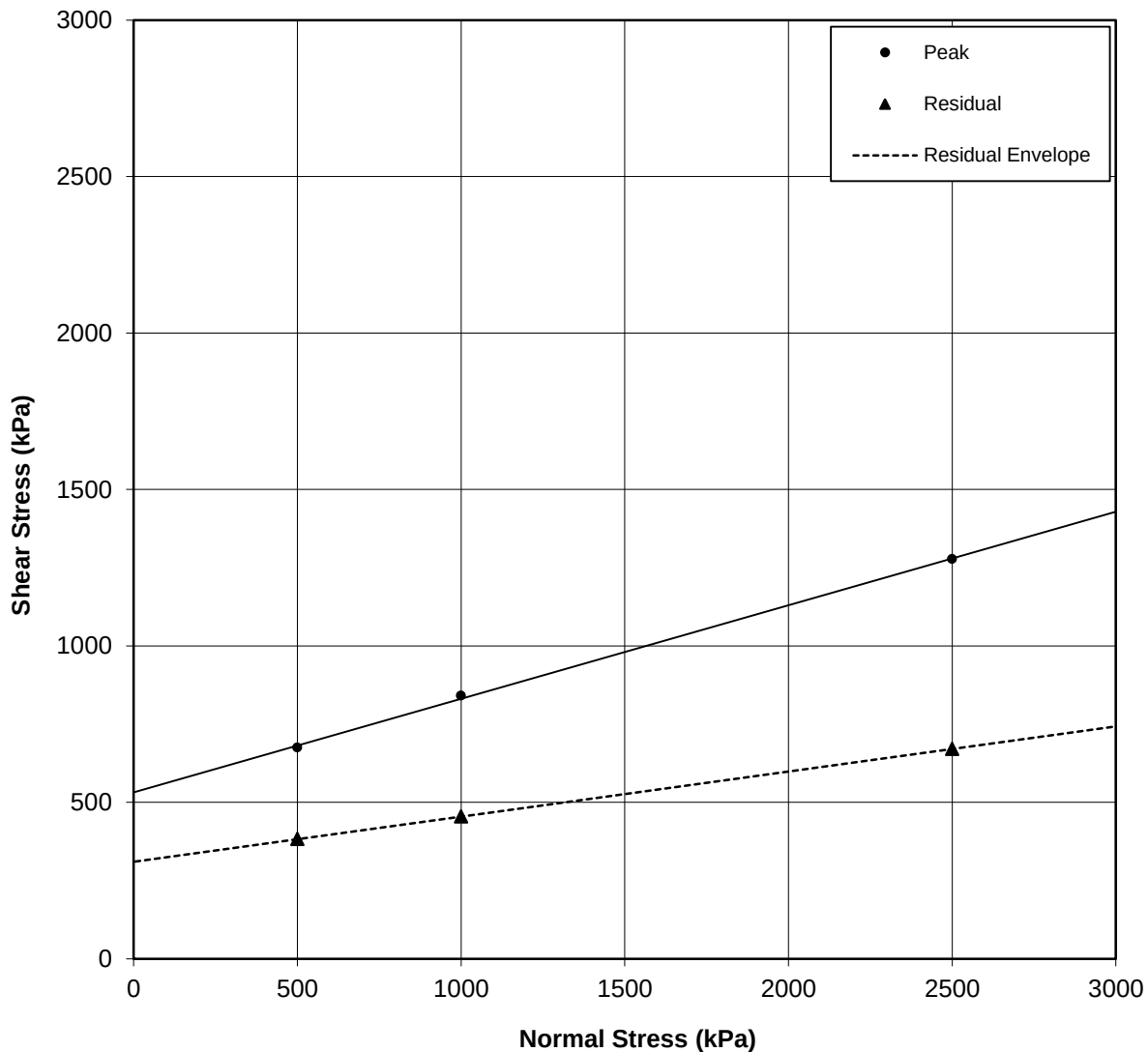
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH03
Depth (m): 17.06

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is sand and fine to medium sub-angular gravel.

Shear Stress v Normal Stress



Peak: $c' = 533$ **Residual:** $c' = 311$
 $\Phi' = 16.5^\circ$ $\Phi' = 8^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method

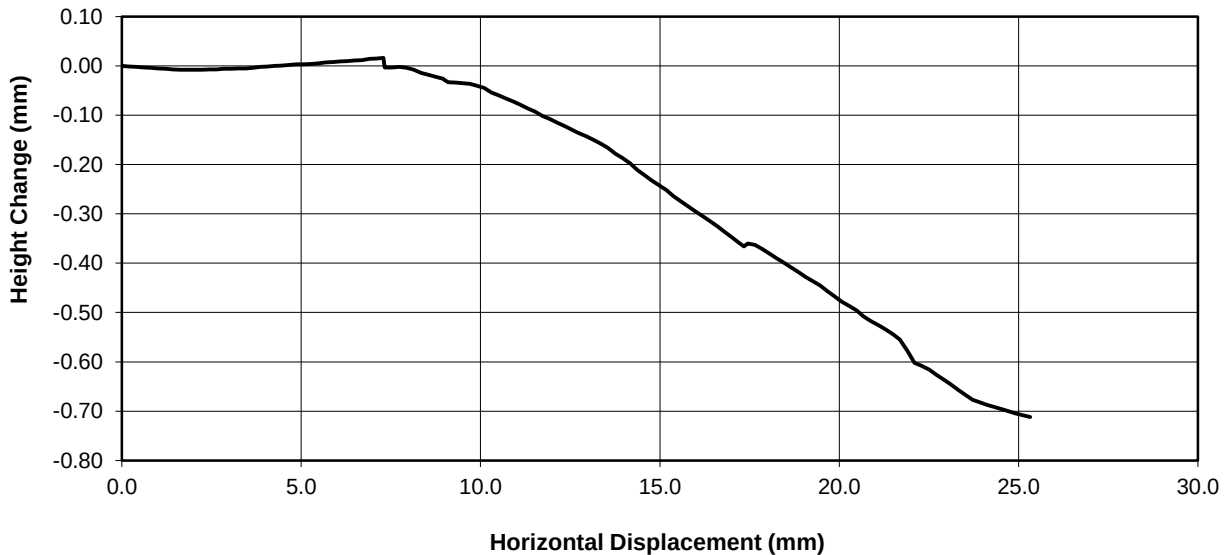
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

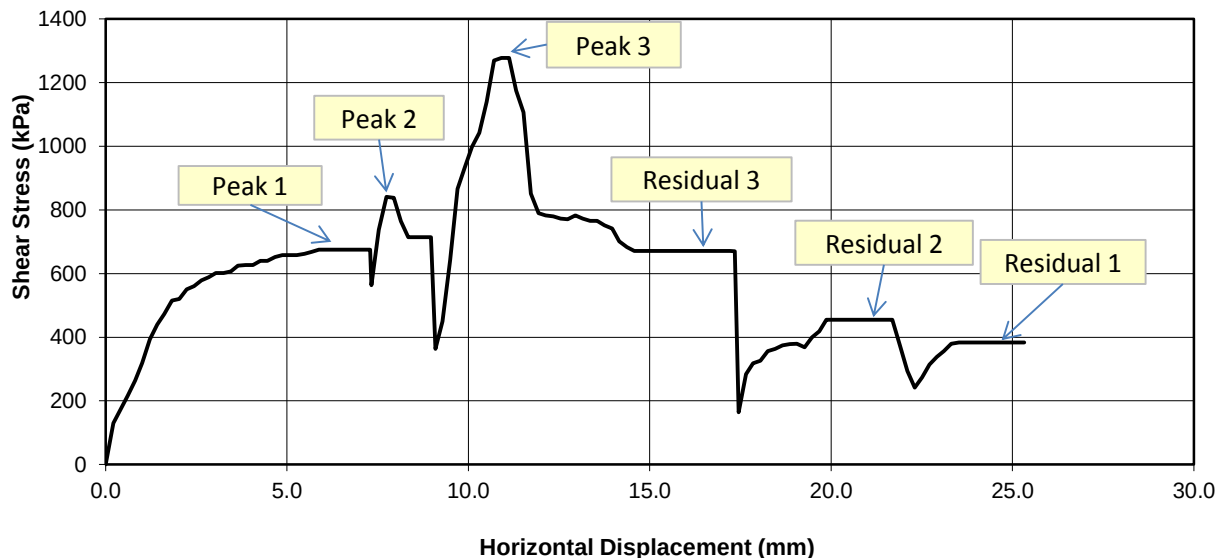
Borehole No: RBH03
Depth (m): 17.06

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 6-8.
Debris is sand and fine to medium sub-angular gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

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S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

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ISRM Suggested Method
Determination of Shear Strength by Direct Shear on Rock Sample
 (large shearbox apparatus)

Borehole No: RBH04
 Depth (m): 12.90

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
 Joint roughness coefficient = 2-4.
 Debris is sand and fine sub-rounded gravel.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number		1
Maximum Length	mm	48.1
Maximum Width	mm	46.2
Area	mm ²	1728.5

Shearing Stage

Normal stress	kPa	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	441.5	579.8	752.4
Horizontal displacement at MSS	mm	2.2	3.9	5.6
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	277.3	369.5	522.7
Final cumulative displacement	mm	15.3		

Duration	day(s)	1
----------	--------	---

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	kPa	396
Angle of Shearing Resistance	degrees	8.5
Residual Condition:		
Apparent Cohesion	kPa	233
Angle of Shearing Resistance	degrees	6.5

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH04

Depth (m): 12.90

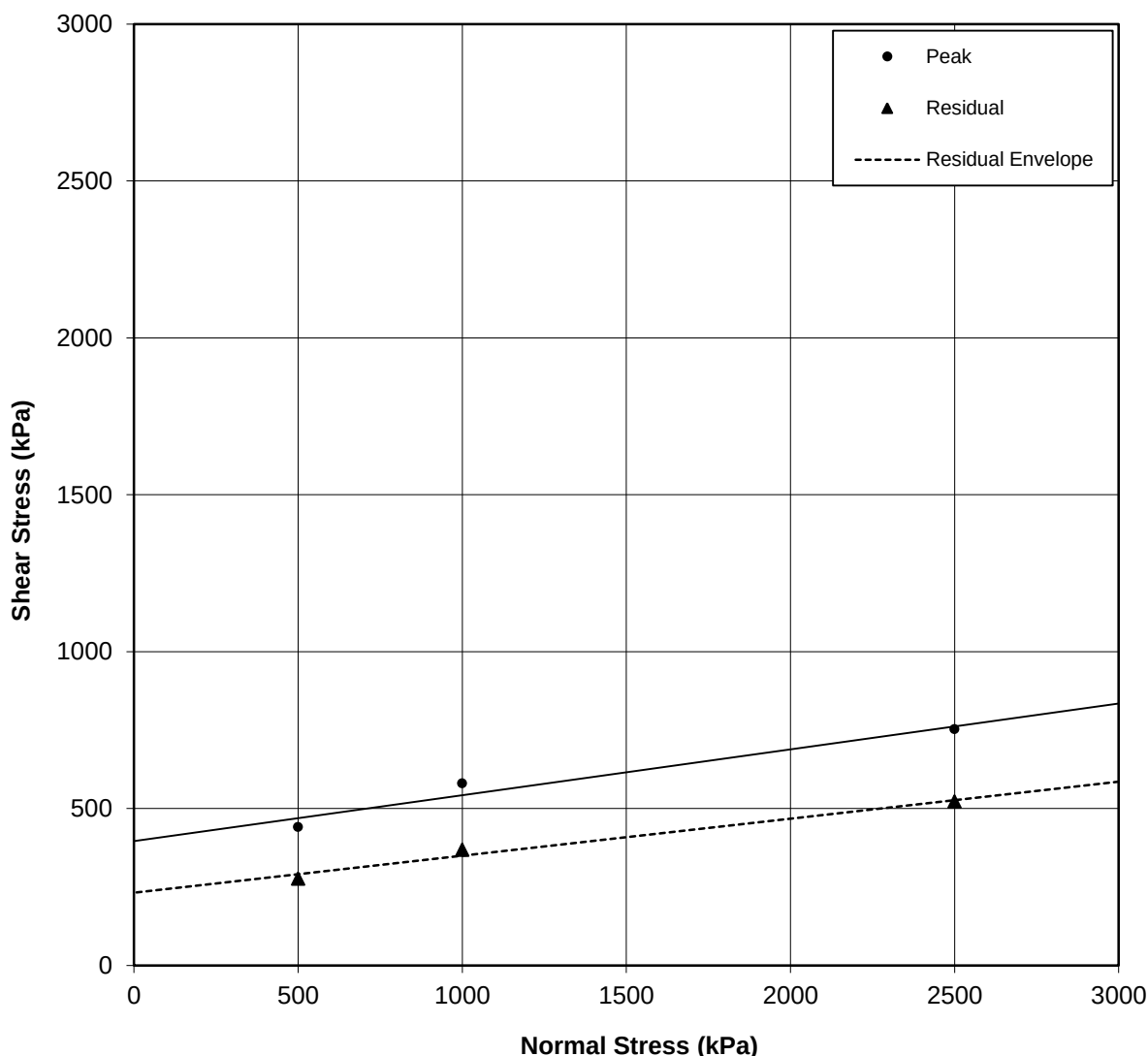
Description:

Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.

Joint roughness coefficient = 2-4.

Debris is sand and fine sub-rounded gravel.

Shear Stress v Normal Stress



Peak: $c' = 396$
 $\phi' = 8.5^\circ$

Residual: $c' = 233$
 $\phi' = 6.5^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

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Project Name:

St John's Masterplan

Project Ref: 42206

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH04

Depth (m): 12.90

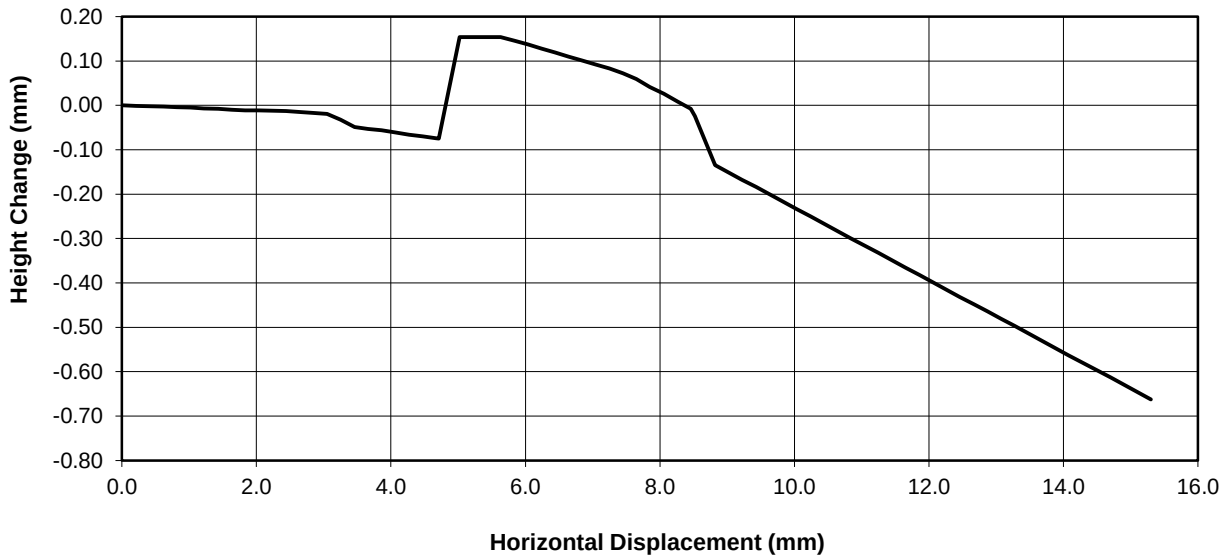
Description:

Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.

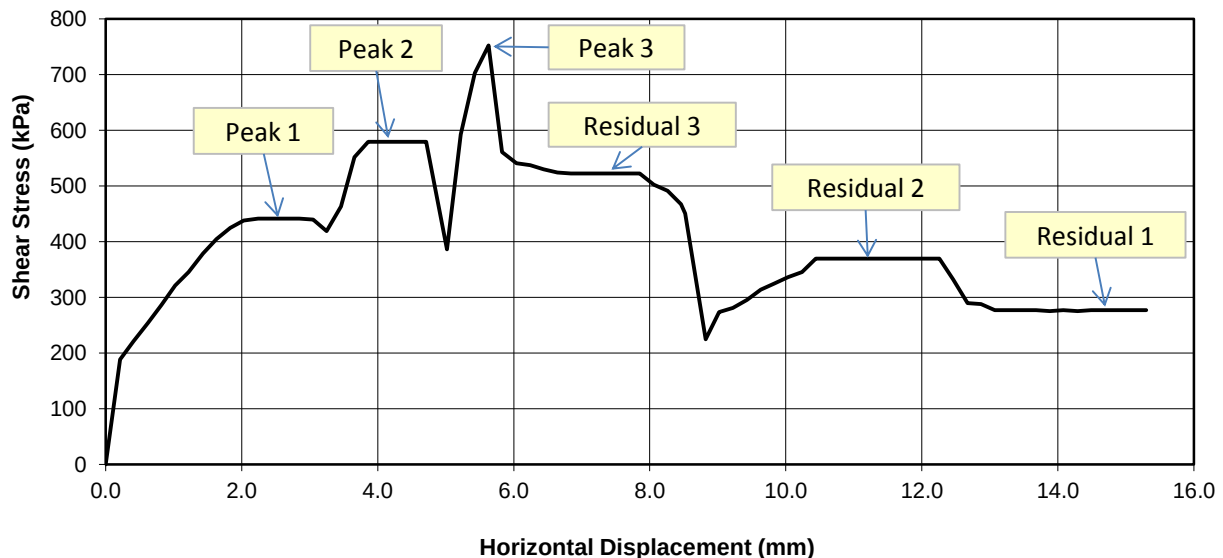
Joint roughness coefficient = 2-4.

Debris is sand and fine sub-rounded gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 30/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH05
 Sample No: C22
 Depth (m): 12.27

Description:
 Medium strong to weak orangish brown fine to medium SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
 Joint roughness coefficient = 4-6.
 Debris is abundant sand and fine to coarse gravel.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number		1
Maximum Length	mm	47.1
Maximum Width	mm	45.4
Area	mm ²	1671.0

Shearing Stage

Normal stress	kPa	100	200	500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	172.0	221.4	366.9
Horizontal displacement at MSS	mm	3.1	5.5	8.6
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	158.6	191.1	296.1
Final cumulative displacement	mm	24.9		

Duration	day(s)	1
----------	--------	---

Shear Strength Parameters

Maximum Condition:

Apparent Cohesion	kPa	124
Angle of Shearing Resistance	degrees	26.0

Residual Condition:

Apparent Cohesion	kPa	123
Angle of Shearing Resistance	degrees	19.0

Notes:

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S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

GEOLABS

ISRM Suggested Method

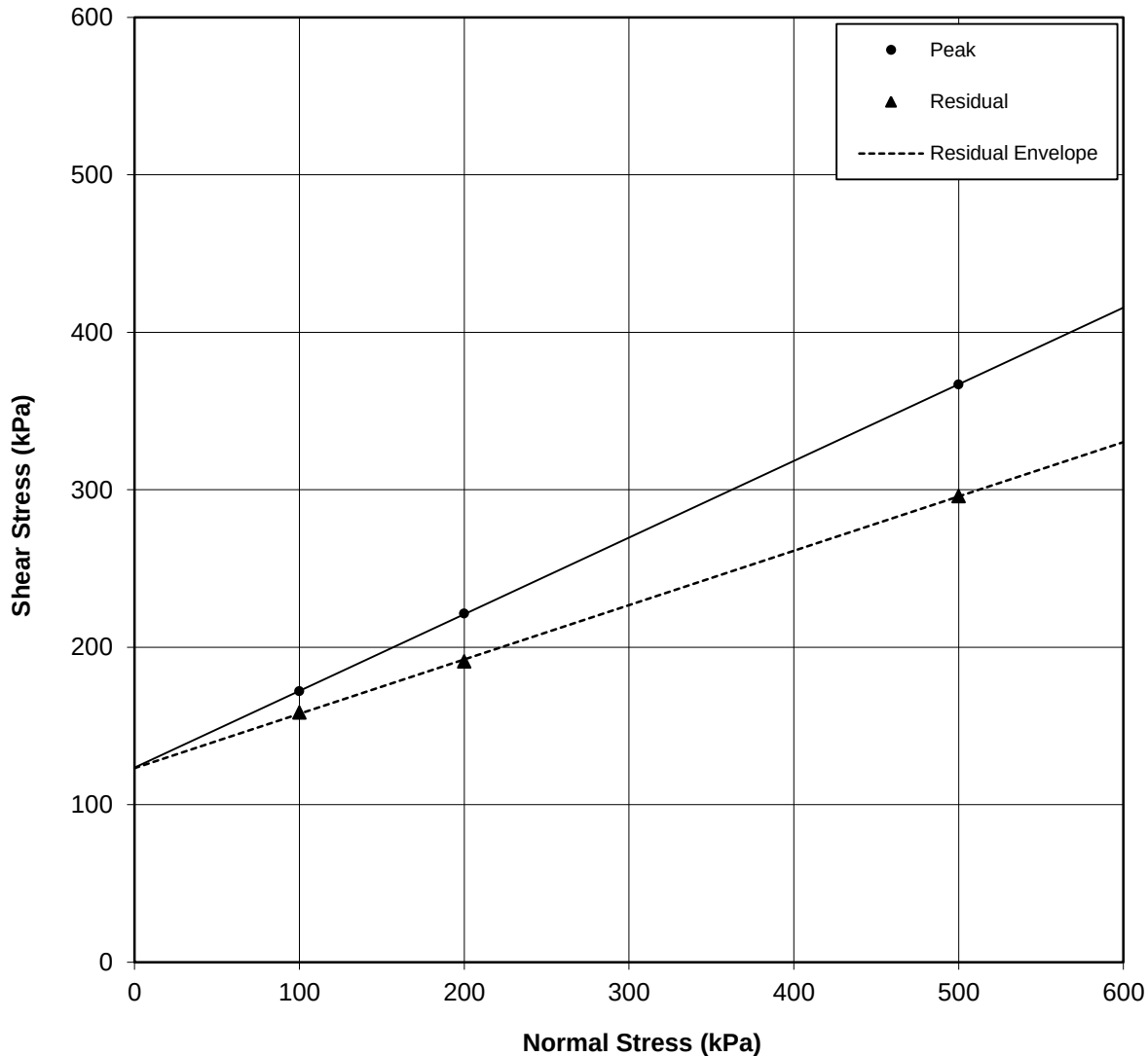
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH05
 Sample No: C22
 Depth (m): 12.27

Description:
 Medium strong to weak orangish brown fine to medium SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
 Joint roughness coefficient = 4-6.
 Debris is abundant sand and fine to coarse gravel.

Shear Stress v Normal Stress



Peak: $c' = 124$
 $\phi' = 26^\circ$

Residual: $c' = 123$
 $\phi' = 19^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS

ISRM Suggested Method

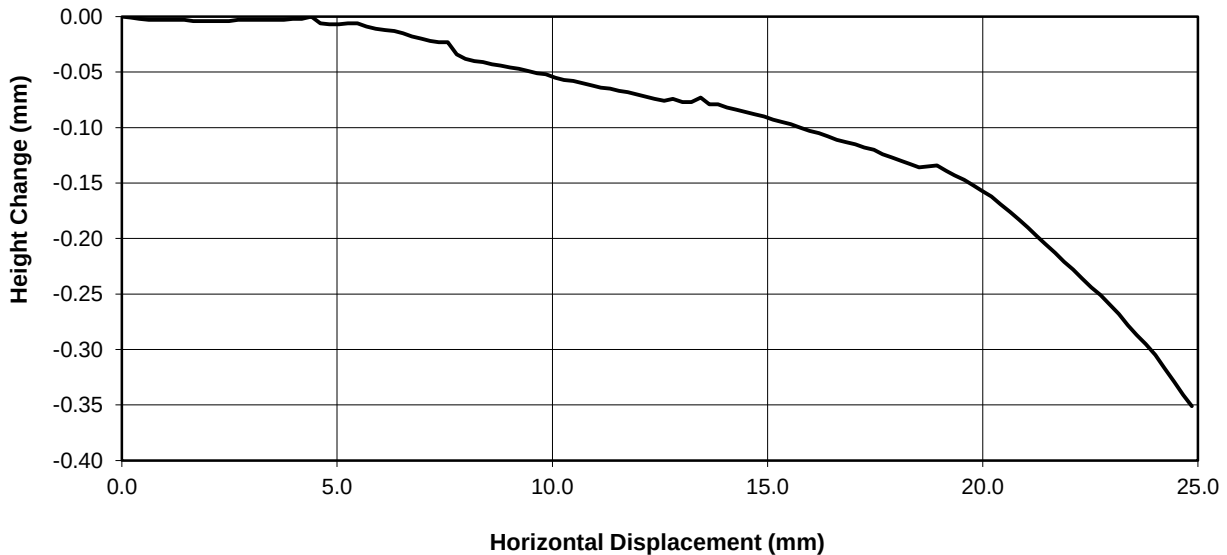
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

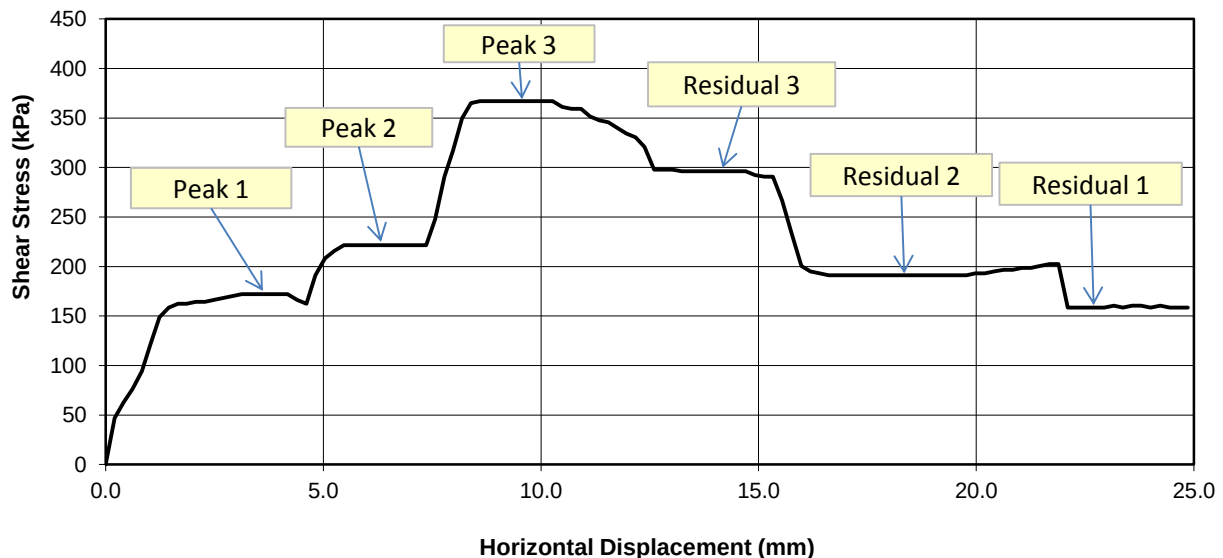
Borehole No: RBH05
Sample No: C22
Depth (m): 12.27

Description:
Medium strong to weak orangish brown fine to medium SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is abundant sand and fine to coarse gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH05
 Sample No: C31
 Depth (m): 18.40

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 4-6.
 Debris is sand and fine to medium gravel.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number		1
Maximum Length	mm	53.4
Maximum Width	mm	46.1
Area	mm ²	1907.4

Shearing Stage

Normal stress	kPa	100	200	500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	140.6	180.7	319.7
Horizontal displacement at MSS	mm	1.5	3.6	6.9
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	85.0	123.3	261.1
Final cumulative displacement	mm	23.3		

Duration	day(s)	1
----------	--------	---

Shear Strength Parameters

Maximum Condition:		
Apparent Cohesion	kPa	93
Angle of Shearing Resistance	degrees	24.5
Residual Condition:		
Apparent Cohesion	kPa	38
Angle of Shearing Resistance	degrees	24.0

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan
Project Ref: 42206

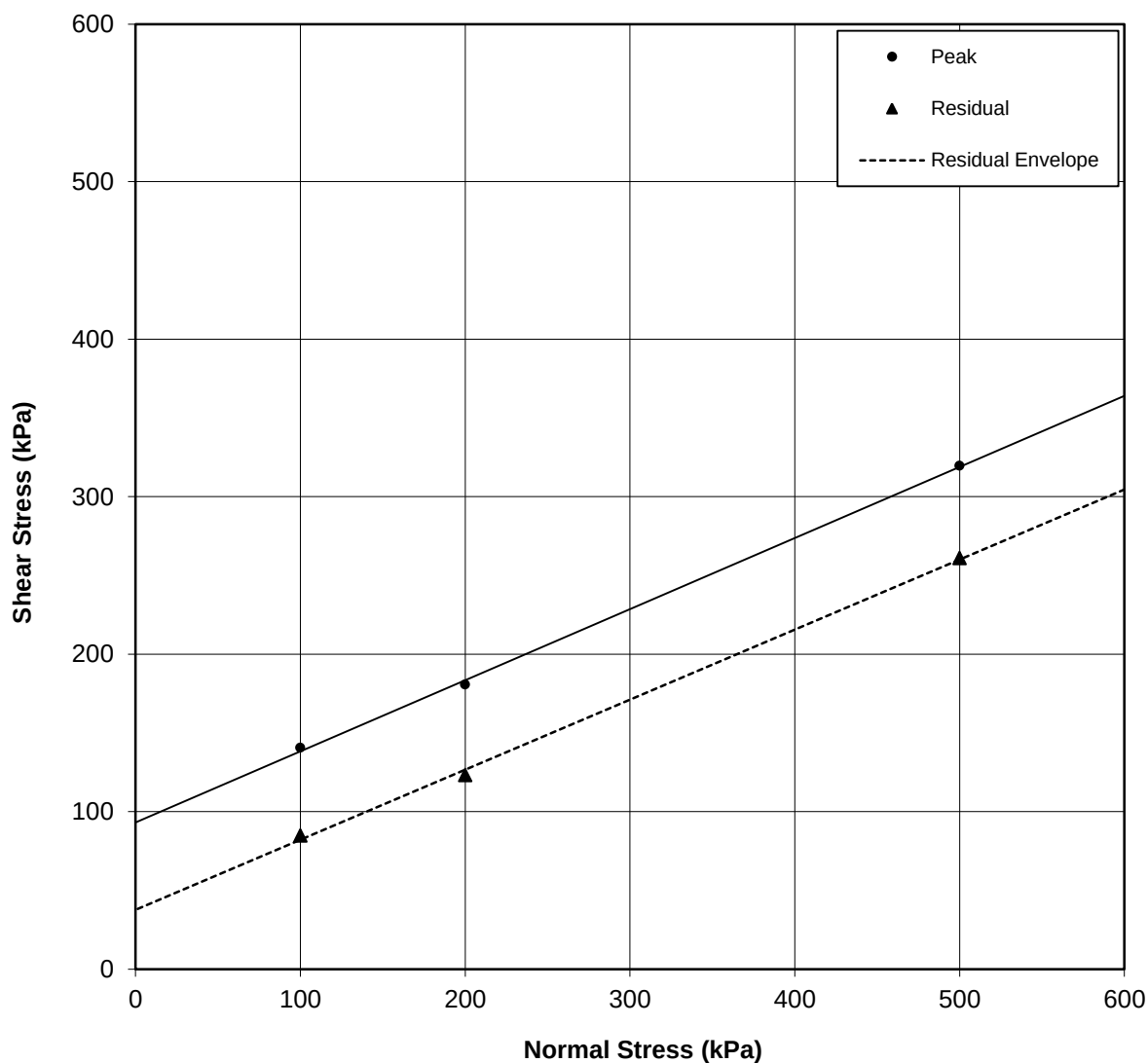
GEOLABS

Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH05
 Sample No: C31
 Depth (m): 18.40

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
 Natural shear plane with no infill material.
 Joint roughness coefficient = 4-6.
 Debris is sand and fine to medium gravel.

Shear Stress v Normal Stress

Peak: $c' = 93$
 $\Phi' = 24.5^\circ$

Residual: $c' = 38$
 $\Phi' = 24^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

St John's Masterplan**Project Ref: 42206****GEOLABS**

ISRM Suggested Method

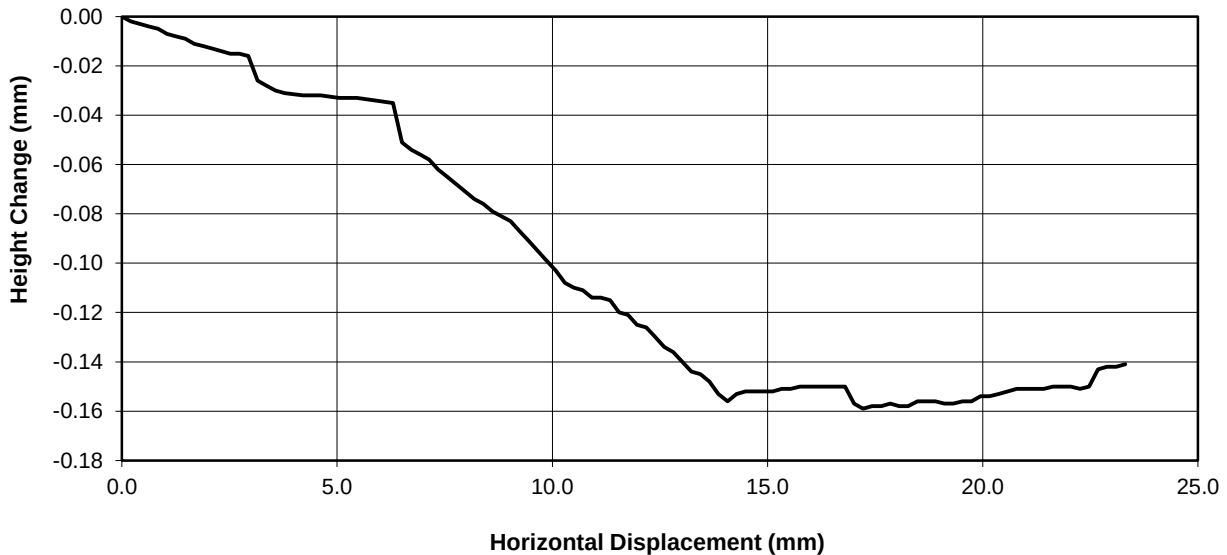
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

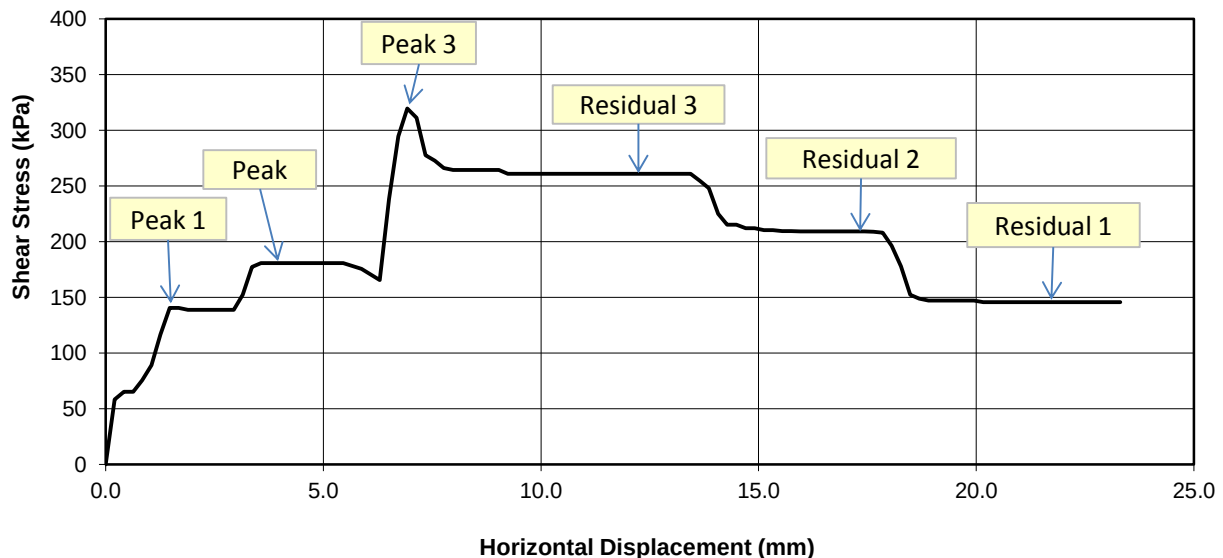
Borehole No: RBH05
Sample No: C31
Depth (m): 18.40

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered.
Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is sand and fine to medium gravel.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 06/09/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

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ISRM Suggested Method
Determination of Shear Strength by Direct Shear on Rock Sample
 (large shearbox apparatus)

Borehole No: RBH06
 Sample No: C23
 Depth (m): 16.63

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
 Joint roughness coefficient = 2-4.
 Debris is abundant sand and fine to coarse gravel.¹

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number		1
Maximum Length	mm	52.0
Maximum Width	mm	50.4
Area	mm ²	2114.1

Shearing Stage

Normal stress	kPa	500	1000	2500
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	577.7	600.2 ¹	579.2 ¹
Horizontal displacement at MSS	mm	3.5	6.1	15.6
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	392.7	339.9 ¹	579.2 ¹
Final cumulative displacement	mm	16.6		

Duration	day(s)	1
----------	--------	---

Shear Strength Parameters

Maximum Condition:

Apparent Cohesion	kPa	n/a ¹
Angle of Shearing Resistance	degrees	n/a ¹

Residual Condition:

Apparent Cohesion	kPa	n/a ¹
Angle of Shearing Resistance	degrees	n/a ¹

Notes: ¹ Specimen disintegrated during shearing rendering the 2nd and 3rd stage shear strengths unreliable.

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS ^{3d}

ISRM Suggested Method

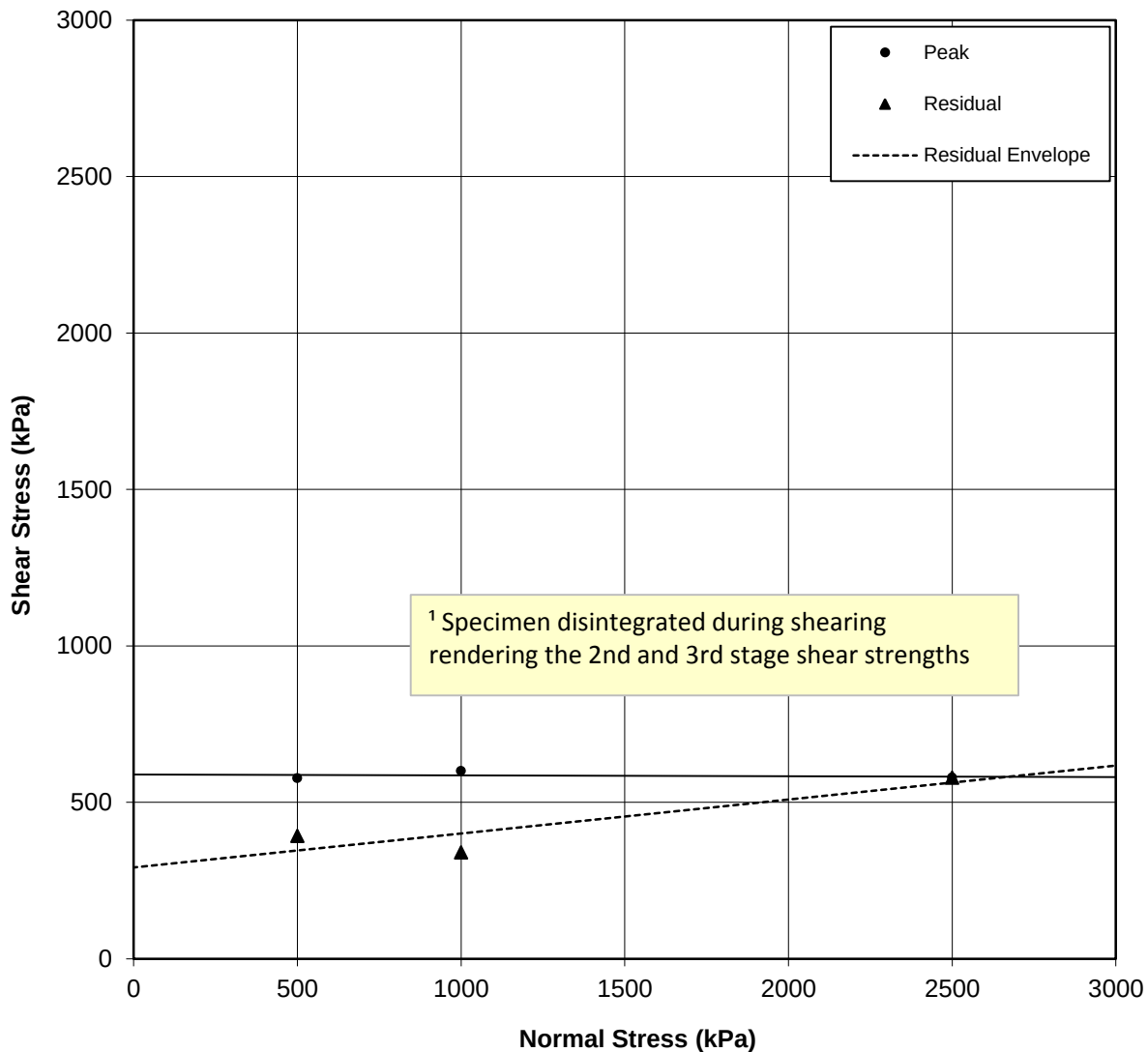
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH06
 Sample No: C23
 Depth (m): 16.63

Description:
 Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
 Joint roughness coefficient = 2-4.
 Debris is abundant sand and fine to coarse gravel.¹

Shear Stress v Normal Stress



Peak: $c' = n/a$
 $\Phi' = n/a$

Residual: $c' = n/a$
 $\Phi' = n/a$

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SRA

S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
 Project Ref: 42206**

GEOLABS

ISRM Suggested Method

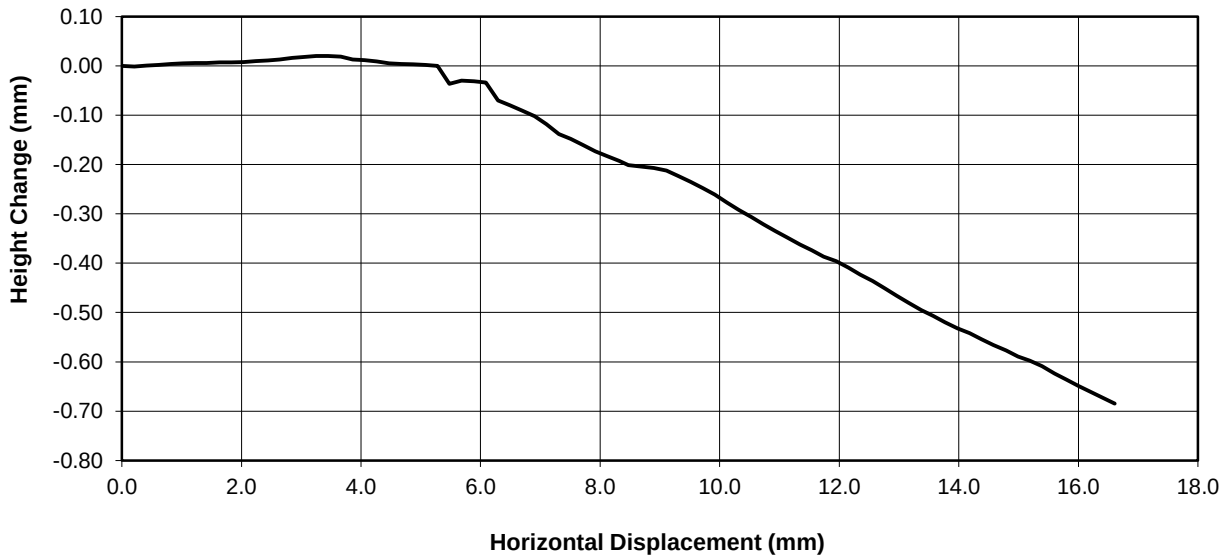
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

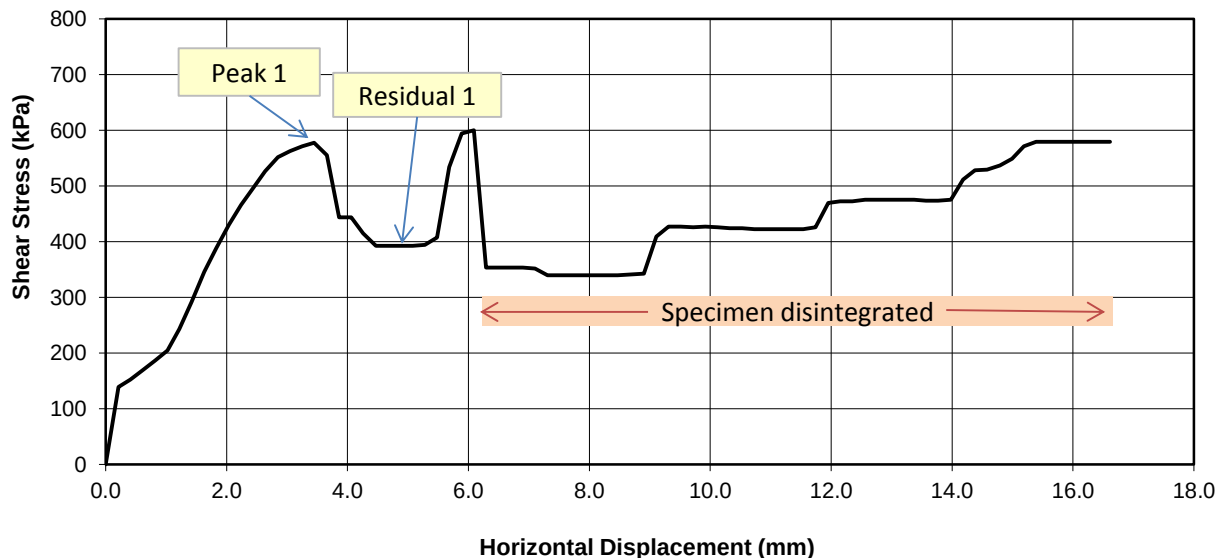
Borehole No: RBH06
Sample No: C23
Depth (m): 16.63

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 2-4.
Debris is abundant sand and fine to coarse gravel.¹

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

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S R Allen (Senior Tech)

Date: 31/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

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ISRM Suggested Method
Determination of Shear Strength by Direct Shear on Rock Sample
(large shearbox apparatus)

Borehole No: RBH06
Sample No: C35
Depth (m): 23.00

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is fine to sub-angular coarse gravel and sand.

Specimen Details

Type of shear plane

Pre existing plane of weakness: Joint

Preparation

Rock core encapsulated avoiding shear-plane then positioned in shearbox with shear-plane parallel to interface of top and bottom halves of shearbox.

Specimen Number

1

Maximum Length

mm 54.1

Maximum Width

mm 49.7

Area

mm² 2125.1

Shearing Stage

Normal stress	kPa	1500	3000	6000
Peak Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Maximum shear stress	kPa	719.3	1132.4	1926.0
Horizontal displacement at MSS	mm	2.9	4.1	5.7
Residual Conditions:				
Rate of horizontal displacement	mm/min	0.1	0.1	0.1
Residual shear stress	kPa	374.1	641.8	770.2
Final cumulative displacement	mm	15.0		

Duration day(s) 1

Shear Strength Parameters

Maximum Condition:

Apparent Cohesion kPa 323
Angle of Shearing Resistance degrees 15.0

Residual Condition:

Apparent Cohesion kPa 310
Angle of Shearing Resistance degrees 4.5

Notes:

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS ^{3d}

ISRM Suggested Method

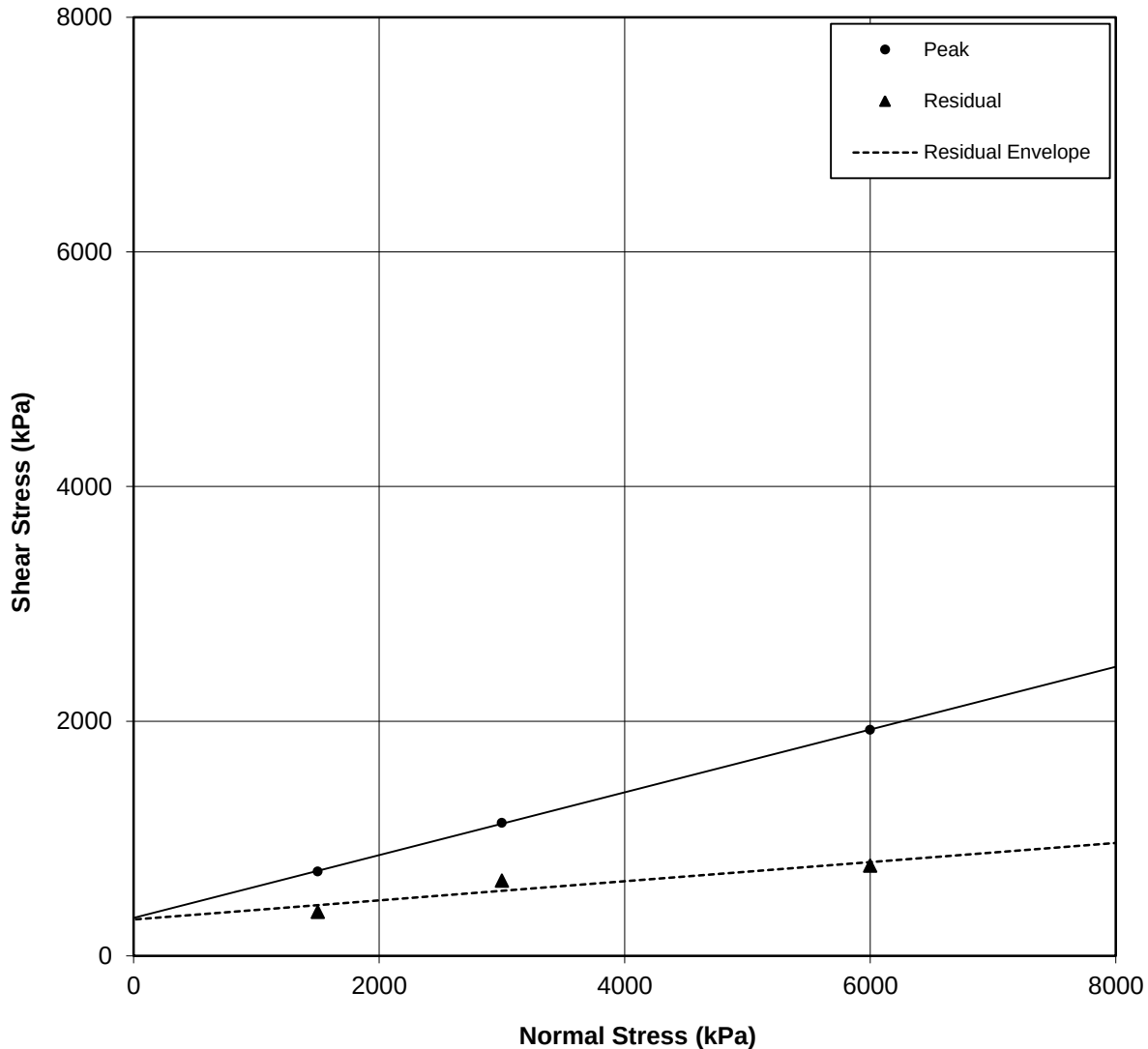
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

Borehole No: RBH06
Sample No: C35
Depth (m): 23.00

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is fine to sub-angular coarse gravel and sand.

Shear Stress v Normal Stress



Peak: $c' = 323$
 $\phi' = 15^\circ$

Residual: $c' = 310$
 $\phi' = 4.5^\circ$

Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

ISRM Suggested Method

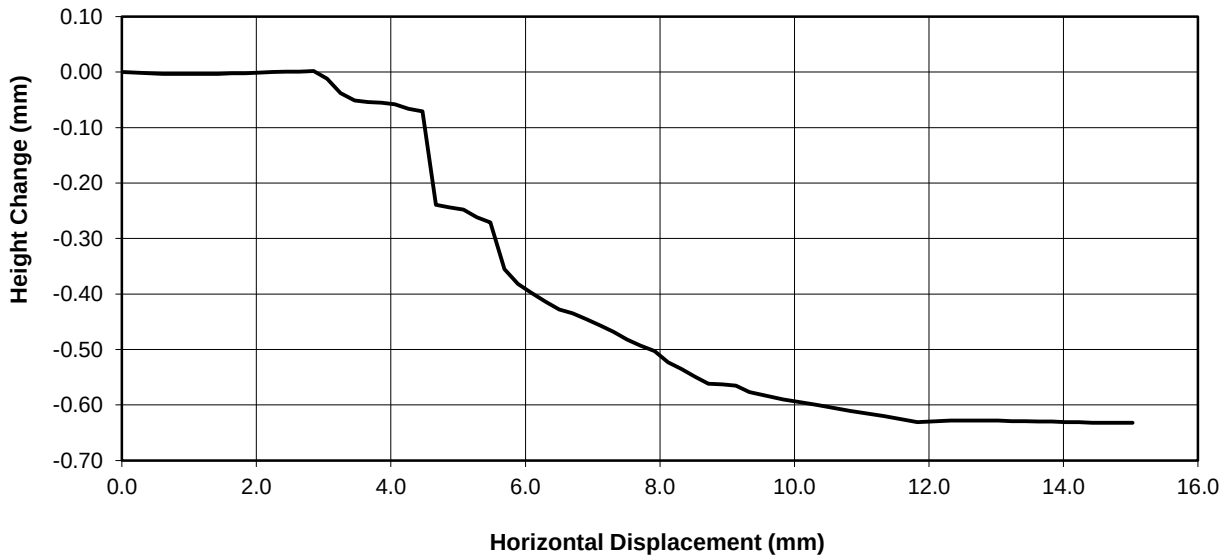
Determination of Shear Strength by Direct Shear on Rock Sample

(large shearbox apparatus)

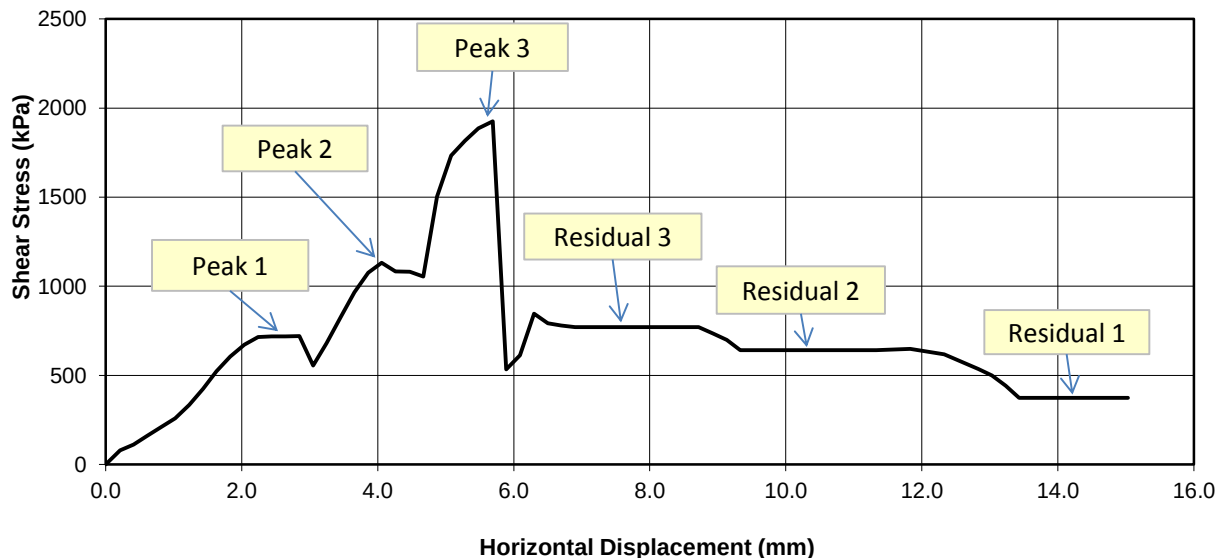
Borehole No: RBH06
Sample No: C35
Depth (m): 23.00

Description:
Medium strong to weak orangish brown fine to medium grained SANDSTONE. Moderately weathered. Natural shear plane with no infill material.
Joint roughness coefficient = 4-6.
Debris is fine to sub-angular coarse gravel and sand.

Height Change v Horizontal Displacement



Shear Stress v Horizontal Displacement



Checked and Approved by

SRA

S R Allen (Senior Tech)

Date: 29/08/2018

Project Number:

GEO / 27859

Project Name:

**St John's Masterplan
Project Ref: 42206**

GEOLABS

SOUND VELOCITY TEST

Sample details										Travel Time		Sound velocity	
Borehole Ref.	Sample Ref.	Depth (m)	Description	D. Tested	Sample Diameter (mm)	Sample Length (mm)	Bulk Density (Mg/m³)	Water Content (%)	Compression wave (µs)	Shear wave (µs)	Compression V_p (m/s)	Shear V_s (m/s)	
BH02	35	14.67-14.76	Very weak, thinly laminated, orangish brown SILTSTONE-MUDSTONE. Highly weathered	20/08/18	98.60	56.30	2.19	-	48.5	82.5	1161	682	
BH03	33	14.40-14.52	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	99.70	84.30	2.11	-	60.2	112.7	1400	748	
BH04B	9	12.65-12.92	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.10	227.70	2.17	-	126.5	219.4	1800	1038	
RBH02		17.12-17.29	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.30	141.50	2.13	-	86.3	150.5	1640	940	
RBH02		15.12-15.26	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.20	132.10	2.25	-	68.9	120.4	1917	1097	
RBH03		13.87-14.09	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.10	188.90	2.18	-	112.6	196.5	1678	961	
RBH03		15.11-15.30	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.40	163.10	2.34	-	91.8	160.7	1777	1015	
RBH04		14.07-14.24	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	100.90	130.60	2.17	-	78.4	140.7	1666	928	
RBH04		16.92-17.34	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.50	131.00	2.34	-	65.7	114.0	1994	1149	
RBH05	25	14.44-14.58	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	101.20	121.50	2.13	-	70.5	123.0	1723	988	

Checked and Approved by  C Clergeaud (Snr. Geologist) Date: 29/08/2018	Project Number: GEO / 27859 Project Name: ST JOHN'S MASTERPLAN 42206	
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SOUND VELOCITY TEST

Sample details										Travel Time		Sound velocity	
Borehole Ref.	Sample Ref.	Depth (m)	Description	D. Tested	Sample Diameter (mm)	Sample Length (mm)	Bulk Density (Mg/m³)	Water Content (%)	Compression wave (µs)	Shear wave (µs)	Compression V_p (m/s)	Shear V_s (m/s)	
RBH05	33	19.72-19.81	Very weak, thinly laminated, orangish brown SILTSTONE-MUDSTONE. Highly to completely weathered	20/08/18	101.10	62.40	2.08	-	48.5	96.5	1287	647	
RBH06	14	12.00-12.11	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	93.40	63.20	2.04	-	50.3	98.4	1256	642	
RBH06	28	20.00-20.20	Medium strong, orangish brown, fine to medium grained SANDSTONE. Moderately weathered	20/08/18	100.10	168.50	2.17	-	83.2	152.6	2025	1104	

Checked and Approved by  C Clergeaud (Snr. Geologist) Date: 29/08/2018	Project Number: GEO / 27859 Project Name: ST JOSEPH'S MASTERPLAN 42206	
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Appendix E – Ground Gas and Groundwater Monitoring Results

Contract Number: 42206						Gas Monitor: GA10157						
Contract Name: St John's Masterplan						Readings Taken By: PN						
Date: 26/07/2018						Checked By: TW						
Background Readings:		Weather Conditions:				Sunny, 25 °		O ₂ %	CO ₂ %	CH ₄ %	CO	H ₂ S
		Ground Conditions (dry / wet etc):				Dry		v/v	v/v	v/v	ppm	ppm
		Atmospheric Pressure (Start):				1011mb		20.9	0.0	0.0	0	0
		Atmospheric Pressure (Finish):				1011mb						
		Time (Start): 07:15 Time (Finish):				14:30						
Hole No:	VOC ppm	O ₂ % v/v	CO ₂ % v/v	CH ₄ % v/v		CO ppm	H ₂ S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Steady	mBGL	mBGL	mBGL
BH02	0.0	19.9	0.1	0.0	0.0	0	0	1.62	0.0	19.81	4.25	ND
BH03	0.0	18.6	0.9	0.0	0.0	0	0	0.97	0.0	9.48	3.92	ND
BH04	0.0	20.6	0.2	0.0	0.0	0	0	0.67	0.0	19.66	3.12	ND
RBH02	0.0	20.4	0.1	0.0	0.0	0	0	7.63	See remarks	18.62	3.41	ND
RBH04	0.0	18.2	1.2	0.0	0.0	0	0	1.07	-0.1	6.23	4.44	ND
RBH06	0.0	19.7	0.2	0.0	0.0	0	0	0.96	0.0	10.25	3.90	ND
WS04	0.0	12.2	4.5	0.0	0.0	0	0	0.09	0.0	2.85	Dry	ND
WS05	0.0	16.2	3.4	0.0	0.0	0	0	0.06	0.0	3.03	Dry	ND
WS06	0.0	19.7	1.6	0.0	0.0	0	0	0.41	0.0	3.03	Dry	ND
WS10	0.0	18.6	1.5	0.0	0.0	0	0	-0.18	0.0	21.80	3.45	ND
>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.												
Remarks:	RBH02 Flow - Initial = -7.0 per hour After 5 minutes flow fluctuating between -1.2 per hour and -2.3 per hour. No access to WS11, WS08 and RBH03 due to on site demolition											

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Gas and Groundwater Monitoring Results

Contract Number: 42206						Gas Monitor: GA10157						
Contract Name: St John's Masterplan						Readings Taken By: PN						
Date: 23rd August 2018						Checked By: HH						
Background Readings:		Weather Conditions:				Overcast, 16 °		O ₂ %	CO ₂ %	CH ₄ %	CO	H ₂ S
		Ground Conditions (dry / wet etc):				Wet		v/v	v/v	v/v	ppm	ppm
		Atmospheric Pressure (Start):				1009mb		20.8	0.0	0.0	0	0
		Atmospheric Pressure (Finish):				1009mb						
		Time (Start): 08:10		Time (Finish):		13:00						
Hole No:	VOC ppm	O ₂ % v/v	CO ₂ % v/v	CH ₄ % v/v		CO ppm	H ₂ S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Steady	mBGL	mBGL	mBGL
BH02	0.0	2.5	4.0	0.0	0.0	0	0	0.27	0.0	19.76	4.26	ND
BH03	0.0	18.7	0.9	0.0	0.0	0	0	0.39	0.0	9.47	1.97	ND
BH04	0.0	20.6	0.2	0.0	0.0	0	0	0.44	0.0	19.64	3.18	ND
RBH02	0.0	19.8	0.2	0.0	0.0	0	0	0.65	1.0	18.37	3.38	ND
RBH04	0.0	19.5	0.6	0.0	0.0	0	0	1.15	-0.1	10.31	4.06	ND
RBH05*	0.0	20.9	0.3	0.0	0.0	0	0	-1.15	0.3	19.75	4.18	ND
RBH06	Unable to access due to demolition in progress											
WS04	0.0	13.0	5.2	0.0	0.0	0	0	-0.33	0.0	2.85	Dry	NA
WS05	0.0	16.1	3.3	0.0	0.0	0	0	-0.35	0.0	3.03	Dry	NA
WS06	0.0	19.1	1.1	0.0	0.0	0	0	0.22	0.0	3.03	Dry	NA
WS08	0.0	17.0	0.2	0.0	0.0	0	0	0.40	0.0	3.05	Dry	NA
WS10	0.0	19.1	1.3	0.0	0.0	0	0	0.41	0.0	21.80	3.44	ND
>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.												
Remarks: *RBH05 Initial flow = 16.1 l/h Steady after 5 minutes. WS11 & RBH03 within demolition area- no access.												

Appendix F – GAC Screening Thresholds

Adopted Soil Generic Assessment Criteria
Sandy loam with 6% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10⁽¹³⁾ 22	85⁽¹³⁾ 150	1.8 3.9	230 410	120 220	560 880
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 21	6 21	1.8 170	33 49	7.7 21	220 250
Lead	200	310	80	2,300	630	1,300
Mercury (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	170	240	80	3600	120	240
Nickel	130⁽¹⁰⁾	180⁽¹⁰⁾	53⁽¹¹⁾	980⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32⁽¹²⁾ 37	35⁽¹²⁾ 40	43⁽¹²⁾ 49	640⁽¹²⁾ 640	79 79	170 170
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
<i>Aliphatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅₋₅ - EC ₆	160	160	3900	12000	600000	180000
EC ₅₋₆ - EC ₈	530	530	13000	40000	620000	320000
EC ₅₋₈ - EC ₁₀	150	150	1700	11000	13000	21000
EC ₁₀₋₁₀ - EC ₁₂	760	770	7300	47000	13000	24000
EC ₁₂₋₁₂ - EC ₁₆	4300	4400	13000	90000	13000	26000
EC ₅₋₁₆ - EC ₃₅	110000	110000	270000	1800000	250000	490000
EC ₃₅₋₃₅ - EC ₄₄	110000	110000	270000	1800000	250000	490000
<i>Aromatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅₋₅ - EC ₇	300	1400	57	86000	56000	92000
EC ₅₋₇ - EC ₈	660	3900	120	180000	56000	100000
EC ₅₋₈ - EC ₁₀	190	270	51	17000	5000	9300
EC ₁₀₋₁₀ - EC ₁₂	380	1200	74	34000	5000	10000
EC ₁₂₋₁₂ - EC ₁₆	660	2500	130	38000	5000	10000
EC ₅₋₁₆ - EC ₂₁	930	1900	260	28000	3800	7800
EC ₂₁₋₂₁ - EC ₃₅	1700	1900	1600	28000	3800	7900
EC ₃₅₋₃₅ - EC ₄₄	1700	1900	1600	28000	3800	7900
Aliph + Arom EC >44-70	1900	1900	3000	28000	3800	7900
Aromatic						
Benzene	0.33 0.87	1.0 3.3	0.07 0.18	95 98	73 140	110 230
Ethyl benzene	350	840	90	2800⁽⁸⁾ [66000]	2800⁽⁸⁾ [25000]	2800⁽⁸⁾ [27000]
Toluene	610	2700	120	4400⁽⁸⁾ [190000]	4400⁽⁸⁾ [56000]	4400⁽⁸⁾ [100000]
Xylene ⁽⁹⁾	230	290	160	2600⁽⁸⁾ [32000]	2600⁽⁸⁾ [43000]	2600⁽⁸⁾ [31000]
Phenol	420	520	280	3200⁽¹⁴⁾ (38000)	3200⁽¹⁴⁾ (10000)	3200⁽¹⁴⁾ (9300)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	13	13	24	1100	4900	3000
Acenaphthylene	920	6000	160	100000	15000	30000
Acenaphthene	1100	6000	200	100000	15000	30000
Fluorene	860	4500	160	71000	9900	20000
Phenanthrene	440	1500	90	23000	3100	6300
Anthracene	11000	37000	2200	540000	74000	150000
Fluoranthene	890	1600	290	23000	3100	6400
Pyrene	2000	3800	620	54000	7400	15000
Benz(a)anthracene	13	15	13	180	29	62
Chrysene	27	32	19	350	57	120
Benzo(b)fluoranthene	3.7	4.0	3.9	45	7.2	16.0
Benzo(k)fluoranthene	100	110	130	1200	190	440
Benzo(a)pyrene	3.0 5.0	3.2 5.3	3.5 5.7	36 77	5.7 10	13 21
Indeno(123cd)pyrene	41	46	39	510	82	180
Dibenzo(ah)anthracene	0.3	0.32	0.43	3.6	0.58	1.4
Benzo(ghi)perylene	350	360	640	4000	640	1600
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.0014	0.0015	0.0018	0.12	3.5	5.4
Trichloroethene (TCE)	0.075	0.08	0.21	5.7	120	120
1,1,1,2 Tetrachlorethane	6.4	8.2	4.4	560	1400	2100
Tetrachlorethane (PCE)	0.90	0.92	3.6	95	1400	1500
1,1,1 Trichlorethane	39	40	240	3000	140000	100000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in italics are S4ULs, numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs**
- Soil organic matter (SOM) is assumed to be 6% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 2.5% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10⁽¹³⁾ 22	85⁽¹³⁾ 150	1.8 3.9	230 410	120 220	560 880
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 <u>21</u>	6 <u>21</u>	1.8 <u>170</u>	33 <u>49</u>	7.7 <u>21</u>	220 <u>250</u>
Lead	<u>200</u>	<u>310</u>	<u>80</u>	<u>2,300</u>	<u>630</u>	<u>1,300</u>
Mercury (elemental)	1	1	26	26	16	26 ⁽⁸⁾ [30]
Mercury (inorganic)	170	240	80	3600	120	240
Nickel	130 ⁽¹⁰⁾	180 ⁽¹⁰⁾	53 ⁽¹¹⁾	980 ⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32⁽¹²⁾ 37	35⁽¹²⁾ 40	43⁽¹²⁾ 49	640⁽¹²⁾ 640	79 <u>79</u>	170 <u>170</u>
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
<i>Aliphatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅ - EC ₆	78	78	1700	5900	590000	130000
EC ₆ - EC ₈	230	230	5600	17000	610000	220000
EC ₈ - EC ₁₀	65	65	770	4800	13000	18000
EC ₁₀ - EC ₁₂	330	330	4400	23000	13000	23000
EC ₁₂ - EC ₁₆	2400	2400	13000	82000	13000	25000
EC ₁₆ - EC ₃₅	92000	92000	270000	1700000	250000	480000
EC ₃₅ - EC ₄₄	92000	92000	270000	1700000	250000	480000
<i>Aromatic risk banded hydrocarbons - TPHCWG method</i>						
EC ₅ - EC ₇	140	690	27	46000	56000	84000
EC ₇ - EC ₈	290	1800	51	110000	56000	95000
EC ₈ - EC ₁₀	83	110	21	8100	5000	8500
EC ₁₀ - EC ₁₂	180	590	31	28000	5000	9700
EC ₁₂ - EC ₁₆	330	2300	57	37000	5100	10000
EC ₁₆ - EC ₂₁	540	1900	110	28000	3800	7700
EC ₂₁ - EC ₃₅	1500	1900	820	28000	3800	7800
EC ₃₅ - EC ₄₄	1500	1900	820	28000	3800	7800
Aliph + Arom EC >44-70	1800	1900	2100	28000	3800	7800
<i>Aromatic</i>						
Benzene	0.16	0.49	0.035	50	72	100
Ethyl benzene	150	380	39	1200⁽⁸⁾ [35000]	1200⁽⁸⁾ [24000]	1200⁽⁸⁾ [22000]
Toluene	270	1300	51	1900⁽⁸⁾ [110000]	1900⁽⁸⁾ [56000]	1900⁽⁸⁾ [95000]
Xylene ⁽⁹⁾	98	120	70	1200⁽⁸⁾ [14000]	1200⁽⁸⁾ [42000]	1200⁽⁸⁾ [23000]
Phenol	290	420	140	1500⁽¹⁴⁾ (35000)	1500⁽¹⁴⁾ (10000)	1500⁽¹⁴⁾ (8300)
<i>Polycyclic Aromatic Hydrocarbons (PAH)</i>						
Naphthalene	5.6	5.6	10	460	4900	1900
Acenaphthylene	420	4600	69	97000	15000	30000
Acenaphthene	510	4700	85	97000	15000	30000
Fluorene	400	3800	67	68000	9900	20000
Phenanthrene	220	1500	38	22000	3100	6200
Anthracene	5400	35000	950	540000	74000	150000
Fluoranthene	560	1600	130	23000	3100	6300
Pyrene	1200	3800	270	54000	7400	15000
Benz(a)anthracene	11	14	6.5	170	29	56
Chrysene	22	31	9.4	350	57	110
Benzo(b)fluoranthene	3.3	4.0	2.1	44	7.2	15
Benzo(k)fluoranthene	93	110	75	1200	190	410
Benzo(a)pyrene	2.7	3.2	2	35	5.7	12
Indeno(123cd)pyrene	36	46	21	510	82	170
Dibenzo(ah)anthracene	0.28	0.32	0.27	3.6	0.57	1.3
Benzo(ghi)perylene	340	360	470	4000	640	1500
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.00087	0.001	0.001	0.077	3.5	5
Trichloroethene (TCE)	0.034	0.036	0.091	2.6	120	91
1,1,1,2 Tetrachlorethane	2.8	3.5	1.9	250	1400	1800
Tetrachlorethane (PCE)	0.39	0.4	1.5	42	1400	1100
1,1,1 Trichlorethane	18	18	110	1300	140000	76000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in italics are S4ULs, numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs
- Soil organic matter (SOM) is assumed to be 2.5% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM



Contaminants	Residential <u>with</u> home grown produce	Residential <u>without</u> home grown produce	Allotments	Commercial	Public open space near residential housing POS _{resi}	Public park POS _{park}
Metals						
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11,000	45	240,000	21,000	46,000
Cadmium	10⁽¹³⁾ 22	85⁽¹³⁾ 150	1.8 3.9	230 410	120 220	560 880
Chromium III	910	910	18,000	8,600	1,500	33,000
Chromium VI	6 21	6 21	1.8 170	33 49	7.7 21	220 250
Lead	200	310	80	2,300	630	1,300
Mercury (<i>elemental</i>)	1	1	26	26	16	26⁽⁸⁾ [30]
Mercury (<i>inorganic</i>)	170	240	80	3600	120	240
Nickel	130 ⁽¹⁰⁾	180 ⁽¹⁰⁾	53 ⁽¹¹⁾	980 ⁽¹⁰⁾	230	800
Vanadium	410	1200	91	9000	2000	5000
Copper	2400	7100	520	68000	12000	44000
Zinc	3700	40000	620	730000	81000	170000
Semi-Metals and non-metals						
Arsenic	32⁽¹²⁾ 37	35⁽¹²⁾ 40	43⁽¹²⁾ 49	640⁽¹²⁾ 640	79 79	170 170
Antimony		550		7500	1500	3300
Selenium	350	600	120	13000	1100	1800
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
EC ₅₋₅ - EC ₆	42	42	730	3200	570000	95000
EC ₆₋₆ - EC ₈	100	100	2300	7800	600000	150000
EC ₈₋₈ - EC ₁₀	27	27	320	2000	13000	14000
EC ₁₀₋₁₀ - EC ₁₂	130	130	2200	9700	13000	21000
EC ₁₂₋₁₂ - EC ₁₆	1100	1100	11000	59000	13000	25000
EC ₁₆₋₁₆ - EC ₃₅	65000	65000	260000	1600000	250000	450000
EC ₃₅₋₃₅ - EC ₄₄	65000	65000	260000	1600000	250000	450000
Aromatic risk banded hydrocarbons - TPHCWG method						
EC ₅₋₅ - EC ₇	70	370	13	26000	56000	76000
EC ₇₋₇ - EC ₈	130	860	22	56000	56000	87000
EC ₈₋₈ - EC ₁₀	34	47	8.6	3500	5000	7200
EC ₁₀₋₁₀ - EC ₁₂	74	250	13	16000	5000	9200
EC ₁₂₋₁₂ - EC ₁₆	140	1800	23	36000	5100	10000
EC ₁₆₋₁₆ - EC ₂₁	260	1900	46	28000	3800	7600
EC ₂₁₋₂₁ - EC ₃₅	1100	1900	370	28000	3800	7800
EC ₃₅₋₃₅ - EC ₄₄	1100	1900	370	28000	3800	7800
Aliph + Arom EC >44-70	1600	1900	1200	28000	3800	7800
Aromatic						
Benzene	0.08	0.3	0.017	28	72	90
Ethyl benzene	65	170	16	520⁽⁸⁾ [17000]	520⁽⁸⁾ [24000]	520⁽⁸⁾ [17000]
Toluene	120	610	22	860⁽⁸⁾ [59000]	860⁽⁸⁾ [56000]	860⁽⁸⁾ [87000]
Xylene ⁽⁹⁾	41	53	28	480⁽⁸⁾ [69000]	480⁽⁸⁾ [41000]	480⁽⁸⁾ [17000]
Phenol	180	310	66	760⁽¹⁴⁾ (31000)	760⁽¹⁴⁾ (10000)	760⁽¹⁴⁾ (7600)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	2.3	2.3	4.1	190	4900	1200
Acenaphthylene	170	2900	28	83000	15000	29000
Acenaphthene	210	3000	34	84000	15000	29000
Fluorene	170	2800	27	63000	9900	20000
Phenanthrene	95	1300	15	22000	3100	6200
Anthracene	2400	31000	380	520000	74000	150000
Fluoranthene	280	1500	52	23000	3100	6300
Pyrene	620	3700	110	54000	7400	15000
Benz(a)anthracene	7.2	11	2.9	170	29	49
Chrysene	15	30	4.1	350	57	93
Benzo(b)fluoranthene	2.6	3.9	0.99	44	7.1	13
Benzo(k)fluoranthene	77	110	37	1200	190	370
Benzo(a)pyrene	2.2	3.2	0.97	35	5.7	11
Indeno(123cd)pyrene	27	45	9.5	500	82	150
Dibenzo(ah)anthracene	0.24	0.31	0.14	3.5	0.57	1.1
Benzo(ghi)perylene	320	360	290	3900	640	1400
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	0.00064	0.00077	0.00055	0.059	3.5	4.8
Trichloroethene (TCE)	0.016	0.017	0.041	1.2	120	70
1,1,1,2 Tetrachlorethane	1.2	1.5	0.79	110	1400	1500
Tetrachlorethane (PCE)	0.18	0.18	0.65	19	1400	810
1,1,1 Trichlorethane	8.8	9	48	660	140000	57000

Notes

- All values above are in mg/kg
- Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters, numbers in italics are S4ULs, numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters and underlined numbers are C4SLs**
- Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
- Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
- For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
- For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
- For classrooms consider increasing the dust loading factor in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m⁻³
- Based on vapour saturation limit as suggested by EA / [] model value
- Lowest of o-, m- and p-xylene
- Based on comparison of inhalation exposure with inhalation TDI
- Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
- Based on a comparison of oral and dermal soil exposure with oral Index Dose only
- Averaged over and based on lifetime exposure
- Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
- NA: Not applicable

Appendix G – Risk Assessment Methodology

The site-specific risk assessment, presented in this report, follows the principle of establishing whether there is a viable linkage between a contaminant source to a potential receptor, via an exposure pathway.

The risk assessment corresponds with the total site area and incorporates both descriptive (qualitative) and, where available, numerical (quantitative) lines of evidence.

Risk assessment is the process of collating known information on a hazard or set of hazards to estimate actual or potential risk to receptors. The receptor may be humans, a water resource, a sensitive local ecosystem or future construction materials. Receptors can be connected to the source by one or several exposure pathways such as direct contact for example. Risks are generally managed by isolating the receptor or intercepting the exposure pathway or by isolating or removing the hazard.

Without the three essential components of a source, pathway and receptor there can be no risk. Therefore, the presence of contaminant source on a site does not necessarily mean there is a risk.

The risk assessment considers the likelihood of an event taking place (accounting for the presence of the source and receptor and the viability of the exposure pathway) in conjunction with the severity of the potential consequence (accounting for the potential severity of the hazard and the sensitivity of the receptor).

In the risk assessment, the consequence of the hazard has been classified as severe or medium or mild or minor and the probability (likelihood) of the circumstances occurring classified as high likelihood or likely or low likelihood or unlikely.

The consequences and probabilities are subsequently cross-correlated to give a qualitative estimation of the risk using Department of the Environment risk classifications as detailed in the table below and as referenced in CIRIA C552.

		Consequence			
		Severe	Medium	Mild	Minor
Probability (Likelihood)	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Phase 2 Site Investigation

In accordance with DoE guidance, the following categorisation of **consequence** has been developed.

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to an ecosystem or organisation forming part of such ecosystem.	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health. Pollution of sensitive water resources. A significant change in an ecosystem or organism forming part of such ecosystem.	Concentration of a contaminant from site exceeds the generic or site-specific assessment criteria. Leaching of contaminants from a site to a Principal or Secondary A aquifer. Death of a species within a designated nature reserve. Lesser toxic and asphyxiate effects
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater (inc. Secondary B aquifers). Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

In accordance with DoE guidance, the following categorisation of **probability** has been developed.

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

In accordance with DoE guidance, the following categorisation of **risk** has been developed.

Classification	Definition
Very High Risk	There is a <i>high probability</i> that <i>severe harm</i> could arise to a designated receptor from an identified hazard at the site without appropriate further action.
High Risk	<i>Harm is likely to arise</i> to a designated receptor from an identified hazard at the site without appropriate further action.
Moderate Risk	<i>It is possible</i> that without appropriate further action <i>harm could arise</i> to a designated receptor. It is relatively <i>unlikely</i> that any such harm would be <i>severe</i> , and if any harm were to occur it is <i>more likely</i> that such harm would be <i>relatively mild</i> .
Low Risk	<i>It is possible</i> that <i>harm could arise</i> to a designated receptor from an identified hazard. It is <i>likely</i> that, at worst, if any harm was realised any effects would be <i>mild</i> .
Very Low Risk	The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

The term 'risk' in this instance refers to the risk that the source, pathway, receptor linkage for a given source of contamination is complete. It does not refer to immediate risk to individuals or features present on the site from potential contaminants and is intended to be used as a tool to assess the necessity of further investigation.

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