

Tidal Lagoon Swansea Bay

OPERATIONAL DRAINAGE SCHEME

DCO REQUIREMENT 11

WORKS 7A

May 2020

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Table of Contents

1	Introduction	1
1.1	The Swansea Bay tidal lagoon.....	1
1.2	DCO Requirement – Operational Drainage Scheme	1
1.3	Purpose of amendment to the approved Operational Drainage Scheme	2
1.4	Linkages to other plans.....	4
2	Operation Drainage Scheme – Work 7a	5
2.1	Overview	5
2.2	Drainage Areas.....	6
2.3	SuDS Evaluation.....	6
2.4	Drainage Strategy	8
2.5	Outfall Design.....	10
2.6	Exceedance Assessment	11
2.7	Discharge of Aqueous Effluent – Foul Water.....	11
2.8	Maintenance	11
3	Requirement 11 (Operational Drainage Scheme) Approval	13
	Appendix A: Drainage Drawings.....	14
	Appendix B: Drainage Calculations	16
	Appendix C – Site Investigation – Infiltration Data	21

1 Introduction

1.1 The Swansea Bay tidal lagoon

- 1.1.1 Tidal Lagoon Swansea Bay (TLSB) will be the world's first purpose built tidal energy lagoon. The generating station will have an installed capacity of 320 megawatts (MW) and will enclose part of Swansea Bay, from the eastern side of the River Tawe to the eastern edge of the new Swansea University Bay-Campus. In total the seawall will form an approximately 9.5km-long, U-shape which will encompass approximately 11.5km² of the seabed, foreshore and intertidal area of Swansea Bay.
- 1.1.2 A Development Consent Order (DCO) for the project was granted by the Secretary of State (SoS) on 9 June 2015. The Swansea Bay Tidal Generating Station Order 2015 came into force on 30 June 2015.
- 1.1.3 **This supporting document is an addendum to the following submission to satisfy DCO Requirement 11 (Operational Drainage Scheme) for the work in Zone 7a:**
- **Construction Environmental Management Plan (CEMP) – Operational Drainage Scheme – DCO Requirement 11 - TLSB-TLP-PMO-XXX-SCM-0002.**
- 1.1.4 The Operational Drainage Scheme (ODS) was approved under application reference 2017/0802/DCO.

1.2 DCO Requirement – Operational Drainage Scheme

- 1.2.1 DCO Requirement 11 states:

11. (1) *No part of the authorised development shall commence until a written scheme to deal with the details of the surface water drainage system and the sewage system (together, the "operational drainage scheme") incorporating a sustainable urban drainage system so far as appropriate has been submitted to and approved by the relevant planning authority in consultation with the relevant drainage authority.*

(2) The operational drainage scheme shall provide for—

(a) prior to commencement of development, a survey to be undertaken to identify existing site drainage within the Order limits including old surface water boreholes, disused draining networks from earlier developments and part demolished sections of existing drainage and the decommissioning of any surface water drainage network or exposed boreholes so identified to the satisfaction of Natural Resources Wales;

(b) a rainwater harvesting system to be included in the authorised development;

(c) surface water that has the potential for oil contamination to be passed through oil interceptors;

(d) measures to avoid risk of spillage of contaminating material;

(e) the discharge of all aqueous effluents via the drainage system comprised in the authorised development;

(f) a system to collect and treat run off from stock piles prior to discharge to the surface water drainage system; and

(g) the avoidance of any tie-in to drains serving the A483 Fabian Way.

(3) The scheme must be implemented in accordance with the approved details prior to operation of the authorised development and maintained during the operation of the authorised development.

1.3 Purpose of amendment to the approved Operational Drainage Scheme

1.3.1 An application to discharge requirements 3 (Construction Phasing Scheme) of the DCO was previously submitted and approved (Application Reference 2017/0801/DCO) by the City and County of Swansea Council (CCSC) and Neath Port Talbot Council (NPTC). During this application process, a number of iterations of the proposed Construction Phasing Scheme were prepared which were subject to consultation with CCSC, NPTC and National Resources Wales (NRW). The Construction Phasing Scheme (reference Construction Phasing Scheme _2.0_May17_TLSB_DCO3, dated 19 May 2017) was approved in 2017.

1.3.2 The last few years has seen significant changes to key aspects of the project. It was previously considered that mobilisation of construction in the first phase would occur in parallel on land and in the marine area (below mean low water) in order to streamline the construction programme. It is more complex to commence the authorised development below mean low water, therefore attention is now focused on mobilising landward construction only in the first phase of the authorised development. It is proposed to undertake Phase 1 mobilisation of the authorised development through commencement of Work 7a and development (on land) in connection with Work 7a (in accordance with Schedule 1 Part 1A of the DCO).

1.3.3 Work 7a was previously planned for later in the construction programme. Therefore, a review of the Phasing Scheme, which included a sequence of work, was required in order to facilitate the revised approach to mobilisation in the first phase to commence the authorised development.

1.3.4 In addition, the Construction Phasing Matrix formed part of the approved Construction Phasing Scheme intended to support a phased approach to approvals, in accordance with Requirement 3(2). Therefore, a review of the matrix was also required in light of the revised approach to the first phase of the authorised development, to support a phased approach to obtaining the approvals required prior to commencement of Work 7a and development (on land) in connection with Work 7a (in accordance with Schedule 1 Part 1A of the DCO). As such, in order to facilitate a phased approach to discharging the requirements of the DCO with the relevant authorities to facilitate the construction of the Swansea Bay Tidal Lagoon, a revised Construction Phasing Scheme is submitted for approval in accordance with Requirement 38 (amendments to approved details).

1.3.5 This revised Construction Phasing Matrix is provided in the Construction Phasing Scheme DCO Requirement 3 (TLSB-TLP-PMO-XXX-SCM-0001 revision 4.0 - 20th April 2020). The 7a works are described below:

- **Work 7a (a new internal access road comprising 2 carriageways together with a fence in between running in a north-easterly direction from 267048E; 191928N to 269035E; 192887N); and in connection with Work 7a (with reference to Part 1A) a), temporary construction works, including workshops and stores, working areas, laydown areas, construction sites, and vehicle parking facilities; f) to the extent shown on the demolition plan, the alteration, removal, clearance, refurbishment, reconstruction, decommissioning and demolition of any buildings and structures within the Order limits; h) lighting columns and lighting; i) safety / emergency points.**

1.3.6 As a result, the Operational Drainage Scheme (ODS) requires amendment to facilitate the change in the construction project phasing and to construct the 7a works (including Part 1A).

1.3.7 This document provides details of the updated Zone 7a (including Part 1A) drainage works.

1.3.8 This document aims to discharge the requirements under DCO Requirement 11 (Operational Drainage Scheme) as shown in Table 1.1:

DCO Requirement 11		Relevant DCO Work(s)	Details provided for approval
11.(1)	<i>No part of the authorised development shall commence until a written scheme to deal with the details of the surface water drainage system and the sewage system (together, the "operational drainage scheme") incorporating a sustainable urban drainage system so far as appropriate has been submitted to and approved by the relevant planning authority in consultation with the relevant drainage authority;</i>	Work 7a (including Part 1A).	Y
11.2 (a)	<i>prior to commencement of development, a survey to be undertaken to identify existing site drainage within the Order limits including old surface water boreholes, disused draining networks from earlier developments and part demolished sections of existing drainage and the decommissioning of any surface water drainage network or exposed boreholes so identified to the satisfaction of Natural Resources Wales;</i>	Work 7a (including Part 1A)	Y
11.2 (d)	<i>measures to avoid risk of spillage of contaminating material;</i>	Work 7a (including Part 1A)	Y

11.2 (e)	<i>the discharge of all aqueous effluents via the drainage system comprised in the authorised development; and</i>	Work 7a (including Part 1A)	Y
11.2 (f)	<i>a system to collect and treat run off from stockpiles prior to discharge to the surface water drainage system</i>	Work 7a (including Part 1A)	Y
11.2 (g)	<i>the avoidance of any tie-in to drains serving the A483 Fabian Way.</i>	Work 7a (including Part 1A)	Y

Table 1.1 – DCO Requirement 11 – Approval of 7a Works

1.4 Linkages to other plans

1.4.1 The following DCO plans and environmental strategies provide information relevant to this report:

- DCO Requirement 3 – Construction Phasing Scheme; and
- DCO Requirement 5 – Construction Environmental Management Plan

1.4.2 The plans listed above are not required for approval of the updated ODS proposals for Works 7a but are listed for ease of reference only.

2 Operation Drainage Scheme – Works 7a

2.1 Overview

- 2.1.1 This supporting document provides details of the revised drainage proposals in connection with Work 7a (including Part 1A). Other areas of the site remain as per the original ODS (TLSB-TLP-PMO-XXX-SCM-0002 revision 2.0).
- 2.1.2 The drainage works in Works 7a have been revised due to updated information on the ground contamination. The Part 1A works also have some minor amendments to the entrance area and temporary road junctions to facilitate the construction. They also include the demolition of a building, and the construction of 2 lay down areas and a stockpile area, to facilitate the construction works.
- 2.1.3 As described in document 'Tidal Lagoon Swansea Bay – Data Review for Phase 7a Works – 7A [5196632]1.0 May 2020' [which has been submitted as part of the discharge of DCO Requirement 12], ground contamination exists within the Works 7a and it is therefore not recommended to utilise infiltration drainage except in the western area of Works 7a. This has been assessed as being west of road chainage 2165m (along new TLSB roadway to the car parking area).
- 2.1.4 The original ODS proposal for Works 7a utilised infiltration as a means of surface water drainage disposal (this in line with Statutory National Standards for Sustainable Drainage Systems for Wales – S1 Priority Level 2). The ODS stated that if this was not possible then the drainage will outfall to the adjacent sea, as no other drainage assets exist in this area (this in line with Statutory National Standards for Sustainable Drainage Systems for Wales – S1 Priority Level 3). In line with Statutory National Standards for Sustainable Drainage Systems for Wales G2.1, as this will be discharging to a surface water body (i.e. the sea), no peak flow or volume control is required.
- 2.1.5 The design for Works 7a has therefore been revised to the east of road chainage 2165m to avoid the utilisation of infiltration drainage and to discharge to the sea. The area to the west of chainage 2165m will continue to be drained by infiltration systems. Calculations have been provided to demonstrate that these infiltration systems will work based on ground water level information and falling head permeability tests. The infiltration rates will however be verified with tests in accordance with BRE Digest 365 prior to the construction of the infiltration trenches.
- 2.1.6 The amended drainage proposal has been designed to accord with the requirements of the original ODS (TLSB-TLP-PMO-XXX-SCM-0002 revision 2.0) and further information has been provided, including drainage calculations and details of the revised Sustainable Drainage Systems (SuDS) strategy.
- 2.1.7 The revised Works 7a drainage scheme also adheres with the latest Design Manual for Roads and Bridges (DMRB) standards.

2.2 Drainage Areas

- 2.2.1 Works 7a work consists of the following 3 distinct areas which all require separate SuDS Strategies due to their unique settings:

Area 1 – Eastern Entrance Area (from Road Chainage 0m to 100m)

- The entrance area to the east of the Welsh Water Treatment works emergency outfall pipe (which creates a physical constraint). This will be a hard-paved entrance area to serve the new TLSB project with a security cabin. The existing port road will also be realigned in this area and a new junction provided.
- The Part 1A works in this area consists of constructing the new TLSB entrance area hard paving and providing temporary road connections to the existing port road and unnamed road connecting to Baldwins Crescent. The temporary junctions will later be amended to suit the final Works 7A proposals.
- There are proposed utilities to the east of the entrance area, a footpath, an existing sea wall which will be removed and replaced with a batter and any design solution needs to ensure minimal encroachment into the landowner (St. Modwen) property to the east.

Area 2 – Central Area - Dual Roads along Seafront (Road Chainage 100m to 2165m)

- This is the main stretch of dual roadway along the sea front, with associated new sea wall, footpath and grassed verges.
- The Part 1A works consist of providing a temporary road entrance to construction manufacture and prefabrication areas from the existing port road.

Area 3 – Western Area (West of Chainage 2165m)

- This is where the roads diverge with the new port road connecting to the existing port and the TLSB roadway connecting to a future carparking area.
- The Part 1A works consists of the demolition of an existing building, and construction of 2 new lay down areas (with new temporary junctions from the existing port road) and a stockpile area.

2.3 SuDS Evaluation

- 2.3.1 A number of SuDS options were considered for Areas 1 and 2, considering amenity, biodiversity, treatment and attenuation properties. Area 3 is proposed to drain to infiltration trenches as per the original ODS (TLSB-TLP-PMO-XXX-SCM-0002 revision 2.0) and in line with the Statutory National Standards for Sustainable Drainage Systems for Wales – S1 Priority Level 2. The SuDS Assessment is summarised in Table 2-1, together with the selected solution.

Tidal Lagoon Swansea Bay

SuDS Type	Area 1 – Eastern Entrance Area	Area 2 – Central Area (Dual Roads along seafront)	Area 3 – Western Area
Attenuation Tank	No attenuation required	No attenuation required	No attenuation required
Rainwater Harvesting	No buildings except security post	No buildings	No buildings
Ponds	Insufficient space	Insufficient space	Infiltration considered a more appropriate solution
Previous Pavement	High traffic loading - considered undesirable for access roadways	High traffic loading considered undesirable for access roadways	High traffic loading considered in undesirable for access roadways and will potentially mobilise contamination
Wetlands	Insufficient space	Insufficient space	Infiltration considered a more appropriate solution
Infiltration Systems	Contamination precludes	Contamination precludes	Selected Solution
Proprietary Treatment Systems	Selected Solution – Vortex Separator with a pipework system	A large number of units would be required to each sea outfall	Infiltration considered a more appropriate solution
Filter Strips	Insufficient Space	Insufficient Space	Infiltration considered a more appropriate solution
Filter Drains	Not preferred due to maintenance requirements	Not preferred due to maintenance requirements	Infiltration considered a more appropriate solution
Tree Pits	Trees not proposed	Trees not proposed	Trees not proposed
Bio Retention Gardens	Insufficient space	Insufficient space	Infiltration considered a more appropriate solution
Green/Blue Roofs	Not suitable for security post roof – no other buildings	No buildings	No buildings
Dry/Wet Swales	Insufficient space	Preferred Solution to provide amenity, biodiversity enhancements and water quality treatment	Infiltration considered a more appropriate solution

SuDS Type	Area 1 – Eastern Entrance Area	Area 2 – Central Area (Dual Roads along seafront)	Area 3 – Western Area
Detention Basins	Insufficient space or benefit and no attenuation required	Insufficient space or benefit and no attenuation required	Infiltration considered a more appropriate solution

Table 2.1 – SuDS Assessment

2.4 Drainage Scheme

2.4.1 The proposed SuDS solution is discussed further below for each area of Works 7a (including Part 1A). Plans of the proposals are included in Appendix A and hydraulic calculations provided in Appendix B.

Area 1 – Eastern Entrance Area

2.4.2 Due to the confined space and small catchment area to the east of the Welsh Water Treatment Works emergency outfall, it is proposed to provide a piped system with a Vortex Separator (ACO V-Septor or similar) to treat surface water flows, prior to them being discharged to the sea. Details of the outfall design is described in Section 2.5.

2.4.3 The pipework system has been designed to adhere with the following DMRB design criteria as per the original ODS:

- No surcharging in a 1 in 1 year return period storm event
- No surface flooding in a 1 in 5 year return period storm event
- Exceedance check in a 1 in 100 year return period storm event
- Climate Change Allowance - +30%

2.4.4 All chambers will be constructed as catchpits.

2.4.5 The pipework, vortex separator and outfall will be built as part of the Part 1A works. Stubs will be provided to drain the remainder of the Works 7a Works Area 1, which consist of the roof to the security post and realigned port road.

2.4.6 Space proofing has also been provided for an additional outfall for the future road connecting to Baldwins Crescent, if in the future infiltration is found not to be viable to drain these roads due to contamination. This will be determined before the port road is constructed.

Area 2 – Dual Roads along seafront

2.4.7 In order to enhance amenity, biodiversity and improve the water quality along this length of road prior to discharging to the sea, dry swales are proposed. The swales will have a 0.5m base and have been designed to enhance water quality.

- 2.4.8 The Swales have been designed to adhere with DMRB CD 532 'Vegetated drainage systems for highway run-off', allowing for the following design criteria:
- No flooding in a 1 in 5 year return period storm event
 - Water Quality – the grass height is at least twice the depth of water to be treated in the 1 in 5 year 24 hour storm event
 - Exceedance check in a 1 in 100 year return period storm event
 - Climate Change Allowance - +30%
- 2.4.9 The swales will be lined and receive inflows from the roadway Combined Kerb Drainage (CKD) units and will outfall to the sea via new outfalls. The design of the outfalls is described in section 2.5.
- 2.4.10 The Swales will have side slopes of 1 in 3 at the head of the runs, with 600mm depth to allow discharge from the CKD gully outlets. The side slopes will taper to 1 in 2 at the outlet points. Grass cutting can be undertaken from the adjacent roads and footpaths with a back actor mower from a road vehicle.
- 2.4.11 The swales will also be attractive to the native species such as reptiles and will create a wildlife habitat. Mostly they will be dry except the 0.5m base, and they have been designed to only fill up a nominal amount even in a 100 year storm rainfall event.
- 2.4.12 If providing a substantial Water Quality enhancement to the sea outfalls is deemed not to be necessary, the swales could alternatively be replaced with Filter Drains at the detailed design stage. These will also provide some treatment, but to a lesser effect than the swales, and the grassed area between the TLSB road and sea wall footpath would be flat.
- 2.4.13 In the Part 1A works, a small temporary entrance is to be built to serve the manufacture and fabrication area. This will be either temporary drained back to the existing road or a small soakaway provided to mimic the existing drainage regime.

Area 3 – Western Area

- 2.4.14 Infiltration trenches are proposed to drain the roadways in line with the original ODS, which also adheres with Statutory National Standards for Sustainable Drainage Systems for Wales – S1 Priority Level 2. Due to the presence of contamination and the future marina area (which constrains outfall locations to the sea), the roadway CKD units between chainages 2065m (chainage 1995m port road) and 2165m will discharge west into the infiltration trenches. The pipework has been designed as per the design criteria for Area 1.
- 2.4.15 The Infiltration Trenches have been designed to adhere with DMRB CD 530 'Design of Soakaways', allowing for the following design criteria:
- No surface flooding in a 1 in 10 year return period storm event
 - Factor of Safety 5 (minor convenience for areas > 1000m²).
 - Half Empty Time < 24 hours

- Exceedance check in a 1 in 100 year return period storm event
 - Climate Change Allowance - +30%
- 2.4.16 The soakaways will be provided with observation wells and access chambers, as per DMRB CD 530. All upstream chambers will be constructed as catchpits.
- 2.4.17 A conservative infiltration Rate of 2.798×10^{-5} m/s (the worst case of the closest falling head tests undertaken at Borehole BH1 and BH2) has been utilised to the size the soakaways. This will be verified by on-site testing in accordance with BRE365 prior to their construction. The base of the soakaways have also been designed to be as high as possible and a minimum 1.2m above ground water levels. Details of the design justification, falling head tests and groundwater modelling taken from 'White Young Green Tidal Lagoon Ground Investigation Interpretive Report (Phase 1) March 2017' are included in Appendix C.
- 2.4.18 For the Part 1A works, small temporary entrances are to be built to serve the construction laydown areas, this will be either drain back to the existing road or small soakaways provided.
- 2.4.19 The new Part 1A temporary construction laydown and stockpile areas will be drained in accordance with the principles set out in the Pollution Prevention Plan (PPP) reference TLSB_DCO_Req5_PPP_May2020_v2, as summarised below:
- Any material that is identified as contaminated and needs to be stockpiled during the Part 1A works will be placed on an impermeable membrane and capped so that it is isolated and does not generate any contaminated runoff.
 - No additional or revised drainage is proposed within the laydown or stockpile areas during Phase 1 works.

2.5 Outfall Design

- 2.5.1 All outfalls have been designed for all of the outfall structures to be located above the Mean High Water Spring (MHWS) tide level of + 4.5mAOD, with outfall pipework set at 4.95 mAOD. The outfall pipes vary in size from 225mm to 300mm diameter, and the outfalls will consist of small concrete structures as shown in Appendix A.
- 2.5.2 The MHWS tide level has been selected as an appropriate tide level to interpret 'high tide' for design purposes, however flap valves have been provided to ensure that infrequent higher tides do not backflow into the drainage system (highest tide in the Lagoon is 5.00m AOD). The upstream pipework and swale systems are also higher than the Highest Astronomical Tide (HAT) level of 5.5m AOD, so all flows could surcharge into the sea in these extreme events.
- 2.5.3 Natural Resources Wales (NRW) have been consulted regarding the requirement for a Flood Risk Activity Permit (FRAP) for the outfall works, and they have confirmed this is not required. As the works are above the MHWS level, a marine license is also not deemed to be required for the Works 7a (including Part 1A).

2.6 Exceedance Assessment

- 2.6.1 All of the areas have been checked against a 1 in 100 year return period storm event (+ 30% climate change event), and the results are summarised in Table 2.2. Further details are provided in the hydraulic calculation in Appendix B.

Area	Worse Case 1 in 100 year storm event flooding (+30% Climate Change)	Notes
Area 1 – Eastern Entrance Area	0 m ³	No flooding
Area 2 – Central Area (Dual Roads along seafront)	0 m ³	Flows will be contained within the swales including Area 3 Exceedance overflows
Area 3 – Western Area	21.8 m ³ (TLSB Road) 30.3 m ³ (Port Road)	This will build up against the kerb and flow east and enter the swale systems - or soakaways can be oversized in detailed design stage.

Table 2.2 – Exceedance Assessment

2.7 Discharge of Aqueous Effluent – Foul Water

- 2.7.1 No foul water drainage is proposed in the Works 7a area and the security post will not have sanitary fittings.
- 2.7.2 A future foul water main will pass through Works 7a (to the east of the entrance area and avoiding Part 1A), which will serve the remainder of the development to the west and forms part of the utilities design.
- 2.7.3 For details of the control of foul water drainage in the construction stage, mobile facilities will be provided during the construction stage which will be emptied by suction trucks.

2.8 Maintenance

- 2.8.1 Maintenance is proposed as per the original ODS, with the following requirements for the infiltration trenches:
- Catchpits will be utilised on all infiltration systems to provide a sump for collection of silt for ease of future maintenance.
 - Catchpit chambers and access points will be provided on the infiltration drains at each change of direction/main pipe diameter and when the distance between chambers exceeds 60-70m. Rodding access points will be provided at the upstream end of each below ground surface water drainage system, where installation of an access chamber. Inspection wells will also be provided.

2.8.2 The following maintenance is expected for the drainage systems, which all have been designed to accord with DMRB standards:

- Trench Soakaways – Litter, debris removal and vegetation management, Long Term: Replace filter materials
- Swales – Litter and debris removal, grass cutting to maintain water quality treatment
- Pipework and CKDs – Litter, debris removal and periodical jetting

2.8.3 The Vortex Separator will be maintained in accordance with manufactures requirements.

3 Requirement 11 (Operational Drainage Scheme) Approval

3.1.1 Table 3.1 highlights the information submitted for the 7a Works for approval under DCO Requirement 11 (Operational Drainage Scheme).

DCO Requirement 11	Notes
11.(1)	This supporting document is considered to fulfill the requirements of 11. (1) for Works 7a (including Part 1A)
11.2 (a)	Survey information was provided in the original ODS (TLSB-TLP-PMO-XXX-SCM-0002 revision 2.0), which is unchanged and is approved under application reference 2017/0802/DCO.
11.2 (d)	Measures to avoid the risk of spillages of contaminating materials is included in the Pollution Prevention Plan (TLSB_DCO_Req5_PPP_May2020_v2).
11.2 (e)	The Works 7a do not include the discharge of any aqueous effluent (foul drainage).
11.2 (f)	Details of the surface water drainage system to collect and treat run off from stockpiles is included in the Pollution Prevention Plan TLSB_DCO_Req5_PPP_May2020_v2). Any material that is identified as contaminated and needs to be stockpiled during the Phase 1 works will be placed on an impermeable membrane and capped so that it is isolated and does not generate any contaminated runoff. No additional or revised drainage is proposed within the laydown or stockpile areas during Part 1A works.
11.2 (g)	The design does not include any tie-in to drains serving the A483 Fabian Way, as per the original ODS (ref TLSB-TLP-PMO-XXX-SCM-0002 revision 2.0).

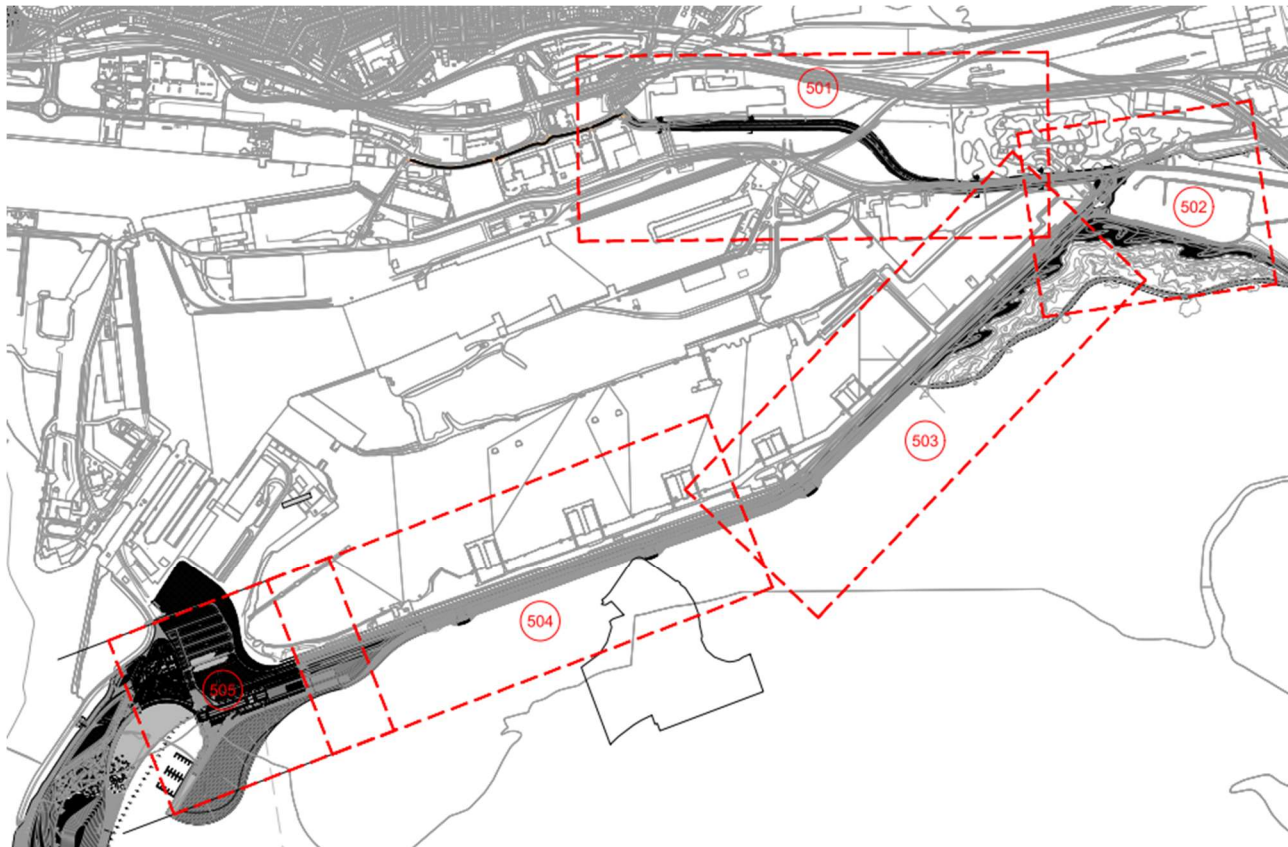
Table 3.1 – Summary of DCO Requirement 11 details for approval for Works 7a (including Part 1A)

Appendix A: Drainage Drawings

Drawing List:

- TLSB-ATK-C133-DRW-DRW-0501 - General arrangement, Drainage Works, Sheet 1 of 5
- TLSB-ATK-C133-DRW-DRW-0502 - General arrangement, Drainage Works, Sheet 2 of 5
- TLSB-ATK-C133-DRW-DRW-0503 - General arrangement, Drainage Works, Sheet 3 of 5
- TLSB-ATK-C133-DRW-DRW-0504 - General arrangement, Drainage Works, Sheet 4 of 5
- TLSB-ATK-C133-DRW-DRW-0501 - General arrangement, Drainage Works, Sheet 5 of 5
- TLSB-ATK-C133-DRW-DRW-0516 - Drainage Works, Typical Cross Sections
- TLSB-ATK-C133-DRW-DRW-0517 - Drainage Works, Typical Details, Sheet 1 of 2
- TLSB-ATK-C133-DRW-DRW-0518 - Drainage Works, Typical Details, Sheet 2 of 2
- TLSB-ATK-03-XX-SK-D-00006 – Surface Water Drainage Layout Part 1A works

Key Plan:



Appendix B: Drainage Calculations

Area 1 – Microdrainage Pipework Calculations

- 1 in 1 year – No Surcharging
- 1 in 5 year - No Flooding
- 1 in 100 year – Exceedance

All including 30% Climate Change

Area 2 – Microdrainage Swale Calculations

For the longest/largest catchment Swale 1

- 1 in 5 year - No Flooding (manning for 0.6m deep swale to CIRIA C753)
- 1 in 5 year – Water Quality Event (manning for 0.2m grass height to CIRIA C753)
- 1 in 100 year – Exceedance (manning for 0.6m deep swale to CIRIA C753)

All including 30% Climate Change

Calculation Notes:

- Swale Length – 110m
- Width of Hardstanding – 17m
- Verge Width – $4\text{m} \times 0.4 \text{ runoff} = 1.6\text{m}$
- Swale – approx. 5m
- Total Catchment = $110 \times 23.6 = 2596\text{m}^3$

Water Level Depth – 5 year storm – 6.353 (53mm depth) OK

Water Level – Depth 100 year storm – 6.380 (80mm depth) OK

Water Level – 5 year 24 hour Water Quality Event – 6.308 (8mm depth) OK

Flow through outfall 1 in 1 year event = 33.4 l/s

Capacity 225mm pipe @ 1 in 170 (velocity 1 m/s) = 1 in 1 year 39.7 l/s OK

For 2 swales lengths – $33.4 \times 2 = 66.8 \text{ l/s}$

Capacity 300mm pipe @ 1 in 240 (velocity 1 m/s) = 1 in 1 year 71.4 l/s OK

Manning values from CIRIA C753 – extract below:

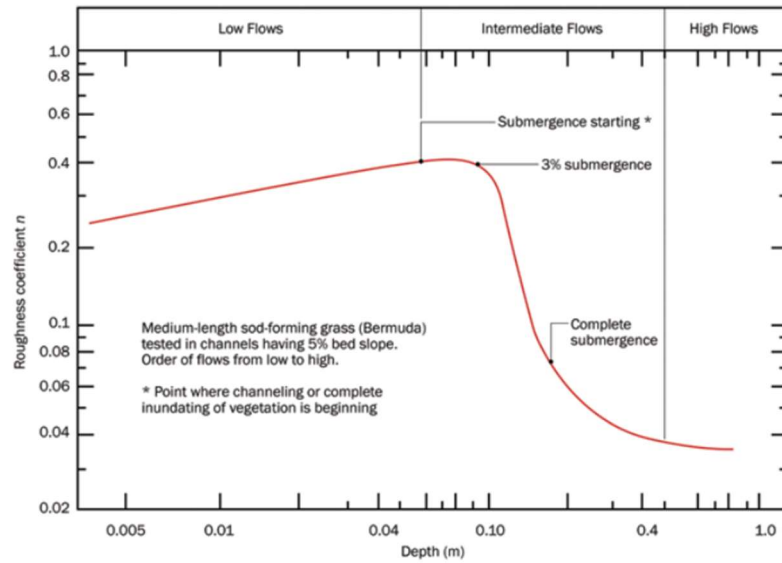


Figure 17.7 Impact of flow depth on hydraulic roughness (from Wong, 2006)

200mm Grass $n = 0.060$ (Water Quality event check)

600mm $n = 0.038$ (Normal capacity check)

Area 3 – Microdrainage Infiltration Trench Calculations (1A, 1B, 2A and 2B) and upstream Pipework (to 1A and 2A)

Summary of results:

	Soakaway 1a				Soakaway 1b				Soakaway 2a				Soakaway 2b							
by Soakaway	Start chainage	2230	m		Start chainage	2290	m		Start chainage	2160	m		Start chainage	2270	m					
	End chainage	2168	m		End chainage	2230	m		End chainage	2125	m		End chainage	2160	m					
	Length of	62	m		Length of	60	m		Length of	35	m		Length of	110	m					
	Road width	5.5	m		Road width	5.5	m		Road width	6.5	m		Road width	6.5	m					
	Verges	4	m		Verges	4	m		Verges	4	m		Verges	4	m					
Extra road	Area	589	m2		Area	570	m2		Area	367.5	m2		Area	1155	m2					
	Start chainage	2168	m						Start chainage	2125	m									
	End chainage	2065	m						End chainage	1995	m									
	Length of Catchment	103	m						Length of Catchment	130	m									
	Road width	5.5	m2						Road width	6.5	m2									
	Verges	2	m						Verges	3	m									
	Path	3	m						Bank	440	m2									
	Extra Path Access	289	m2																	
	Area	1370.5	m2						Area	1675	m2									
	TOTAL CATCHMENT	1959.5	m2	0.19595	ha	TOTAL CATCHMENT	570	m2	0.057	ha	TOTAL CATCHMENT	2042.5	m2	0.20425	ha	TOTAL CATCHMENT	1155	m2		
	Cover Level	6.6	m	(at road level)	Cover Level (C)	6.66	m	(start of road at road level)	Cover Level	6.6	m	(at road level)	Cover Level (C)	7.85	m	(low point at road level)				
						8.775	m	(end of road at car park at road level)	Road High Point	7.85	m			8.35	m	(high point at road level)				
	Allow 400mm to protect subgrade (1 in 10yr)	0.4	m		Allow 400mm to protect subgrade (1 in 10yr)	0.4	m		Allow 400mm to protect subgrade (1 in 10yr)	0.4	m		Allow 400mm to protect subgrade (1 in 10yr)	0.4	m					
	Soakaway Effective Depth	1.3	m		Soakaway Effective Depth	0.8	m		Soakaway Depth	1.55	m		Soakaway Effective Depth	0.9	m					
	Invert Level	4.9	m		Invert Level	5.46	m	(lowest point)	Invert Level	4.65	m		Invert Level	6.55	m	(lowest point)				
	GWL	3	m		GWL	3	m		GWL	3	m		GWL	3	m					
	GWL Depth BGL	3.6	m		GWL Depth BGL	3.66	m		GWL Depth BGL	3.6	m		GWL Depth BGL	4.85	m					
	Freeboard	1.9	m		Freeboard	2.46	m		Freeboard	1.65	m		Freeboard	3.55	m					
	Worse Case Infiltration	2.8E-05	m/s	0.10073	m/hr	Worse Case Infiltration	2.8E-05	m/s	0.10073	m/hr	Worse Case Infiltration	0.00002798	m/s	0.10073	m/hr	Worse Case Infiltration	2.8E-05	m/s	0.10073	m/hr

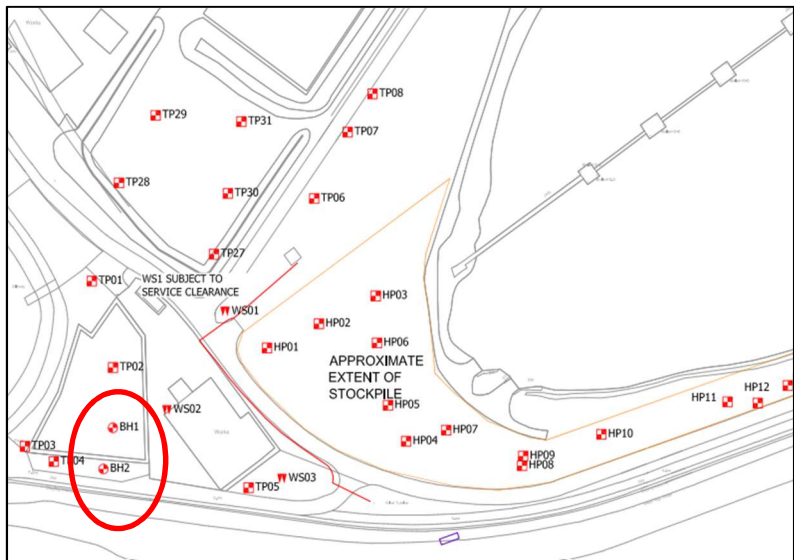
Tidal Lagoon Swansea Bay

Soakaway 1a				Soakaway 1b				Soakaway 2a				Soakaway 2b			
Soakaway Eff				Soakaway Depth (10 yr)	0.8	m		Soakaway Eff				Soakaway Depth (10 yr)	0.9	m	
Depth (10 yr)	1.3	m						Depth (10 yr)	1.55	m					
Deepest Depth from CL	1.7	m						Deepest Depth from CL	3.2	m			Deepest Depth from CL	1.8	m
Soakaway Width (10 yr)	1	m		Soakaway Width (10 yr)	1	m		Soakaway Width (10 yr)	1.75	m			Soakaway Width (10 yr)	1	m
Porosity	0.95			Porosity	0.3			Porosity	0.95				Porosity	0.3	
Max Level 10yr	1.267	m		Max Level 10yr	0.773	m		Max Level 10yr	1.447	m			Max Level 10yr + CC	0.878	m
Flooding 1 in 100yr (winds)	25.6	m3		Flooding 1 in 100yr (winds)	3.6	m3	(minor flooding of road)	Flooding 1 in 100yr (winds)	28.1	m3			Flooding 1 in 100yr (winds)	9.5	m3
Extra storage in trench up to top of kerb)	7.4	m3						Extra storage in trench up to top of kerb)	7.3	m3					
Cumulative TLSB Road					21.8	m3	m3 (1a + 1b - storage behind kerb) This will build up against the kerb and flow east and enter						30.3	m3	This will build up against the kerb and flow east and enter the swale systems - or soakaways can be oversized in detailed design stage
Upstream Pipe				Upstream Pipe				Upstream Pipe				Upstream Pipe			
Start	2072	m						Start	2030	m					
End	2168	m						End	2125	m					
Length	96	m						Length	95	m					
Catchment Area	1370.5	m2						Area	1675	m2					
CL	6.6	m						CL	6.6	m					
Pipe	0.225	m						Pipe	0.225	m					
Cover	0.6	m						Cover	0.6	m					
Gradient	170	m						Gradient	170	m					
IL at head of run	5.775	m						IL at head of run	5.775	m					
IL at Swale	5.21	m						IL at Swale	5.22	m					
Velocity	1	m/s						Velocity	1	m/s					
Flow (1 yr)	23.2	l/s						Flow (1 yr)	22.3	l/s					
Capacity (1 yr)	39.8	l/s						Capacity (1 yr)	39.8	l/s					
Flooding 5yr + CC	0	m3						Flooding 5yr + CC	0	m3					

Appendix C – Site Investigation – Infiltration Data

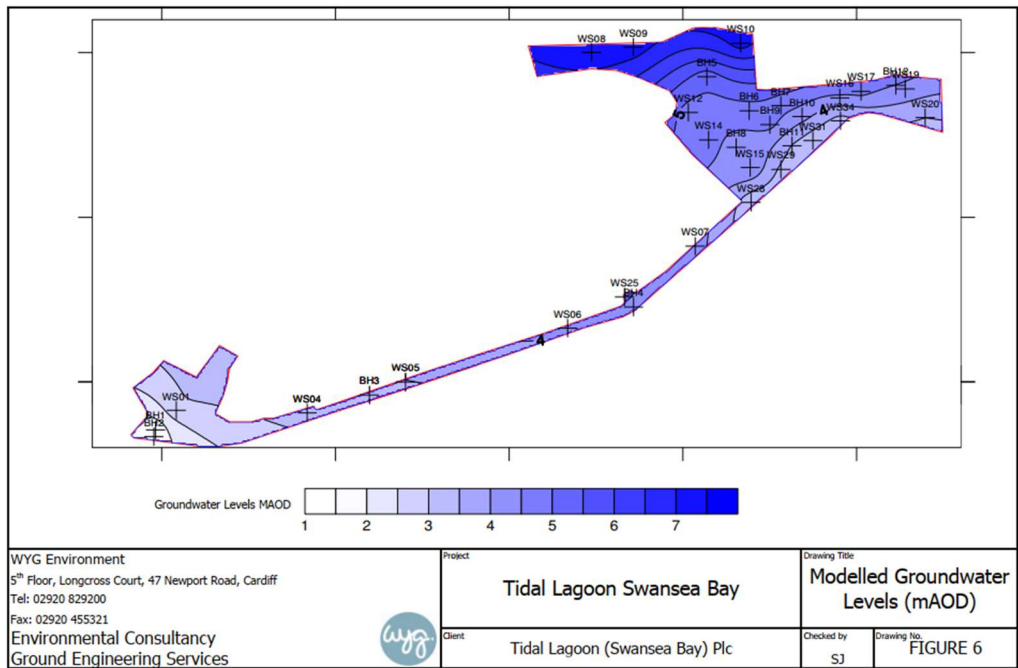
Source: White Young Green Tidal Lagoon Ground Investigation Interpretive Report (Phase 1)
- March 2017

Location of Boreholes BH1 and BH2:



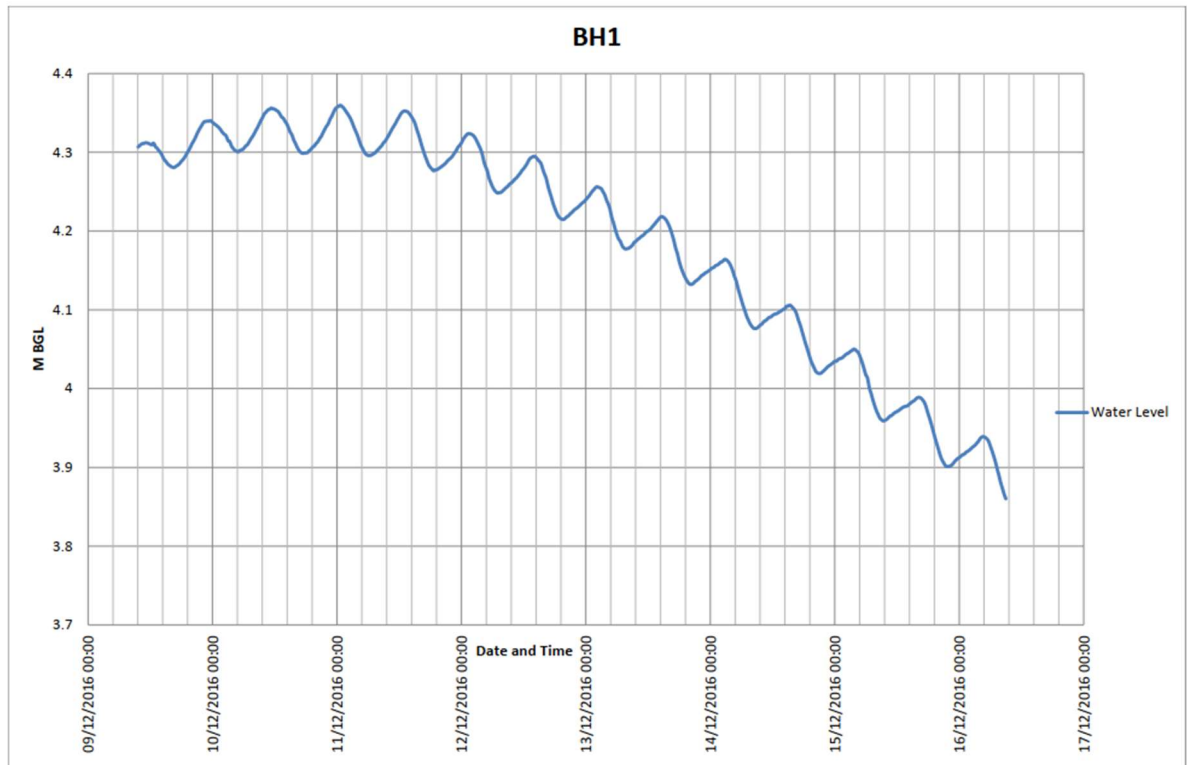
Groundwater Level Data:

Mean groundwater levels:



From chart area 3 – mean GWL level = 3m AOD

Groundwater modelling BH1 and BH2:



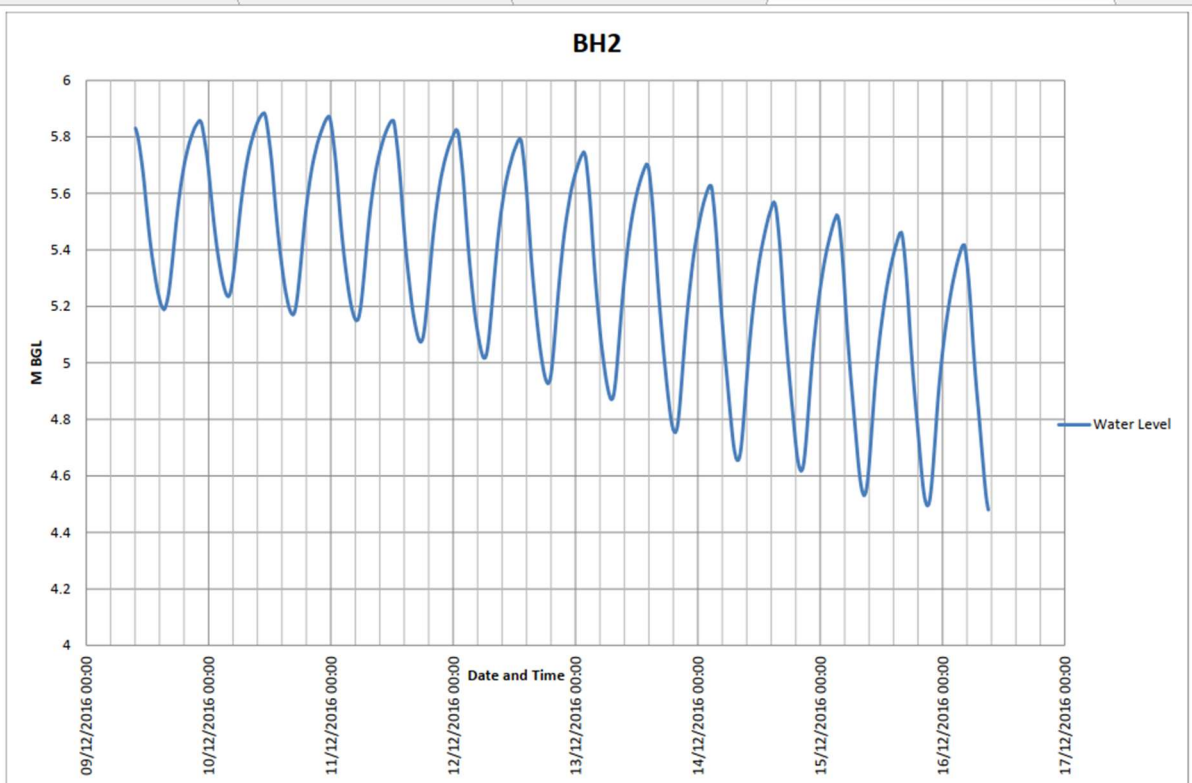
Cover Level = 6.03m

Highest GWL = 2.2m AOD

Water Level = 2.1m AOD

The tidal influence at BH1 is approx. 0.1 to 0.25m twice daily, which is still below the mean GWL of 3.0m selected in the design.

Tidal Lagoon Swansea Bay



Cover Level = 6.66m

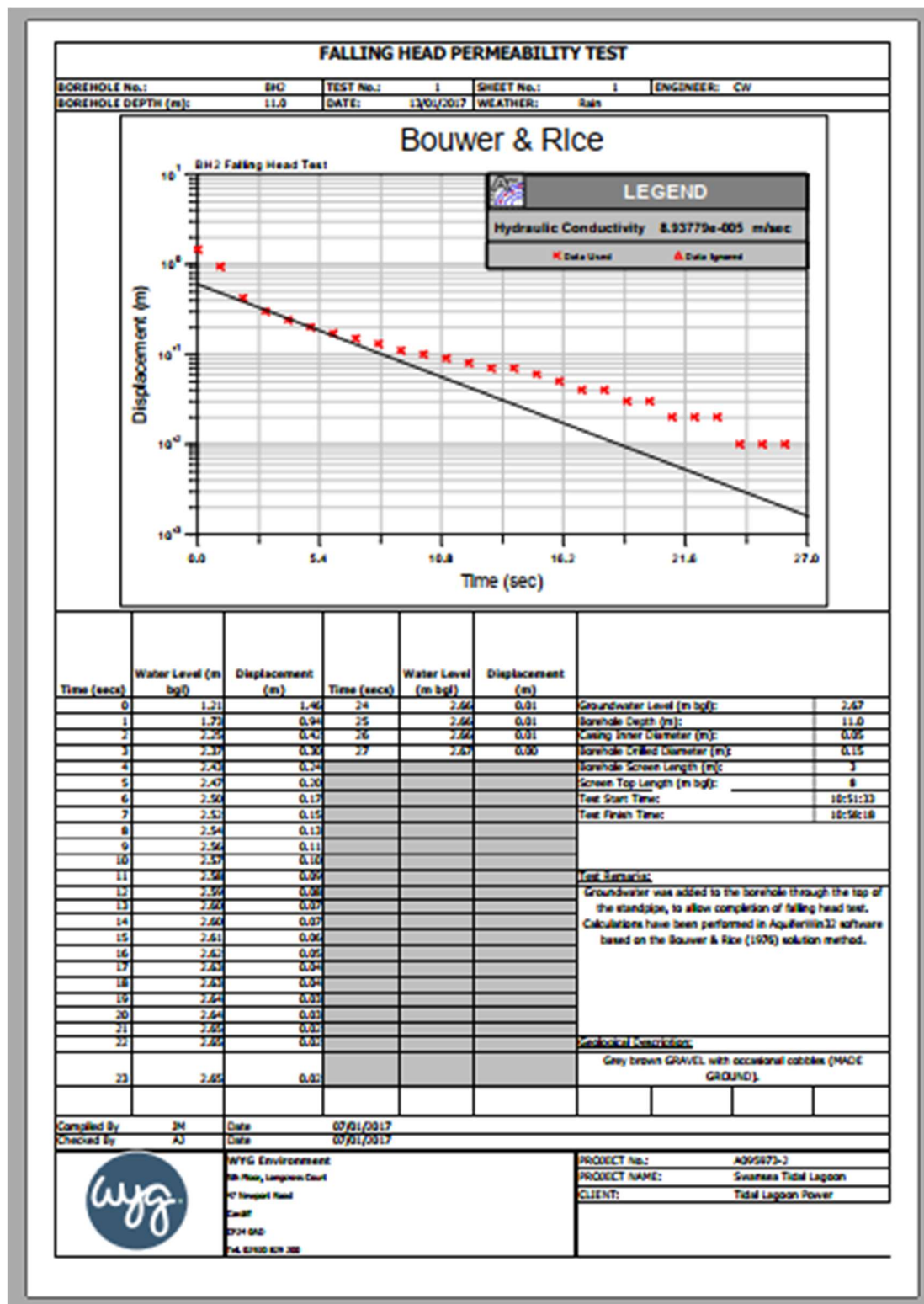
Highest GWL = 2.21m AOD

Water Level = 1.86m AOD

The tidal influence at BH2 is approx. 0.6m twice daily, which is still below the mean GWL of 3.0m selected in the design.

Boreholes more inland are expected to have a tidal range of 0.02m or less each day.

Design level of GWL 3m AOD considered conservative



Worse Case for Design – 2.798×10^{-5} m/s