AQUIND Limited

AQUIND INTERCONNECTOR

Environmental Statement – Volume 3 – Appendix 3.6 Surface Water Drainage and Aquifer Contamination Mitigation Strategy

The Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Regulation 5(2)(a)

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

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APPENDIX 3.6 SURFACE WATER DRAINAGE AND AQUIFER CONTAMINATION STRATEGY

1.1. GENERAL

1.1.1. INTRODUCTION

1.1.1.1. This report outlines only the strategy proposed by WSP, to mitigate contamination of aquifer during the operational life of the Converter Station.

1.1.1.2. The information contained herein is for information purposes only. It is the responsibility of the appointed contractor(s), to develop the design and verify all information presented within this report as part of the design development process.

1.1.1.3. The appointed contractor is responsible for all aspects of the civil design and construction to ensure the converter station civil works meet the employer, Local Authorities and Environmental Agency requirements and to identify and apply all relevant information and Eurocodes, British Standards and other appropriate codes and guides as highlighted within this report (the list within section 9 is not exhaustive).

1.1.1.4. The risk to the aquifer is imposed by infiltration of potentially contaminated water from the Proposed Development into the ground. This report therefore details principles for the control of surface water, foul water and water susceptible to contamination from oil/fuel and glycol to mitigate risk of contamination to aquifer.

1.1.1.5. Following submission of the initial report, WSP met with Portsmouth Water (‘PW’) and Environmental Agency (‘EA’) on 18 July 2019. The initial meeting was then followed by a telephone discussion with Portsmouth Water on 2 September 2019. This report has been updated following the outcome of the discussion.

1.1.2. PROPOSED DEVELOPMENT

1.1.2.1. The Converter Station Area is located within a rural landscape north of Portsmouth and west of the outlying residential developments of Lovedean and Horndean. The existing National Grid 400/132kV Lovedean Substation is located immediately east of the proposed Converter Station (Plate 1).

1.1.2.2. The Site is located on a hillside sloping downwards from north to south, with a natural ridge to the west and a valley to the east. The nearest watercourse and surface water feature identified on mapping is located approximately 1.8 km to the south, flowing away from the Site.

1.1.2.3. Existing geology of the Site comprises shallow topsoils overlying Tarrant Chalk bedrock, identified as a Principal Aquifer providing a water supply to Portsmouth.

Plate 1 - Converter Station Area Layout (Option B(i))

1.1.3. SITE FEATURES

Aquifer

1.1.3.1. The Converter Station Area known to be underlain by a Principal Aquifer (chalk). Aquifer Source Protection Zone 1 (‘SPZ1’) designation. Therefore, the SPZ1 requires a considered approach to mitigate any potential contamination, turbidity or groundwater issues caused by construction and Operation and Maintenance activities over the design life of the development.

1.1.3.2. A Water Management Strategy is to be prepared by the Engineering Procurement and Construction Design and Build Contractor in order to mitigate the associated contamination risk. This is to be approved by local and National Authorities (including PW and the EA) due to the regional importance of the aquifer prior to start of any ground work related construction activities.

Karstic Features

1.1.3.3. Karstic terrain and features are a product of dissolution of soluble rocks by groundwater and can be contributed to further by other geochemical processes. Commonly the rocks most affected by these processes are limestone, chalk, dolomite and gypsum. The formation of sinks, solution pipes, caves/voids, dolines (sinkholes propagated to surface), sink holes and stream sinks are some of the features than can occur in karstic terrains. These ground conditions can lead to the following geotechnical risks which can impact ground stability and present constraints and risks to development on karstic ground:

- Differential / total settlement
- Soft spots
- Collapsible ground
- Groundwater control issues
- Sinkholes
- Variable depth to rockhead
- Groundwater features or movement through karsts

1.1.3.4. Conductivity and resistivity geophysical survey were undertaken to identify potential karstic features. The surveys located three potential karstic features of which two of them are within Converter Station Option B(i) and option B(ii), as detailed in Table 1.

Table 1 – Karst Features

Karstic Feature	Coordinates (Approximate Centre Point)	Geophysics Interpretation	CPT Probing
SD1 **(Also referred to as Karstic Feature 1)**	467359 E 113070 N Located south of proposed access track (Not within proposed Converter Station Area)	A circular feature identified to be approximately 20.00m in diameter and extends to approximately 6.00m bgl.	Four CPTs were conducted in a north-south direction an east-west probing line was not feasible due to a 132kV.power cable. The CPTs achieved between 1.70-4.30m bgl, where they encountered refusal (possible competent rock). Cross referencing with the geophysical report it appears the CPTs were refusing short of the top of the infilled karstic feature. The feature appears infilled approximately 20.00m wide and 6.00m in height, with the feature present from 4.00m bgl to 10.00m bgl.
SD2 **(Also referred to as Karstic Feature 2)**	467180 E 113479 N	A circular feature identified to be approximately 25.00m in diameter and	Six CPTs were conducted in a cross pattern, approximately north-south and east-west.

		extending to 6.00m bgl	The CPTs achieved between 7.90-14.70m bgl, where they encountered refusal (possible competent rock). The feature appears infilled, approximately 20.00-25.00m wide and 5.00m in height, with the feature present from 4.00m bgl to 9.00m bgl.
SD3 **(Also referred to as Karstic Feature 3)**	467209 E 113656 N	The feature is identified to be circular. The full geometry is difficult to determine from the geophysics due to the feature being identified at the end of the ERT line.	Six CPTs were conducted in a cross pattern, approximately north-south and east-west. The CPTs achieved between 8.80-12.00m bgl, where refusal was encountered (possible competent rock). The feature appears infilled, approximately 10.00m wide and 6.00m in height, with the feature present between 3.00m bgl to 9.00m bgl.

1.1.3.5. Two of three Karstic features identified on site are located within the proposed converter station footprint, denoted SD2 and SD3 on Plate 2 below.

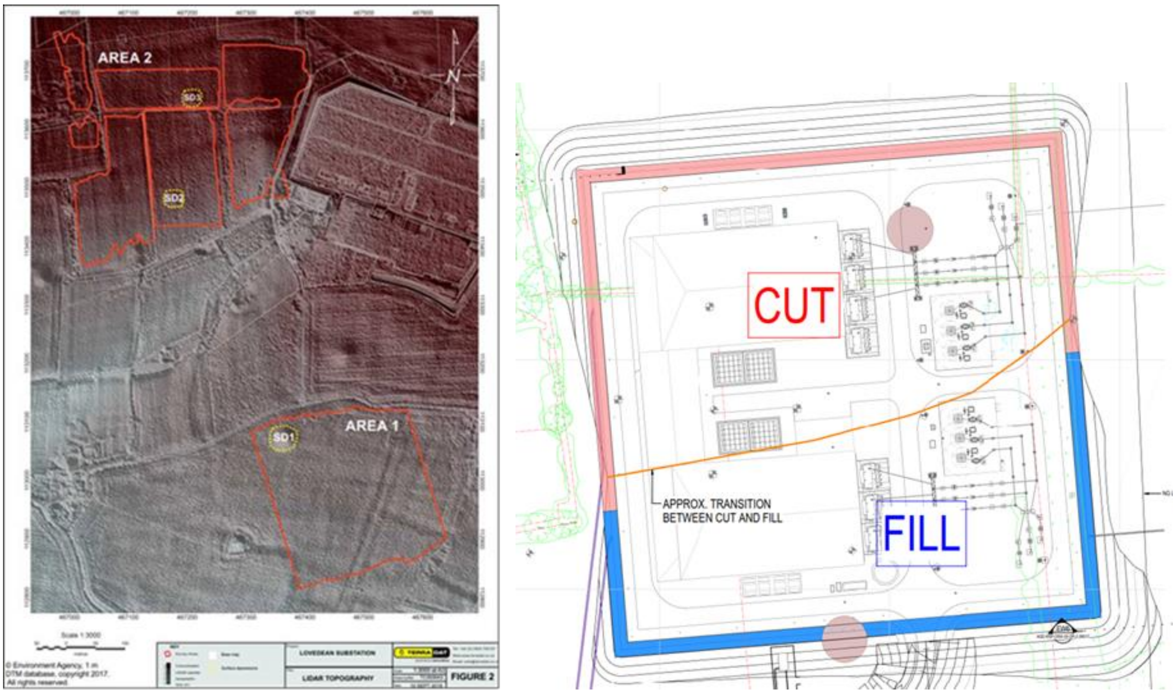


Plate 2 – Karst Features (Karst features shown in pale red circles)

1.1.3.6. The ground investigation works found the karstic features to be (naturally) infilled with a Grade D Chalk from CPT records, this should be reviewed at detailed design stage to inform any required mitigation measures. The infilling of the karstic features reduces the risk of the void migration to surface. At detailed design stage consideration should be given to installing boreholes over identified karstic features to prove the infilling of karstic features, and nature of the infill.

1.1.3.7. The potential for perched water tables within these karstic features is highlighted within Engineering in Chalk, however there was no indication of abnormal groundwater during the ground investigation works.

1.1.3.8. Karstic features can accelerate water permeation from surface to the aquifer.

1.1.3.9. Karstic/dissolution features have been identified by geophysical surveys, existing datasets and walkover surveys.

1.1.3.10. Additional Ground Investigation and Monitoring to be carried out by the appointed contractor during detailed design to validate these findings.

1.1.3.11. Engineering in Chalk identifies the following treatment strategies for dissolution/karstic features:

1. Excavation and replacement with compacted suitable material.
2. Bridging.

3. Ground stabilisation by grouting.
4. Ground treatment by grouting.
5. Piling.
6. Control of drainage.

1.1.3.12. Groundwater and groundwater flow has a fundamental influence on bedrock dissolution and the formation of karstic features. The control of surface water drainage and drainage within the ground should be carefully considered during detailed design to avoid increasing the risk of dissolution.

1.1.3.13. It was confirmed by PW and EA that, ground stabilisation and treatment by grouting will be their preferred solution. In-line with CIRIA C574, to minimise influence of grouting on the SPZ1, the appointed contractor to propose a grout mix that is of suitable composition, control and cure time to PW and EA for their review and comment.

1.1.3.14. A suitable approach to mitigate karstic risk to foundations is considered to be piling. This should be reviewed at detailed design when foundation locations and layout plans are available. Where possible, access track, cable routes, structures and drainage infrastructure should be moved to avoid known dissolution features. Where this is not possible the appropriate treatment, or risk management, should be determined at detailed design and discussed and agreed with PW and EA.

1.1.4. IDENTIFICATION OF CONTAMINATION AND RISK MANAGEMENT

1.1.4.1. Whilst use of the following liquids or fuels in a converter station are an integral part of the anticipated Convertor Station works, there is a risk these can contaminate the aquifer if infiltrated directly/indirectly into the ground;

- Oil in Converter Transformers;
- Glycol (Antifreeze agent) in Valve Coolers;
- Diesel in Emergency Generators and above ground fuel tank;
- Effluent from kitchen/WC/Bathroom in Control Building;
- Oil contaminated water in oil dump tanks, oil interceptors, oil containment areas and related oil/oily water drainage systems; and
- Lubrication/cooling oil in vehicles, plant, HV switchgear and equipment.

1.1.4.2. During day to day operation of the Converter Station, it is unlikely for the above to contaminate the aquifer/watercourse, however to deal with any accidental spillage/leakage the appropriate provisions such as monolithic in-situ concrete bunds and various drainage networks will be designed and constructed to capture any contaminated water. These networks will either direct it to designated treatment facilities, or contain it within a fully sealed area for manual removal under controlled conditions.

1.1.4.3. The following sections will provide further detail and information to clarify how risk of contamination resulting from accidental incidents/spillage during the operation of the Converter Station will be dealt with in a safe and compliant manner.

1.1.5. GENERAL ASSUMPTIONS

1.1.5.1. Based on available existing underground services information and in lieu of any site specific Ground Penetrating Radar Survey, WSP has made following assumptions;

- There is no record of existing foul drainage network within the Converter Station Area
- There are no records of existing surface water drainage network within the Converter Station Area.
- There is no evidence of any existing land drainage system across the site except a shallow overland flow route as identified on the Environment Agency Long Term Flood Map for events with a return period of 100-1000 years

2. SURFACE WATER DRAINAGE

2.1. EXISTING SITE FEATURES

2.1.1.1. The Site is located within a rural landscape north of Portsmouth and west of the outlying residential developments of Lovedean and Horndean. The existing National Grid 400/132kV Lovedean Substation is located immediately east of the proposed converter station, which has operated since 1970's, which have a higher contamination risk than that associated with the new Convertor station, due to adoption of the latest design and construction methodology and practice.

2.1.1.2. The Site is located on a hillside sloping downwards from north to south, with a natural ridge to the west and a valley to the east. The nearest watercourse and surface water feature identified on mapping is located approximately 1.8 km to the south, flowing away from the site.

2.1.1.3. Existing geology of the Site comprises shallow topsoils overlying Tarrant Chalk bedrock, identified as a Principal Aquifer providing a water supply to Portsmouth. As such, the site is located within a SPZ1.

2.2. PROPOSED DEVELOPMENT

2.2.1.1. The Converter Station Area comprises a converter station; an access road; landscaping; and surface water drainage comprising conventional pipe networks and sustainable drainage ('SuDS') features including filter drains, infiltration drains, infiltration swales, a detention basin, infiltration basin and soakaway.

2.3. POLICIES AND GUIDANCE DOCUMENTS

2.3.1.1. Surface water drainage from this Site is to be designed in accordance with the following documents:

- Sewers for Adoption (SFA) 7th Edition;
- Local Authority Standards;
- Building Regulations Part H Drainage and Waste Disposal;
- CIRIA SuDS Manual (C753);
- HR Wallingford Greenfield Runoff Rate Estimation Tool (UKSuDS);
- SNIFFER UEUW01: Source control pollution in Sustainable Drainage (Final Report, February 2008);
- SNIFFER UEUW01: Source control pollution in Sustainable Drainage: Supplementary Report (Draft Report, September 2008);

- SNIFFER UEUW02: SuDS Pollution Degradation (Final Report, October 2008);
- Napier, F.; Jefferies, C; Heal, KV; Fogg, P; D'Arcy, BJ; Clarke, R. (2008) *Evidence of traffic-related pollutant control in soil-based Sustainable Urban Drainage Systems (SUDS)*. Edinburgh, Scotland. (Referenced below as Napier *et al* 2008a);
- Napier, F.; D'Arcy, B.J.; Jefferies, C.; Fogg, P.; Lowe, W.; Clarke, R.; (2008) *Oil and SUDS: managing a priority urban pollutant*. 12th International Conference on Integrated Diffuse Pollution Management, Khon Kaen University, Thailand. (Referenced below as Napier *et al* 2008b);
- Non-statutory technical standards for sustainable drainage systems;
- BS EN 752 2017 Drain and Sewer Systems Outside of Buildings (2017);
- BS EN 12056 Gravity drainage inside buildings;
- National Grid Technical Specification 2.10.01 Oil Containment;
- Discharges to surface water and groundwater environmental permits (EA guidance);
- Pollution prevention for businesses (EA guidance); and
- The Environment Agency's approach to groundwater protection.

2.4. SURFACE WATER DRAINAGE STRATEGY

2.4.1.1. Surface water is proposed for discharge in accordance with the Building Regulations 2010 Part H hierarchy which states that surface water should be discharged, in order of priority to:

1. a soakaway or infiltration system; or where that is not reasonably practicable,
2. a watercourse; or where that is not reasonably practicable,
3. a sewer.

2.4.1.2. The proposal for surface water discharge from this site is in accordance with the first priority above, an infiltration system.

2.4.1.3. Discharge to ground will be restricted by existing ground infiltration rates and as such, surface water flood attenuation will be provided by SuDS features including infiltration drains, filter drains, infiltration swales, a detention basin, infiltration basin and soakaway. Various SuDS features will independently serve separate parts of the development which are the converter station and access road. Attenuation will be provided to prevent flooding or exceedance flows for events up to and including a 100 year return period plus 40% climate change.

2.4.1.4. Infiltration rates and maximum groundwater levels are still to be confirmed, after which detailed design and hydraulic modelling will be undertaken to confirm the size of drainage and attenuation features by the appointed contractor. In addition, BRE365 Soakaway Design states that proposed basins require a 1m standoff between groundwater and the basin base and as such, this will also be confirmed in detailed design by the appointed contractor.

2.4.1.5. Refer to Appendix 1 for Work In Progress ('WIP') drainage proposal.

2.5. CONVERTER STATION DRAINAGE

2.5.1.1. The Converter Station has a development area of approximately 4.3 ha which will comprise buildings, roads, external electrical switchgear and associated infrastructure. All permanent roads, hardstanding and footpaths will be of impervious construction laid to falls. Otherwise, substation finishes will generally comprise of a minimum 75mm thick layer of converter station surfacing (chipping) over a minimum thickness of 300mm unbound free-draining sub-based complying with the specification for highway work. Approximately 1.7 ha will be impermeable and positively drained via a typical gravity controlled below ground pipe and chamber network. This network will receive runoff from building roofs; parts of the road subject to 'oily water'; and oil containment areas including transformer bunds, valve cooler bunds, above ground fuel storage and diesel generator bunds and associated precast trenches and any other precast trenches within oil containment area. Treatment will be provided by a proprietary oil separator and SuDS features prior to discharge to groundwater via a soakaway, or other infiltration features, subject to detailed design development by the appointed contractor design team.

2.5.1.2. In addition to the positive drainage network, the convertor station contains significant permeable granular fill/chipping areas which will act as a storage attenuation drainage area and will control water discharges to the ground under the site. These areas will receive runoff from low traffic roads within the Convertor Station site area that are not within the designated oil containment road and paving areas.

2.5.1.3. Drainage from oil containment and 'oily water' areas is outlined here and addressed in detail within Section 4 of this report. Oil containment areas are bunds designed to capture polluting material including oils, fuels, diesels and glycol coolant to valve coolers during a catastrophic equipment failure, but these areas will also be exposed to rainfall that will be separated and drained to the surface water network. To achieve this, the oil containment areas, will drain to a dump tank for the first stage of separation; the bulk of pollutants will be retained within the dump tank while the water is pumped to an oil separator for the second stage of separation. Discharge from the separator will then be conveyed through a SuDS network for further removal of pollutants prior to discharge to groundwater.

2.5.1.4. ‘Oily water’ may be generated on roads adjacent oil filled plant and equipment, which may be subject to spills or leaks that raise the pollutant loading in rainfall runoff. Runoff from oily water areas will therefore be collected by channel drains and directed to the oil separator for treatment, bypassing the dump tank. Flow from the separator will then be conveyed through a SuDS network for further removal of pollutants prior to discharge to groundwater.

2.5.1.5. The separation of oily water and treatment by the separator, is in accordance with the National Grid Technical Specification 2.10.01 section 3.4.2, accepted by the Environment Agency, which identifies areas within substations which do, and do not, require treatment by an oil separator.

2.5.1.6. The SuDS network receiving flow from the oil separator will comprise a detention basin then soakaway. The requirement for additional catchpit chambers with silt traps to be located within the compound drainage network, will be determined at detailed design.

2.5.1.7. Roof run-off is to be collected by a positive drainage network which will include catchpit chambers with silt traps. The network will discharge to the detention basin then soakaway, bypassing the dump tank and oil separator.

2.5.1.8. Gravel areas within the compound, but external to the buildings, will be designed to function as infiltration drains that will receive direct rainfall and road runoff, excluding the oily water area. Two additional infiltration/cut off collector drains will surround the converter station site to capture greenfield runoff from the embankment north of the site, in addition to road runoff. Surface water runoff treatment will be provided through the infiltration drains prior to reaching the groundwater.

2.5.1.9. It is assumed that infiltration rates through the existing geology underlying the infiltration drains will be sufficient to discharge runoff from events up to and including a 100 year return period plus 40% climate change, with additional surface water storage provided within the infiltration drains. In addition, it is assumed that the maximum groundwater levels are at least 1 m below the base of the infiltration drains. However, if infiltration rates or groundwater levels in combination with detailed design and hydraulic modelling do not suit this design, then more capacity can be provided by connecting the infiltration drains via underdrains, to the detention basin and soakaway. In addition, the detention basin will be able to overflow during extreme events to an infiltration basin further south, again providing additional surface water storage.

2.6. OVERLAND FLOW DRAINAGE

2.6.1.1. Overland flow and shallow subsurface runoff may be directed toward the converter station due to natural topography north of site. As such, a filter drain will intercept these flows prior to the northern embankment. The filter drain will connect to the outermost infiltration drain surrounding the converter station for direct infiltration to ground. It is expected that the volume of overland flow intercepted will be limited by the high infiltration capacity of the chalk geology and that the greenfield runoff will not require treatment, although this will still be provided by the filter drain and infiltration drain.

2.6.1.2. A shallow overland flow route is identified on the Environment Agency Long Term Flood Map for events with a return period of 100-1000 years. The flow route intersects with the proposed access road and as such, culverts or other suitable infrastructure is proposed to allow this flow to continue southwest of the road on its existing course. Detailed design will ensure that there will be no increase in existing flood risk to local residences from these works.

2.7. ACCESS ROAD DRAINAGE

2.7.1.1. The proposed Access Road will approach the Converter Station from the southeast and will create an impermeable surface of approximately 1.7 ha. The road will be designed with a cross fall to its south/west to direct runoff to an infiltration swale. The swale will be sized to store surface water and allow infiltration through an underlying infiltration drain, but will also be able to convey exceedance flows to an infiltration basin if additional storage is required. Water quality treatment will be provided by the swale and vegetation, then subsequent infiltration through the underlying drain.

2.7.1.2. Refer to Appendix 1 for Indicative Drainage Proposal.

2.8. VALVE COOLERS

2.8.1.1. Glycol is used as an antifreeze agent in valve coolers. Total cooling liquid per pole is about 10,000 litres and 40% glycol that gives approximately 8000 litres per site with a small amount of about 500 litres in the make-up tanks which is located inside the building. Valve coolers will be located within a monolithic in-situ reinforced concrete bunds (design to BS EN 1992-3:2006 – Design of concrete structures for retaining liquids). Under normal operational conditions, bunds will only discharge run-off from rain water, which will accumulate in a sump within the bund. The sump will host a Bund Water Control Unit ('BWCU'), which will pump water out into adjacent drainage system. BWCU to be equipped with glycol detecting system, which will force stop the pump should any glycol be detected. When glycol is detected, an alarm will be activated and all glycol and any rain water entering the bund after alarm activation will be stored in the bund, until the bund is emptied by appropriately trained staff under controlled conditions. The contaminated liquid will be pumped to a designated tanker storage vehicle, which will transfer this off site to an appropriate waste facility. The pump alarm will be connected to the Converter Station Supervisory Control and Data Acquisition ('SCADA') system.

2.8.1.2. It is recommended by AQUASENTRY (BWCU supplier) a minimum of an annual service but six monthly is the practical norm within the industry. This recommendation has been given by a supplier which may not be the supplier of the system. Therefore, the final maintenance requirement will be confirmed by the appointed contractor during the design development.

2.9. FUEL TANK AND DIESEL GENERATOR

2.9.1.1. Diesel Generator and Fuel Tank will be located within monolithic in-situ reinforced concrete bunds (design to BS EN 1992-3:2006 – Design of concrete structures for retaining liquids). The piping between the fuel tank and Diesel generator will be also installed inside a fully sealed precast or in-situ concrete trench that is connected to the oily water drainage system.

2.9.1.2. Under normal operational conditions, bunds will only discharge run-off from rain water, which will accumulate in a sump within the bund into to oily water drainage system. The sump will host a BWCU, which will pump water out into adjacent oily water drainage system. BWCU will force stop the pump should any diesel be detected. In that case bund will need to be cleaned manually. The pump will be alarmed and connected to the Converter Station SCADA system.

3. FOUL WATER DRAINAGE

3.1.1.1. The facility will typically be unoccupied. The very limited foul water flows generated from kitchen and toilets control building when the facility is occupied for routine maintenance will be routed via below ground drains to a fully sealed cess tank. The design will be in accordance with Building Regulations Part H and BS EN 752:2017.

3.1.1.2. All drains will be provided with suitable gradients to ensure self-cleansing in accordance with Building Regulations Part H and Sewers for Adoption version 7.

3.1.1.3. The cess tank will be an underground fully sealed container with a minimum of 9000L capacity in an accessible location on site to facilitate future maintenance and emptying. The cess pool will be double lined i.e tanker cased in concrete and will be fitted with float switch and high-level alarm system and will be connected to SCADA system.

3.1.1.4. In addition to the above, discharge from Sulphur hexafluoride ('SF6') shower/wash-down area that is located within control building and will be used only in an emergency will be also connected to the fully sealed underground cess tank.

3.1.1.5. SF6 is an inorganic, colourless, odourless, non-flammable, heavy gas that is widely used in electrical substation because of its excellent electrical insulator. Although SF6 is inert during normal use, highly toxic by-products are produced that pose a serious threat to the workers who come into contact with them when electrical discharge occur during maintenance of some of the electrical equipment (only in an unlikely accidental event) within converter station that are contained SF6.

4. OIL CONTAINMENT AND OILY WATER DRAINAGE

4.1. INTRODUCTION

4.1.1.1. Oily water is classified as rainwater runoff and/or surface wash down which may potentially contain small amounts of low hydrocarbon concentrates that can be treated directly by the oil separator.

4.1.1.2. All areas where rainwater runoff may potentially contain small amounts of oil (e.g. resulting from leaks or spillages) shall be drained off site through an oil separator; this drainage is referred to as the oily water drainage. Areas to be drained via the oil separator are:

- Oil handling areas and test areas for oil containing equipment;
- Roads or areas that are designated for the siting of plant/vehicles for servicing of oil containing plant or storage tanks; and
- Skidways and Transformer bunds.

4.1.1.3. The Converter Station will contain six working Transformers and a spare transformer (will be kept empty of any oil) which will be connected into a remote underground containment facility (dump tank); this is referred to as the oil drainage.

4.1.1.4. An Emergency Oil Containment and Drainage plan and an operating manual will be prepared to aid maintenance and to enable the emergency services to deal effectively with an incident involving accidental spillage of Oil.

4.1.1.5. The following areas in the Converter Station Area have been deemed not to typically require drainage via an oil separator;

- Roads and car parking outside the oil containment area which shall drain to the adjacent stone surfacing; and Open areas outside oil containment surfaces by gravel.

4.2. OIL DRAINAGE

4.2.1. TRANSFORMERS

4.2.1.1. Transformers will be sited within fully reinforced concrete liquid retaining bunds which will be linked to underground dump tank. Subject to site fire assessment and through discussion with local fire authority a fire active suppression system may be designed and installed on site. The size of the bund may be determined based on volume of oil, volume of water (for active fire suppression system) as well as an appropriate factor of safety and will be designed to BS EN 1992 - liquid retaining structures.

4.2.1.2. To ensure that all oil is contained in case of a catastrophic equipment failure the minimum clear horizontal distance between the internal face of the oil retaining area walls and transformer will be minimum of 2.0 m. The adoption of the compliant underground containment oil design philosophy will prevent flame or burning liquid being transferred into elements of the work outside the bund structure.

4.2.1.3. Rain water or other surface water will permeate through a flame trap. Each oil containment area will have an outlet into the oil drainage system; this will contain a cast in ductile iron U-bend syphon flame trap (to contain fire to bund area only) and rectangular in-situ manhole chamber housing an isolation gate valve to isolate the bund in an emergency. The isolation gate valve, downstream of the flame trap, in the outlet chamber is to allow the bund to be isolated if required.

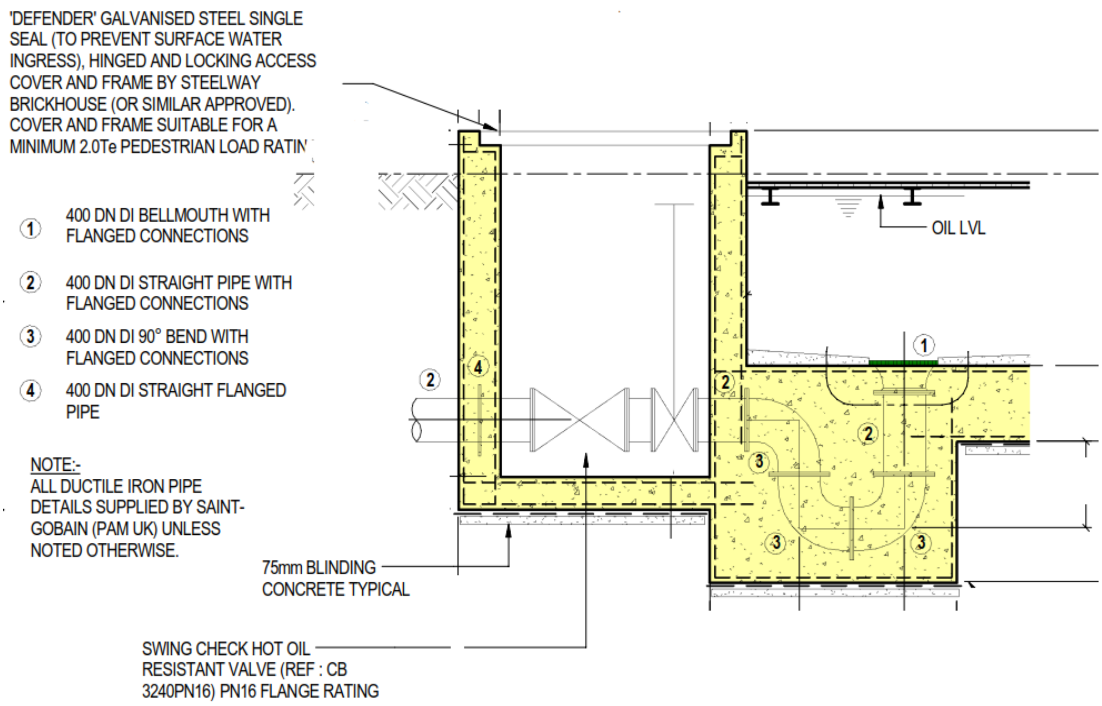


Plate 3 – Typical U-bend Syphon Flame Trap

4.2.1.4. The use of an underground containment will prevent flame or burning liquid being transferred into elements of the work outside the bund structure and will limit the fire pool to a defined perimeter in relation to the footprint of the oil containment area.

4.2.1.5. In the event of a catastrophic equipment failure, oil from one bund is prevented from entering an adjacent bund by having independent trenches and pipe outlets and no penetrations through the bund dividing walls. Backing up of oil from one bund into another via the oil pipework is prevented as the oil pipework system is designed to have the capacity to drain away oil flows from the affected bund pipework without backing up.

4.2.1.6. On completion of the bund(s) construction they are to be water tested by temporarily sealing the fire trap outlet. All bunds shall be subject to a water retention test in accordance with requirements of BS EN 1992 - liquid retaining structures

4.2.1.7. Following completion and commissioning of the system it is considered unlikely that any maintenance of the 400 mm diameter pipework would be required.

4.2.1.8. For maintenance and inspection of the oil pipework should it be required any personnel entry into the manholes would be regarded as entering confined space and therefore requiring accompanied inspection and necessary monitoring. In the unlikely event of sudden transformer oil discharge occurring during this event sufficient warning/time should be available to vacate the manhole.

4.2.1.9. Should it be necessary to maintain any bund any risk of backflow from adjacent bunds may be eliminated by the use of plugs inserted into the pipework.

4.2.1.10. During the workshop with PW and EA on 18th July 2019, WSP was asked to explore the possibility of enclosures/hard cover to the Transformers to collect rain water run-off via enclosure roof to mitigate potential low hydrocarbon run-off from bunds. WSP Electrical team has confirmed that usually the radiators and conservator would sit outside any enclosure as these require cool outside air to blow through them and often fans attach to the bottom of the radiators to encourage that flow of air and therefore a four-sided enclosure (3 sides and the roof) may impact the air circulation and negatively impact the transformer performance. Considering the SuDS and Water quality management system that was discussed with PW and has been explained in principle in chapter 5 of this report, an appropriate system will be designed and constructed by the appointed contractor which would provide appropriate level of protection against contamination of the Aquifer.

4.2.2. OIL DRAINAGE PIPEWORK

Once through the bund flame trap, the oil or water (or both) will be conveyed to the underground dump tank by means of 400 DN ductile iron or an appropriate alternative pipes. The flame traps, manholes and pipes forming the interconnecting drainage system, between the Transformers oil retaining areas and the dump tank, is a closed free flowing gravity system capable of accommodating oil and water at temperatures of 80°C at a rate of 7000 litres per minute (117 litres per second)

The appointed contractor design team will carry out design of ductile iron pipework between transformers and dump tank/s to ensure:

- Each individual pipe run is capable of taking design flow rate of 117l/s of oil; and
- Minor head losses that occur in the longest pipe route (from furthest flame trap to the dump tank) do not reduce flow rate and velocity below the designed minimum acceptable to meet design requirements.

4.2.3. UNDERGROUND OIL CONTAINMENT (DUMP TANK)

4.2.3.1. The tank will be sized to accommodate the maximum volume from a catastrophic failure of the largest oil containing equipment on site.

4.2.3.2. The dump tank construction shall be of Glass Reinforced Polymer (‘GRP’) with a chemical resistant liner (or reinforced in-situ/precast water and oil tight concrete) resistant to all types of oil at 80°C. Clean water will be pumped out of the Dump tank via a bund water control pump to a manhole at appropriate discharge rate (to be calculated as detailed design stage), before flowing by gravity to an oil separator prior to be being discharged into the surface water drainage system.

4.2.3.3. The pipework will incorporate a penstock valve immediately before the dump tank to allow the tank to be isolated during maintenance if required.

4.2.3.4. The dump tank will be double lined i.e tanker cased in concrete and will be fitted with high-level alarm system and will be connected to SCADA system.

4.2.3.5. Following PW and EA request, WSP explored the possibility of an above ground dump tank. The current proposed drainage system is a gravity system. The raising of the dump tank above ground will require the installation of a pump chambers below ground, which is considered likely to negate any benefits and to introduce additional risk. For example, introducing pumps will introduce the risk of pump failure, which would potentially result in untreated pollutants flooding from the pump chambers to the existing ground. Therefore, considering the oil dump tank above ground is likely to increase complexity of the system, risks to the drainage design and infrastructure.

4.3. OILY WATER DRAINAGE

4.3.1. DEFINITION

4.3.1.1. Oily water is classified as rainwater runoff and/or surface wash down which may potentially contain small amounts of low hydrocarbon concentrates. This can be treated directly by the oil separator.

4.3.2. INTERNAL ROADWAYS (OIL CONTAINMENT ROAD AREAS)

4.3.2.1. The main Access Road and skidways immediately adjacent to the transformers shall be fitted with raised sealed kerbs, linear drainage channels, gullies and an associated gravity drainage system which connected to the oil separator. This is to ensure that any minor oil spillages during transformer maintenance work are effectively contained and discharged through the oily water drainage system in accordance with National Grid operational protocols.

4.3.3. OIL SEPARATOR

4.3.3.1. The oil separator shall be a Class 1 full retention unit to BS EN 858-1 incorporating a coalescer automatic closure device and high oil level alarm and rated to suit a hard-standing area to cater for the rainfall intensity in accordance with the EA's Pollution Prevention Guideline (PPG3).

4.3.3.2. A minimum oil storage volume to suit catchment area will be provided by the separator and the separator shall be fully capable of isolating all upstream oil flow if the high-level oil alarm is activated.

4.3.3.3. Oil resistant nitrile rubber seals will be employed throughout the oil & oily water drainage systems. The oil separator will be vented in accordance with the manufacturer's recommendations, with vents located clear of all site operating areas, a minimum 2000 mm above ground level. Vent pipes will be supported by means of a concrete post and protected from vehicular traffic by means of spaced concrete bollards.

4.3.3.4. The oil separator will follow the requirement of EA'sPPG3) and will be designed to European Standard BS EN 858-1: Separator systems for light liquids (e.g. oil and petrol)

4.3.3.5. The separated water will discharge directly into the surface water drainage system, as the treated water.

4.3.3.6. The oily water drainage will incorporate a penstock to close off the system in accordance with Environmental Agency requirements, to prevent discharge off site in the unlikely event of an environmental incident on site coinciding with a fault of the oil/oily water system separator/dump tank.

4.3.3.7. The interceptor will be double lined i.e tanker cased in concrete and will be fitted with float switch and high-level alarm system and will be connected to SCADA system.

4.3.3.8. During meeting with PW and EA it was advised that there is a preference for design development of a system with above ground interceptor. The appointed contractor to consider the preference through detailed design and agree the final solution through discussion with PW and EA. However, it is currently considered that raising of the dump tank and interceptor above ground will require the installation of a pump chambers below ground, which is considered likely to negate any benefits and to introduce additional risk. For example, introducing pumps will introduce the risk of pump failure, which would potentially result in untreated pollutants flooding from the pump chambers to the existing ground. Finally, there is limited space above ground, so to raise the infrastructure would require detailed changes to the compound boundary and layout. As such, to provide a dump tank and/or interceptor above ground is likely to add complexity and associated risks to the drainage design and infrastructure with no real benefit.

5. SUDS AND WATER QUALITY SYSTEM

5.1.1.1. Surface water from oil containment areas and oily water areas will be directed through the proprietary system of an oil separator. The manufacturer SPEL has provided specifications for their 'Puraceptor' which advises that, for all units tested, the discharge water has an average hydrocarbon concentration of 1.22mg/litre. The Environment Agency has advised that the

> '…*former drinking water standard (still used by most water companies) is 0.01 mg/l. As well as this, in line with the permitting regulations, hydrocarbons must not enter groundwater at detectable quantities.'*

5.1.1.2. Therefore, it is proposed to use SuDS to further reduce the hydrocarbon concentration of water discharged from the oil separator, prior to discharge via a soakaway to groundwater.

5.1.1.3. The principles of treatment below present existing research into the removal of TPH (total petroleum hydrocarbons), PAH (polycyclic aromatic hydrocarbons) and heavy metals, from water by SuDS. Included in the research is soil selection, effect of environmental parameters and design recommendations, as well as data to demonstrate the subsequent pollutant removal by SuDS.

5.2. PRINCIPLES OF TREATMENT

5.2.1.1. The principles of treatment are based on the SNIFFER (UEUW01 & UEUW02, 2008) reports and Napier *et al* (2008) articles identified in Section 2.3 and which also support the Ciria C753 SuDS Manual. This series of documents were produced by dual projects researching the water quality treatment provided by infiltration SuDS receiving carriageway runoff that contained Total Petroleum Hydrocarbons') ('TPH'), Polycyclic Aromatic Hydrocarbons ('PAH') and heavy metals. The research was undertaken in laboratory and field experiments. Within the laboratory, experiments used soil core lysimeters to which pollutants were applied and their discharge concentration measured, before destructive sampling of the soils; in addition, degradation studies were undertaken to assess the effect of varying parameters upon the degradation of organic pollutants within soil. Within the field, researchers measured pollutant concentration in the soils and pore water of SuDS that have been operational for approximately 10 years (UEUW02, 2008 pp.20).

5.2.1.2. The studies identified a two-stage process for pollutant removal; the first stage is removal of TPH, PAH and heavy metals from water by infiltrating it through soils; the second stage is removal of the TPH and PAH from the soils by 'degradation', which removes these organic pollutants from the SuDS system. UEUW01 (2008) identified that the process of degradation may involve biotransformation of TPH and PAH to daughter products or smaller molecules 'before the compound could be said to be completely degraded or mineralised' (pp. 22). While Napier *et al* (2008b) confirms that it is only the organic compounds, TPH and PAH that will be degraded, as the heavy metals will remain within the soils.

5.3. SOIL SELECTION, LYSIMETER AND DEGRADATION STUDIES

5.3.1.1. To inform soil selection, the lysimeter study investigated loamy sand (HOST class 3 (Hydrology of Soil Type), clay loam (HOST class 21), silty clay loam (HOST class 18) and a constructed SuD lysimeter of gravel, sand and a top layer of biologically active topsoil. The lysimeter study applied a single dose of pollutants in solution, to the surface of the soil cores and irrigated these for 135 days, measuring the pollutant concentrations within the discharging drainage water. At the end of the irrigation period destructive sampling of the soil cores was undertaken.

5.3.1.2. The separate degradation study investigated the effects upon pollutant degradation of moisture, temperature, pollutant concentration and bioactivity (microbial activity) by destructive sampling of loamy sand lysimeters. This degradation study was undertaken for 2 months and reported in UEUW01 (2008), then extended to 6 months being reported in UEUW02 (2008) to give further results for TPH degradation. Napier *et al* (2008 b) identifies that heavy metals will be retained within the soils, but not degraded and as such, high loadings may eventually require removal and appropriate disposal.

5.3.1.3. UEUW02, (2008; pp. 30 Fig. 21) recommends 'loamy soil' as most suitable for pollutant removal and the study results demonstrate that the silty clay loam (HOST class 18) achieves the most desirable results (Table 2 to 4 below). UEUW02 (2008) further explains that sandy soil can be unsuitable as it allows more rapid flow thereby reducing the treatment provided, while clayey soil may crack under dry conditions allowing rapid flow, or can prevent flow when the clay is saturated also reducing the treatment provided. As such it is recommended that a silty clay loam is used as the SuDS filtration media in the Converter Station Area.

5.3.1.4. To maintain water quality at the area within Order Limits as suitable to the underlying chalk, the pH of the silty clay loam filter media selected should be neutral or alkaline, while an acidic soil should not be used.

5.3.1.5. SNIFFER UEUW02 (2008) also identified the influence of nutrient levels, particularly nitrogen to support microbial activity. However, the study recognised that fertiliser would not typically be added to SuDS and as such did not use it to artificially enhance microbial degradation in the experiments. The nitrogen concentration of the soils used in the study was reported as 'within the range of reported concentrations (2.5mg/kg – 29.8 mg/kg)' (pp.4) which may be suitable for a comparative range if it is of concern during construction. However, addition of nitrogen to the Converter Station Area is not recommended.

5.4. TPH AND PAH DEGRADATION

5.4.1.1. The SNIFFER and Napier *et al* (2008) studies highlight the importance of degradation to remove TPH and PAH pollutants from the soils and therefore from the SuDS system. Microbial degradation was identified as 'the main method of hydrocarbon degradation in soils and sediments' (UEUW02, 2008 pp.3). While the environmental parameters relevant to SuDS which can further affect or compliment microbial degradation are changes in temperature, soil moisture and pollutant loading.

5.4.1.2. It is worthwhile noting that changes in these parameters was not reported as affecting the removal of TPH and PAH from water into the soils, but rather as slowing the rate of organic pollutant degradation within the soils for overall removal from the SuDS. UEUW02 (2008) also suggests that the breakdown of organic pollutants may experience seasonal variation, particularly with regard to temperature with 'rapid breakdown in summer temperatures and slower rates in winter' (2008, pp.3). Therefore, it is expected that warmer seasons will allow for the degradation of pollutants retained within soils.

5.4.1.3. Soil moisture is reported in the SNIFFER and Napier *et al* (2008) documents as strongly affecting organic pollutant degradation. As part of the field study, ponds under permanently saturated conditions were found to contain high concentrations of pollutants that have been captured by the soils, but not degraded. It was considered likely that the permanent saturation had resulted in low oxygen conditions which prevented the aerobic microbial degradation (UEUW02, 2008 pp.22). Whereas, the basins subject to a wet/dry cycle experienced aerobic conditions that resulted in organic pollutant degradation. As such, this cycle is recommended by SNIFFER and Napier *et al* (2008) to achieve removal of organic pollutants from SuDS. Therefore, a wet/dry cycle is also recommended for the design of SuDS at the Converter Station Area.

5.4.1.4. Pollutant loading was reported as resulting in higher residual pollutant concentrations within the soils, which had not been degraded. However, at the Converter Station, discharge from the oil separator is advised by the manufacturer SPEL as providing an average hydrocarbon concentration of 1.22 mg/l (The unit does work at a discharge rate of <5mg of oil per litre - 5 parts per million when discharging to surface water). As such, high concentrations or extreme fluctuation of discharged organic pollutant is not expected. In addition, runoff from roads discharging to infiltration drains and not to the separator, is expected to contain comparatively low pollutant loads due to the low traffic levels.

5.5. POLLUTANT REMOVAL

5.5.1.1. The UEUW01 Final Report (2008) demonstrates through the lysimeter studies that greater than 99.9% of TPH and PAH was removed by soils, leaving less than 0.068% of pollutants to potentially reach the groundwater. Of the >99.9% organic pollutants removed by the soils, the silty clay loam achieved the highest degradation with 76.06% TPH and 68.10% PAH removed from the soils.

	SUD	Sand	Silt	Clay
% leached	0.003	0.003	0.005	0.056
% retained	64.00	64.90	31.89	54.56
% degraded	35.99	35.10	68.10	45.38

% retained included any PAH present in the soil prior to treatment.

Plate 4 - PAH mass balance for SUD, sand, silt and clay lysimeters (UEUW01, 2008, Final Report Tb 6)

	SUD	Sand	Silt	Clay
% leached	0.005	0.011	0.012	0.068
% retained	19.30	70.70	23.93	29.39
% degraded	80.69	29.29	76.06	70.54

% retained included any TPH present in the soil prior to treatment.

Plate 5 - TPH mass balance for SUD, sand, silt and clay lysimeters (UEUW01, 2008, Final Report Tb 7)

5.5.1.2. The lysimeter studies also demonstrate that greater than 99.84% of heavy metals were removed by the silty clay loam, leaving only 0.16% to 0.04% of the heavy metals to potentially reach the groundwater. Napier *et al* (2008b) do identify however, that heavy metals are not degraded and will therefore remain within the soils which may require disposal if high concentrations accumulate.

	SUD	Sand	Silt	Clay
Cadmium	0.05	0.25	0.16	0.23
Copper	0.19	0.11	0.13	0.45
Zinc	0.03	0.02	0.04	0.31

Plate 6 - Percentage of applied metals measured in drainage water (UEUW01, 2008, Final Report Tb 8)

5.5.1.3. The UEUW01 Final Report (2008) also took soil water samples to a depth of 0.9m at the inlet of an existing SuDS basin receiving carriageway runoff containing TPH, PAH and heavy metals. The design of the basin (29A) also resulted in the majority of pollutants being removed at its inlet. Therefore, measurement of pollutants within soil water samples at this location is measuring the worst case scenario.

Sampling date	Cd mg l^{-1}	Cu mg l^{-1}	Pb mg l^{-1}	Ni mg l^{-1}	Zn mg l^{-1}	pH	TPH mg l^{-1}	Total PAH µg l^{-1}
23/03/07	*	0.001	*	0.003	*	ns	*	0.33
31/03/07	*	0.009	0.002	0.003	0.010	7.6	0.2	0.99
11/05/07	*	0.013	0.001	0.003	0.010	7.7	*	0.16
29/06/07	*	0.009	0.002	0.211	0.020	8.2	0.1	ns

Plate 7 - Summary of pollutant concentration in soil water (UEUW01, 2008, Final Report, Tb 17, measurements from Basin 29A)

5.5.1.4. The results demonstrate that the Total PAH concentrations in soil water were a maximum of 0.00099 mg/l (0.99µg/l) while the TPH concentrations 'either remained or very quickly fell to below the analytical reporting limit' (UEUW01, 2008 pp.15) for aqueous samples, as confirmed by the reporting limits included in the UEUW01 (2008) (Table 6 below).

	Reporting limit	
Determinand	Aqueous	Soil/sediment
Cadmium	0.0001 mg l^{-1}	0.1mg kg^{-1}
Copper	0.001mg l^{-1}	0.5mg kg^{-1}
Lead	0.001mg l^{-1}	0.5mg kg^{-1}
Nickel	0.001mg l^{-1}	0.5mg kg^{-1}
Zinc	0.002mg l^{-1}	3mg kg^{-1}
TPH	0.1mg l^{-1}	10mg kg^{-1}
Total PAH	0.01ug l^{-1}	1.28mg kg^{-1}
Nitrate N	0.3mg l^{-1}	5mg kg^{-1}
Ammoniacal N	0.01mg l^{-1}	0.5mg kg^{-1}
Total N		0.30%
Available P		0.1mg l^{-1}
Dissolved P	0.3mg l^{-1}	
Phosphate	0.01mg l^{-1}	
Total P	0.3mg l^{-1}	30mg kg^{-1}
TOC		
FOC	0.1mg l^{-1}	0.02%

Plate 8 - Analytical reporting Limits (UEUW01, 2008, Final Report Tb 25)

5.6. POLLUTANT SOIL RETENTION DEPTH

5.6.1.1. The soil core lysimeters producing the results above, had a depth of 0.6m and the SNIFFER and Napier *et al* (2008) studies identify that TPH, PAH and heavy metal pollutant retention is concentrated within the top 100 mm of soil with limited migration to 300 mm depth.

5.6.1.2. UEUW01 (2008, pp.16) reports that below the top 100 mm of soil, no soil samples showed PAH concentrations above the analytical reporting limits. This result was reported for all soil types, except the clay, however it is the silty clay loam that is recommended for the Converter Station Area. In addition, UEUW01 (2008) concludes that the minimum percentage removal for all pollutants and all soils in the lysimeter study was '99.55% within a 300mm deep column of soil' (pp. 45).

5.6.1.3. It has been agreed with PW that as a precautionary measure, an infiltration layer of 0.6 m depth will be will be implemented at the Converter Station Area for treatment of water discharging from the oil separator, in accordance with the lysimeter studies.

5.7. ADDITIONAL DESIGN FEATURES

5.7.1.1. In addition to the research results above, the SNIFFER and Napier *et al* (2008) documents identified design features that further enhanced pollutant removal.

5.7.1.2. Napier *et al* (2008a) best explain the effect of inlet design on the pattern of pollutant removal within a basin (or other SuDS feature) and identify that an inlet where 'inflow velocity quickly dissipates' (pp. 6) will result in the majority of pollutants being deposited near to the inlet; whereas a long narrow inlet channel which maintains inflow velocity will transport pollutants further.

5.7.1.3. In line with the above, SNIFFER and Napier *et al* (2008) recommend that basin design should be 'wide and shallow' rather than 'narrow and deep' (Napier *et al*.; 2008a; pp. 9). UEUW02 (2008) further advises that a small and deep area is the poorest option, but that a long and more narrow design such as a low flow channel, can be a good compromise due to the extended contact provided.

5.7.1.4. These features have been considered in the SuDS design described below.

5.8. SPECIFICATION FOR SUDS COMPONENTS

5.8.1.1. The water quality treatment features recommended for inclusion in the SuDS design at the Converter Station Area are summarised here. While the design of each individual SuDS feature, that must be suitable for surface water flood attenuation as well as water quality treatment, will be described in more detail in section 2.11 and in the construction drawings (AQD-WSP-OS-UK-DR-D-200340).

5.8.1.2. Infiltration has been identified as the primary process for removal of TPH, PAH and heavy metals from water and as such, SuDS will be designed to allow infiltration through specified filter media. Infiltration basins and drains will then be able to continue the infiltration to groundwater, whereas detention basins and filter drains that are not intended for direct infiltration to groundwater, will be designed to collect water in underdrains below the filter media, then convey this water further along the surface water drainage system.

5.8.1.3. The soil type recommended is the silty clay loam (HOST class 18), with a neutral or alkaline pH. Please note, an acidic soil is not suitable and should not be used. Nitrogen should not be added to the SuDS or treatment filter media, but the naturally occurring nitrogen concentration of the selected silty clay loam, can be compared to the study's reported ranges of 2.5 mg/kg – 29.8 mg/kg if required.

5.8.1.4. The depth of treatment filter media downstream of the oil interceptor should be 0.6m, as agreed with PW to replicate the lysimeter studies and as a precautionary approach. If this depth is to be altered in other locations, the treatment filter media should be no less than 0.3 m in accordance with recommendations in the SNIFFER reports (UEUW01, 2008 pp.45; UEUW02, 2008 pp.30). In the event that other filter media is required for hydraulic performance, this should be in addition to the 0.6m or 0.3m of treatment media and should not replace the material, unless its water quality benefits have been demonstrated.

5.8.1.5. The inlets to basins and swales will incorporate flow dissipation apparatus to enhance pollutant deposition near the inlet. The beds of basins and swales will also be maintained as shallow and wide as possible to maximise pollutant treatment and spreading of water. In the case of the detention basin, a wide low flow channel is proposed to utilise the full length of the basin and maximise retention time for infiltration and pollutant removal. Without the channel, there is potential for flow routes to 'short circuit' the basin and flow directly from the inlet to the outlet. The low flow channel width will be a minimum 2 m and the depth will be a maximum 200 mm, allowing higher flow rates to overtop and spread over the rest of the basin, avoiding erosion into a deep narrow channel.

5.8.1.6. A wet/dry cycle has been identified as essential for degradation of the organic pollutants TPH and PAH and as such, features should be designed so that complete drainage is possible, creating aerobic conditions within sediments. Where features are designed to permanently hold water, these should be located in areas receiving the lowest pollutant concentrations possible, such as away from the inlet.

5.9. OIL CONTAINMENT AND OILY WATER AREAS

5.9.1.1. As previously described, oil containment areas will drain to the dump tank and then the oil separator; whereas the oily water areas will drain runoff directly to the oil separator. The oil separator will be discharging surface water with an averaged hydrocarbon concentration of 1.22 mg/l which will be conveyed to the detention basin for additional treatment.

5.10. ROOF RUNOFF AND CATCHPITS

5.10.1.1. Roof runoff will be directed through the conventional drainage network to the detention basin bypassing the dump tank and hydrocarbon interceptor. The CIRIA C753 Simple Index Method identifies roof runoff from commercial/industrial roofs as having a 'low' pollution hazard level which will be suitably treated by any SuDS feature and as such, treatment within the detention basin is considered satisfactory. However, additional pre-treatment for removal of suspended solids will be provided by catchpit chambers with silt traps that will require maintenance for removal and disposal of sediment and other pollutants.

5.11. DETENTION BASIN

5.11.1.1. The detention basin will be lined and impermeable, but will contain a layer of added filter media to allow treatment by infiltration. The basin will be designed for the dual purpose of water quality treatment and surface water attenuation upstream of the soakaway.

5.11.1.2. The basin will be vegetated, with a maximum bank gradient of 1:3 and a maximum depth to bed level of 2 m which includes 0.3 m freeboard. Underlying the bed will be a 0.6 m deep layer of treatment filter media (silty clay loam, neutral to alkaline pH). The base of the filter media will be impermeable to prevent infiltration to groundwater and as such, underdrains placed at the base of the infiltration layer will collect and convey treated water to the soakaway. If required, treated water will pass through a flow control to ensure discharge at agreed rates, however this is not expected to be a requirement. During large rainfall events the basin will start to fill as the discharge rate will be limited by the infiltration rate of the filter media. In the event that inlet rates are higher than the infiltration and discharge rates, water will be able to pass through a 'high level overflow' to the soakaway.

5.11.1.3. The basin will drain completely and remain dry between rainfall events, due to the need to infiltrate water through the treatment filter media which requires aerobic conditions.

5.11.1.4. The basin inlet will include a level spreader and flow dissipation apparatus to reduce flow rates and maximise pollutant removal and infiltration near the inlet. A low flow channel, of 2 m width and maximum 0.2 m depth will help spread water through the basin and increase residency time, ensuring that flows don't hydraulically short-circuit through the basin. As flows increase, water will overtop the channel and spread over the basin bed for more uniform infiltration.

5.11.1.5. In the event that erosion protection of the low flow channel is required, then 'rock rolls' such as those provided by Salix could be suitable. The use of coir should be investigated before use, to determine potential effects on nutrients, pH or plant growth.

5.11.1.6. The required volume of surface water storage will be determined by the infiltration rate of the existing substrate surrounding the soakaway, which is yet to be confirmed. In the absence of this information, the current basin design provides 2300m^3 of surface water storage based on a Microdrainage Quickstorage Estimate of between 1700m^3 - 2400m^3 for an event with a 1:100 year return period plus 40% Climate Change and a discharge rate of 3.4 l/s. This discharge rate was calculated from 2l/s/ha of impermeable area generating the runoff, as advised within the HR Wallingford Greenfield Runoff Rate Estimation Tool (UKSuDS, 2018).

5.11.1.7. The treatment filter media underlying the basin has not been included in surface water storage estimate.

5.11.1.8. Detailed design and hydraulic modelling is required which will take account of chalk and filter media infiltration rates and maximum groundwater levels. In the event that this demonstrates a need for additional surface water storage, this can be provided by extending the current footprint of the basin or geocellular soakaway, as well as by use of an overflow from the detention basin to the infiltration basin further south. In the event that modelling demonstrates that a smaller volume of surface water storage is required, then the basin should be made shallower with a larger bed, then the bank gradients reduced.

5.11.1.9. It is expected that the detention basin will be subject to vegetation management, such as litter & debris collection and an annual cut and rake, but this should confirmed upon detailed design and with further consultation with the project ecologist and landscape architect. In addition, removal of sediment build-up may be required.

5.12. SOAKAWAY

5.12.1.1. A geocellular soakaway is proposed to allow infiltration of surface water to ground. The infiltration rate is yet to be confirmed by field testing, which will determine the final size of the feature. The soakaway has also been selected at this stage based on the available information, as it provides flexibility to suit the site gradients and to maximise the discharge volumes.

5.12.1.2. The final water quality treatment stage is proposed by lining the soakaway with a geotextile membrane and surrounding the base and sides with a layer of treatment filter media (silty clay loam, neutral to alkaline pH). A depth/width of 0.3m, is recommended in accordance with recommendations by SNIFFER and Napier *et al* (2008). Based on the studies, it is expected that pollutant concentrations discharging from the detention basin will be very low, at or near analytical reporting limits and as such the additional 0.3 m filter media on the soakaway is precautionary and meets the reports' recommendations. However, should the 0.6 m be required this can be accommodated.

5.13. GRAVEL AREA AND INFILTRATION DRAINS

5.13.1.1. Gravel areas are located within the compound and external to buildings, in locations that are not roads, but may contain infrastructure. In accordance with the National Grid TS 2.10.01 section 3.4.2, these gravel areas will receive direct rainfall and runoff from roads, excluding the oily water areas. As such, the gravel areas will be implemented as infiltration drains.

5.13.1.2. It is expected that traffic within the compound during operation will be low and as such, this has been equated to the CIRIA C753 Simple Index Method land use of 'individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change i.e. <300 traffic movements/day' with a 'low' hazard index.

5.13.1.3. The CIRIA guide identifies that an infiltration trench, with specific design and filtration media requirements, is sufficient to provide treatment to metals and hydrocarbon for this land use. The infiltration trench will also provide the majority of treatment required for total suspended solids, however a permeable geotextile membrane in the upper layers of the media will be required for removal of grit and sediments from filtration water. This layer will require maintenance to remove the trapped sediments and ensure the ongoing function of the infiltration drain.

5.13.1.4. The treatment filter media should be silty clay loam with a neutral to alkaline pH and a depth of 0.3 m. A second permeable geotextile membrane should underlie the filter media to ensure it does not enter the chalk. The 0.3 m depth of treatment filter media is in accordance with recommendations by SNIFFER and Napier *et al* (2008) for treatment of runoff from heavily trafficked roads and is therefore considered suitable for treatment of runoff from the low traffic roads within the compound that are not subject to 'oily water' nor the oil containment areas.

5.13.1.5. Detailed design and hydraulic modelling is required which will take account of chalk and filter media infiltration rates and maximum groundwater levels. In the event that this demonstrates a need for additional surface water storage, underdrains can be installed at the base of the gravel areas to collect and convey surface water to the detention basin.

5.14. INFILTRATION SWALE AND ACCESS ROAD RUNOFF

5.14.1.1. An infiltration swale is proposed for capture, infiltration and conveyance of surface water runoff from the Access Road to the Converter Station. The swale is currently proposed for a depth of 0.4 m, a base width of 0.6 m and banks with a 1:3 gradient, giving a total width of 3 m. Underlying the swale will be an infiltration trench and both the trench and swale will be underlain by 0.3 m of infiltration treatment media (silty clay loam, neutral to alkaline pH).

5.14.1.2. Water quality treatment will be provided by the swale and the infiltration trench sufficient for the pollutants expected to runoff from the access road. Low levels of traffic are expected during operation will be low and as such, this has been equated to the CIRIA C753 Simple Index Method land use of 'individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change ie <300 traffic movements/day'.

5.14.1.3. CIRIA C753 identifies that a swale is sufficient to treat the pollutant loading from this land use and as such, the treatment provided by the infiltration trench is an additional benefit, provided that the features are designed in accordance with the C753 guidance and this report.

5.14.1.4. As such, the 0.3 m depth of treatment filter media is considered sufficient and in accordance with recommendations by SNIFFER and Napier *et al* (2008) for treatment of runoff from heavily trafficked roads and is therefore considered suitable for treatment of runoff from what is expected to be low traffic roads. However, the depth of treatment filter media can be increased up to 0.6m as a precautionary measure in accordance with the lysimeter study reported by SNIFFER and Napier *et al* (2008), if required.

5.14.1.5. Maintenance may be required for the removal of sediments captured by the swale.

5.14.1.6. Surface water storage will be provided within the swale and within the underlying infiltration drain. Should additional surface water storage be required, the swales will be designed to convey exceedance flows to an infiltration basin. An optional underdrain can also be added to the infiltration drain if additional conveyance is required. The storage requirements will be confirmed in the final design subject to hydraulic modelling and confirmation of infiltration rates.

5.14.1.7. There is also potential for the infiltration swale to convey exceedance flows from the detention basin in the north, to the infiltration basin further south if additional surface water storage is required. However, this is subject to receipt of infiltration rates and hydraulic modelling and is only expected to occur during extreme events.

5.15. INFILTRATION BASIN

5.15.1.1. The infiltration basin is proposed for the southwest extent of the development and at a low point in the existing topography. This will allow runoff from the Access Road to be conveyed along infiltration swales from the north and east.

5.15.1.2. The size and outline design of the infiltration basin is the same as the detention basin further north, providing 2300 m^3 of surface water storage with a maximum bank gradient of 1:3 and a maximum depth of 2 m which includes a 0.3 m freeboard.

5.15.1.3. Underlying the bed, a 0.3 m deep layer of treatment filter media (silty clay loam, neutral to alkaline pH) will be implemented to provide water quality treatment. The 0.3 m depth of treatment filter media is in accordance with recommendations by SNIFFER and Napier *et al* (2008) for treatment of runoff from heavily trafficked roads and is considered sufficient for the infiltration basin that is receiving surface water from a low traffic road, and which has previously been provided treatment by the infiltration swale. However, the depth of treatment filter media can be increased up to 0.6 m as a precautionary measure in accordance with the lysimeter study reported by SNIFFER and Napier *et al* (2008), if required.

5.15.1.4. Like the detention basin, the infiltration basin is proposed for an inlet design that will include flow dissipation and a level spreader apparatus to maximise pollutant removal near the inlet and to help reduce erosion. However, a low flow channel is not proposed, as the bed area should be maximised for infiltration over its full extent and there is no opportunity for the water to short-circuit to an outlet.

5.15.1.5. The 2300 m^3 of surface water storage provided by the infiltration basin has been based on the impermeable area of 1.7 ha created by the access road. Microdrainage provides a Quickstorage Estimate of 1700 m^3 - 2400m^3 storage for an event with a 1:100 year return period plus 40% Climate Change and a discharge rate of 3.4l/s. This discharge rate was calculated from 2l/s/ha of impermeable area generating the runoff, as advised within the HR Wallingford Greenfield Runoff Estimation Tool.

5.15.1.6. The final volume of the infiltration basin will be determined by the infiltration capacity of the underlying chalk and treatment filter media, in addition to the maximum groundwater levels, which is still to be confirmed. In the event that greater storage is required, it is anticipated that the surface area of the basin can be increased, but the basin depth and bank gradient should not be increased. Potential exceedance flows from the detention basin in the north may also be accommodated within the infiltration basin and may require an increase in basin storage.

5.15.1.7. Should infiltration rates or the final design allow the volume of surface water storage to be reduced, then the basin should first be made shallower then bank gradients reduced, in order to maximise the bed area. This is to maximise the infiltration through a larger bed, maximise the water quality treatment benefits from a larger bed, and to maximise the vegetated margins of most benefit to wetland ecology.

5.15.1.8. It is expected that the detention basin will be subject to some vegetation management, such as an annual cut and rake, but this should be confirmed with the ecologist and landscape architect. In addition, removal of sediment build-up may be required.

5.16. SUDS MAINTENANCE

5.16.1.1. Sustainable drainage systems should be designed in accordance with this WSP report and preliminary design drawings, as well as the policies and guidance identified in Section 2.3 including the CIRIA C753 SuDS Manual, to ensure their suitability for surface water storage and water quality treatment.

5.16.1.2. A SuDS maintenance plan should also be developed to outline requirements for vegetation, removal of potential pollutants and to ensure the long-term function of the SuDS features.

5.17. CONCLUSION

5.17.1.1. Surface water is proposed for infiltration to ground and features will be designed to ensure no exceedance flows for an event with a return period of 100 years + 40% climate change. The size and design of the drainage network and SuDS features is subject to confirmation of infiltration rates, maximum groundwater levels and detailed hydraulic modelling and as such, are currently designed to allow a discharge rate of 2l/s/ha of impermeable surface area producing the runoff.

5.17.1.2. The drainage strategy proposes water quality treatment through a series of proprietary and SuDS systems. Water from the oil containment areas is proposed for the highest level of treatment through a dump tank then oil separator; while runoff from the oily water areas is proposed for treatment through the oil separator. Flow from the oil separator is expected to contain an average hydrocarbon concentration of 1.22mg/l and therefore will pass through SuDS features for additional water quality treatment.

5.17.1.3. The studies by SNIFFER (2008) and Napier *et al* (2008), demonstrate that properly designed SuDS are capable of removing TPH, PAH and heavy metals from infiltrating water, prior to degradation of the organic pollutants for removal from the SuDS system. The results of the lysimeter studies demonstrate that greater than 99.9% of TPH and PAH, and greater 99.84% of heavy metals were removed from the infiltrating water by silty clay loam, proposed to be the treatment filter media for the Aquind UK site. In addition, field studies of functional SuDS demonstrated that soil water at a depth of 0.9m contained a maximum of 0.00099 mg/l (0.99µg/l) of Total PAH, while the TPH concentrations 'either remained or very quickly fell to below the analytical reporting limit' (presented in section 2.10.4). As such, the SuDS design for the Converter Station Area has been informed by the SNIFFER and Napier *et al* (2008) studies in order to provide water quality treatment and protection of groundwater.

5.17.1.4. The SuDS system will receive discharge from the oil separator which will combine with roof runoff at the detention basin. Roof runoff is proposed for pre-treatment through catch pit chambers with silt traps. At the basin, runoff will be provided additional treatment prior to discharge via a soakaway.

5.17.1.5. Runoff from low traffic roads within the converter station will discharge to gravel areas installed as infiltration drains; while runoff from the site access road will pass to an infiltration swale that has the potential to convey high flows to the southern infiltration basin during extreme events.

5.17.1.6. Basins will be designed with inlets to dissipate the flow, protect from erosion and maximise pollutant treatment by concentrating this near the basin inlet and allowing any remaining low levels of pollutants to be treated within the remaining basin. The detention basin will be underlain by 0.6m of treatment filter media to allow infiltration to an impervious base and underdrains that will convey flow to the soakaway. All other features will allow infiltration to ground and will be underlain by 0.3m of treatment filter media to provide water quality treatment prior to infiltration through the chalk to groundwater. The detailed design of these features will be in accordance with the description provided in this report and associated construction detail and design drawings (AQD-WSP-OS-UK-DR-D-200140-141 & AQD-WSP-OS-UK-DR-D-200140-141).

5.17.1.7. In the event that smaller volumes of storage are required, the basins should be first made shallower, then gradients reduced in order to maximise the bed area and maximise the water quality treatment, ecological benefits and vegetated margins, as well as increased infiltration. The depth of treatment filter media however should remain as specified in this report.

5.17.1.8. Final design of features is to be undertaken in consultation with the ecology and landscape architect in order to maximise benefits of the feature.

5.17.1.9. The above outline strategy will be subject to the discussion and agreement of the EA and PW will be subjected to a full hydrological risk assessment to ensure no unacceptable risk to the natural environment and sensitive receptors.

6. SCADA SYSTEM

6.1.1.1. The AQUIND Interconnector control room will have a SCADA system used to remotely control and supervise the Interconnector. Part of the functionality of this system is for the system operators to receive and prioritise information that is sent through. This information includes (but is not limited to) Major alarms, measurements, indications and minor alarms. Within the maintenance and repair plan for the project there will be personnel on standby to respond to any situations that arise.

6.1.1.2. Depending on the severity of the situation, it may result in actions ranging from a repair or investigation at the next scheduled maintenance outage or an immediate site visit within a pre-agreed time frame

6.1.1.3. The interval between an alarm being triggered and being sent to the standby maintenance and repair personnel happens within milliseconds. Which means that there can be a person on site within the agreed time frame.

7. FOUNDATION SOLUTION

7.1.1.1. Converter Station Area was found to be directly underlain by Head Deposits consist predominantly of gravelly Clays; sometimes becoming clayey Gravel. Generally underlying the Head Deposits was Structureless Grade D Chalk predominately described as Grade Dm with occasional interbedded layers of Dc. Below the Structureless Grade D Chalk, Chalk quality and grade broadly improved with depth becoming Structure Chalk Grades C to A.

Table 2 – Converter Station West Preliminary Ground Model

Strata	Ground model (m AOD) (unit thickness (m))	Description
Head Deposits	85.00-84.20 (0.80)	Firm to stiff red brown CLAY with gravel and cobble content. Occasionally gravel content becomes such it is clayey GRAVEL.
Structureless Chalk (Grade D)	84.20-76.90 (7.30)	Consisting of both Grade Dm and DC Chalk, interbedded throughout with no distinguishable boundary or profiling.
Structured Chalk (Grade C – A)	76.90-55.00 (21.90+)	Very low to medium density, density increasing with depth. Flint bands were noted during drilling, theses were often thin (0.10-0.30m thick) and occurred between change of grades. There were six notable grade changes. Zones of core loss were recorded within BH29 and BH30, this is considered to be due to flint bands marking the transition from Grade B to C

		Chalk, with the flint causing loss of recovery. Grade A was noted between 79.06-74.56m AOD and 64.06-58.06m AOD.
Groundwater	40.00-30.00m AOD Informed by Portsmouth Water	The groundwater depth was informed by the Portsmouth Water representatives, who have a monitoring well within 1.00km of the site and detailed groundwater mapping records. Groundwater is known to become shallower from north to south.

7.1.1.2. The majority of the potential fill material will consist of Grade D chalk and head deposits. On-site reworked fill is unlikely to be suitable for shallow foundations above 75KPa as it would not be able to achieve bearing resistance greater than this or the 25mm long term settlement tolerances. Where bearing resistance and/or settlement requirements are not met for shallow foundations deep foundation options (piles will need to be considered. This is only a guide. Total and differential settlement limits are confirmed by the switchgear and plant manufacturer.

Table 3 – Classification of Chalk by Discontinuity Spacing

Grade	Description
D	Structureless or remoulded mélange.
C	Typical Discontinuity aperture >3 mm
B	Typical Discontinuity aperture <3 mm
A	Discontinuities closed.

7.1.1.3. The initial piling assessment has been based on pre-cast driven piles as this was discussed with PW and EA at our meeting on 18 July 2019 and considered to have the lowest impact on the chalk aquifer and conditions set by Portsmouth Water around SPZ1 designation. The indicated pre-cast piles can be up to 15m long from formation level (formation level is usually about 1.0m below finished converter station level). This is subject to detailed design by the appointed contractor design team.

7.1.1.4. In addition to a piling specification, the appointed contractor to provide a detailed risk assessment for all piling/foundation works within the SPZ1 to PW, EA and HCC in-advance of procurement and construction.

8. TEMPORARY SURFACE WATER MANAGEMENT

8.1.1.1. Appointed contractor is to take all steps necessary to avoid cross contamination and shall use appropriate water management techniques during the ground work.

8.1.1.2. Appointed contractor is required to clean all equipment used in the construction before repositioning the equipment. Waste-water must not be allowed to enter natural water bodies or intrusive locations. Waste-water should not enter drains or sewers without prior authorisation. The appointed contractor is to liaise with the employer and EA to obtain such authorisation. Waste material must not be carried out onto public land (e.g. on wheels of site vehicles). All equipment used in the construction shall be cleaned before leaving site.

8.1.1.3. For any further site Investigation Aquifer protection measures shall be put in-place throughout the works. Works shall be undertaken in accordance with Environmental Agency guidance as outlined in “Technical Report P5-065/TR)”.

8.1.1.4. Construction of the proposed Converter Station requires levelling the site and the excavation of the foundations for the building and equipment. A temporary low permeable construction compound will also be needed to house the heavy vehicles and construction works.

8.1.1.5. The excavation of the foundations and levelling of the site is likely to change the natural hydrological characteristics of the site potentially increasing the surface water flood risk. The flood risk also has the potential to increase due to the low permeable construction area which is likely to temporarily increase runoff to the surrounding land and drainage networks.

8.1.1.6. Activities on site during construction could lead to an increase in turbid run-off and spillage/leaks of fuel, oil, etc. That could affect aquifer through surface water runoff. However, the construction process would include mitigation measures to intercept run-off and ensure that discharge from the site are controlled in quality and volume. This may include the use of settling tanks or ponds to remove sediment, temporary interceptors and hydraulic brake.

8.1.1.7. The construction methodologies will ensure the risk of flooding and contamination is not increased during development through the use of surface water run-off management strategies. Recommended mitigation measures are provided below and will be included within Draft Code of Construction Practice (CoCP).

8.1.1.8. In addition, construction phase pollution prevention measures will be required and will be designed and implemented by the appointed contractor with reference to the documents highlighted within reference section of this report (Note : List is not exhaustive).

8.1.1.9. Due to the above requirements it is proposed that a Temporary Site Water Management Plan is developed and submitted to the Environment Agency, Portsmouth Water and Hampshire Country Council for approval prior to commencement of construction work by appointed contractor.

8.1.1.10. This plan will be in addition to, or in support of other construction phase licences and permissions which may be contractor led.

8.2. TO SUMMARISE:

All construction work would be undertaken in accordance with guidance and the measures outlined in the Code of Construction Practice which will in turn inform the detailed Construction Environmental Management Plan ('CEMP') to be produced by the appointed contractor prior to construction. Current Guidance includes:

- Environmental Agency, Pollution Prevention Guidance Note 6 (PPG6): Pollution Prevention Guidelines – Working at Construction and Demolition Sites;
- Environmental Agency, Pollution Prevention Guidance Note 5 (PPG5): Working in, near or liable affect watercourses;
- Control of Water Pollution in form Construction Sites – Guidance for Consultants and Contractors CIRIA (C650); CIRIA – DuDS Manual;
- Prevent surface water being affected during earthwork operations. No discharge to surface watercourses will occur without permission from EA (SuDS Manual);
- Wheel washers and dust depression measures to be used as appropriate to prevent the migration of pollutants (DuDS Manual);
- Regular cleaning of roads of any construction waste and dirt to be carried out (SuDS Manual);
- A construction method statement to be submitted for approval by the responsible authority (SuDS Manual); and
- All other relevant good industry practice guides and all UK statutory legislation.

8.2.1.1. Although localised contamination of soil may occur during construction as a result of leaks or spills of fuels, oils and chemicals, the potential for contamination to occur will be reduced by implementing the following pollution mitigation measures;

- Refuelling of machinery would be undertaken within designated areas where spillages can be easily contained. Machinery would be routinely checked to ensure it is in good working condition.
- Any tanks and associated pipe work containing hazardous substances would be double skinned and be provided with intermediate leak detection equipment.
- The following specific mitigation measures for the protection of surface water during construction activities would be implemented;
  - Management of construction works to comply with the necessary standards and consent conditions as identified by the EA, PW and HCC.
  - Provide appropriate spill kits on the construction site and laydown areas and provide training and briefing for all staff highlighting the importance of water quality, the location of watercourses and pollution prevention included within the site induction.
  - Area with prevalent run-off to be identified and drainage actively managed, e.g. through bunding and/or temporary drainage.
  - Area at risk of spillage, such as vehicle maintenance areas and hazardous substances stores (including fuel, oils, and chemicals) to be bunded and carefully sited to minimise the risk of hazardous substances entering the drainage system to the local watercourses, additionally the bunded areas will have impermeable base to limit the potential for migration of contaminants into ground.
  - following any leakage/spillage. Bunds used to store fuel, oil etc. to have 110% capacity of the volume of fuel, oil, etc. to be stored.
  - Excavated material to be placed in such a way as to avoid any spillage with potential contamination of aquifer.
  - All plant machinery and vehicles to be maintained in a good condition to reduce the risk of fuel leaks.
  - Temporary drainage works to be constructed to relevant statutory guidance and approved via Lead Local Flood Authority prior to commencement of construction.
  - Consultation with the EA to be ongoing throughout the construction period to promote best practice and to implement proposed mitigation measures.
  - Appropriate site operational protocols and procedures to be implemented at all times by the site operator over the full operational life of the site.

REFERENCES

Environment Agency (2001a) PPG1 General Guide to the Prevention of Pollution.

Environment Agency (2011a) PPG2 Above Ground Oil Storage Tanks.

Environment Agency (2006) PPG3 Use and design of oil separators in surface water drainage systems.

Environment Agency (2007a) PPG5 Works and Maintenance In or Near Water.

Environment Agency (2010) PPG6 Working at Construction and Demolition Sites.

Environment Agency (2011) PPG7 The safe operation of refuelling facilities.

Environment Agency (2004) PPG8 Safe Storage and Disposal of Used Oils.

Environment Agency (2007b) PPG13 Vehicle Washing and Cleaning.

Environment Agency (2000) PPG18 Managing fire water and major spillages.

Environment Agency (2009) PPG21 Pollution incident response planning.

Environment Agency (2011c) PPG22 Dealing with Spills.

Environment Agency (2001) PPG25 Development and Flood Risk.

Environment Agency (2011) PPG26 Storage and handling of drums and intermediate bulk containers.

Environment Agency (2011d) PPG27 Installation, decommissioning and removal of underground storage tanks.

British Standard BS 10175 (2011) Investigation of Potentially Contaminated Sites

Department for Environment, Food and Rural Affairs (Defra) (2012) Environmental Protection Act 1990: Part 2A- Contaminated land Statutory Guidance

Environment Agency (2012) Groundwater Protection: Principles and Practice (GP3)

Environment Agency (2004) Contaminated Land Report 11

CIRIA (2001) Report C532. Control of water Pollution from Construction Sites. Construction Industries Research Association;

CIRIA (1999) Report C502 Environmental Good Practice on Site. Construction Industries Research Association;

CIRIA (2007) Report C697 (2007) The SuDS manual. Construction Industries Research Association;

Sewers for Adoption (SFA) 7th Edition

Local Authority Standards

Building Regulations Part H Drainage and Waste Disposal

CIRIA SuDS Manual (C753)

SNIFFER UEUW01: Source control pollution in Sustainable Drainage (Final Report, February 2008)

SNIFFER UEUW01: Source control pollution in Sustainable Drainage: Supplementary Report (Draft Report, September 2008)

SNIFFER UEUW02: SuDS Pollution Degradation (Final Report, October 2008)

Napier, , F; Jefferies, C; Heal, KV; Fogg, P; D'Arcy, BJ; Clarke, R. (2008) Evidence of traffic-related pollutant control in soil-based Sustainable Urban Drainage Systems (SUDS). Edinburgh, Scotland. (Referenced below as Napier et al 2008a)

Napier, F.; D'Arcy, B.J.; Jefferies, C.; Fogg, P.; Lowe, W.; Clarke, R.; (2008) Oil and SUDS: managing a priority urban pollutant. 12th International Conference on Integrated Diffuse Pollution Management, Khon Kaen University, Thailand. (Referenced below as Napier et al 2008b)

Non-statutory technical standards for sustainable drainage systems

BS EN 752 2008 Drain and Sewer Systems Outside of Buildings (2017)

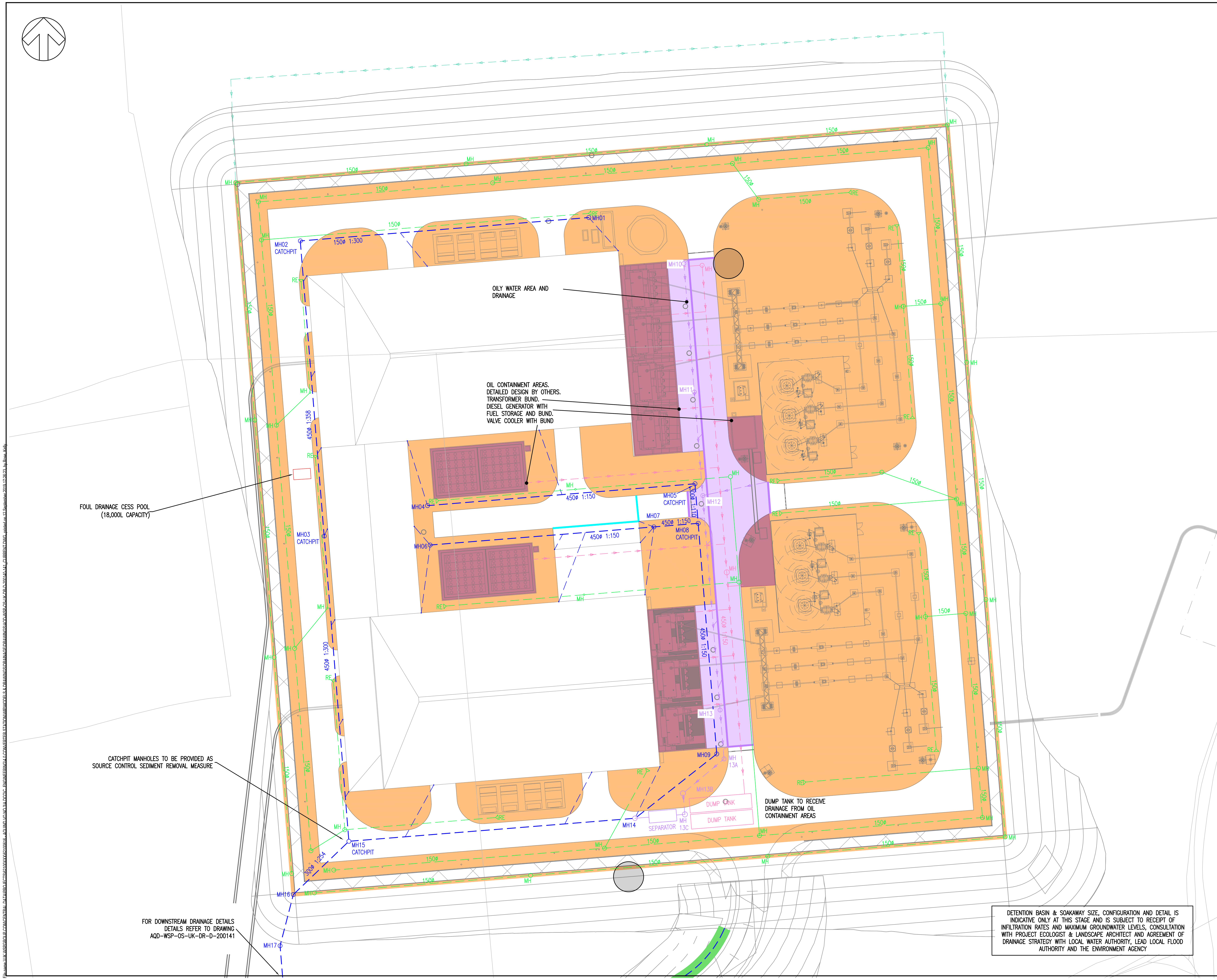
BS EN 12056 Gravity drainage inside buildings

Discharges to surface water and groundwater environmental permits (EA guidance)

Pollution prevention for businesses (EA guidance)

The Environment Agency's approach to groundwater protection

Appendix 1 – Proposed Surface Water Drainage



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1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS, SCHEDULES AND SPECIFICATIONS INCLUDING
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   - AQD-WSP-OS-UK-DR-D-200141 BELOW GROUND DRAINAGE LAYOUT (SHEET 2 of 2)
   - AQD-WSP-OS-UK-DR-D-200340 BELOW GROUND DRAINAGE TYPICAL DETAIILS

KEY:

- SURFACE WATER DRAINAGE
- SURFACE WATER FILTER DRAIN (SITE)
- SURFACE WATER FILTER DRAIN (EARTHWORKS)
- SURFACE WATER DRAINAGE CHANNEL
- DRAINAGE FROM OIL CONTAINMENT AREA
- OIL CONTAINMENT AREA (BUND)
- OILY WATER DRAINAGE
- OILY WATER DRAINAGE CHANNEL
- OILY WATER DRAINAGE AREAS
- GRAVEL SURFACE AREAS
- SuDS - SWALE
- SUDS - DETENSION BASIN
- SUDS - INFILTRATION BASIN
- SUDS - SOAKAWAY
- KARST FEATURES

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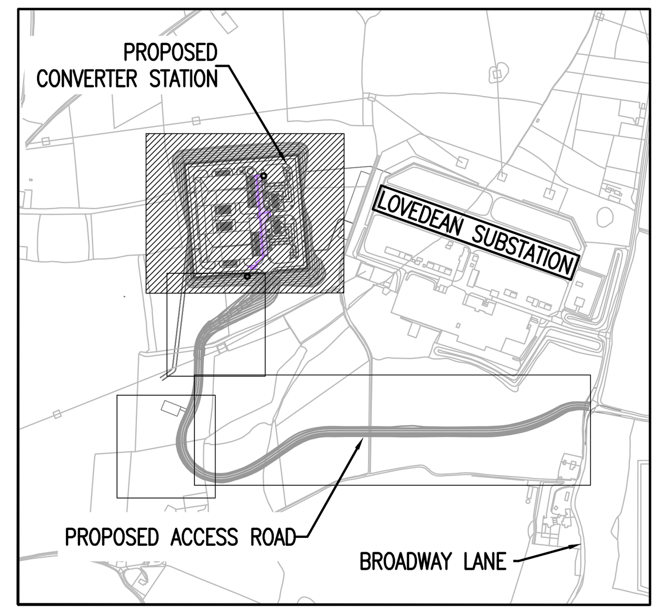

REV	DATE	BY	DESCRIPTION	CHK	APP
01	13/11/2019	KR	FIRST ISSUE	MD	PW

DRAWING STATUS: FINAL

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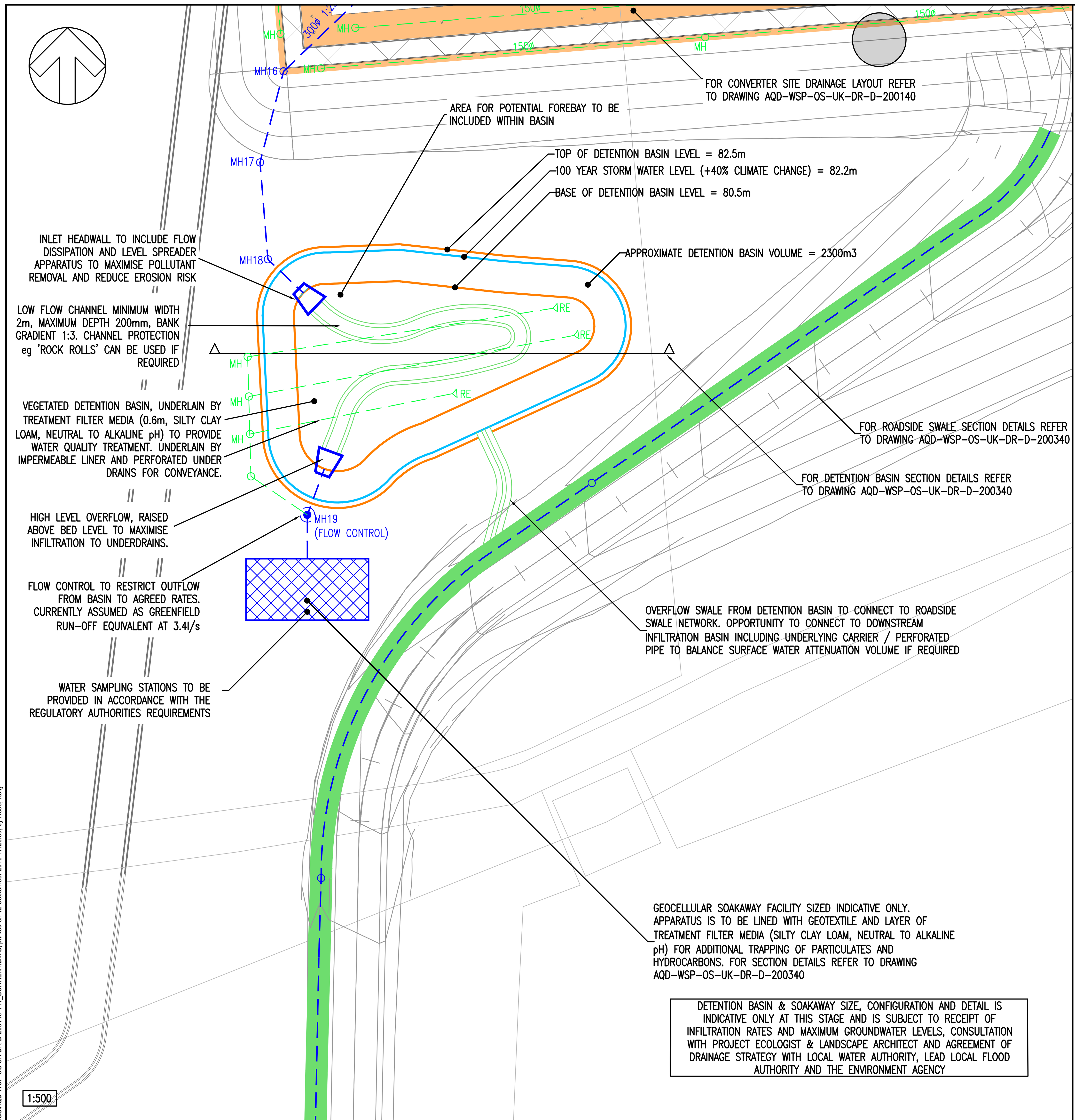
ARCHITECT: -

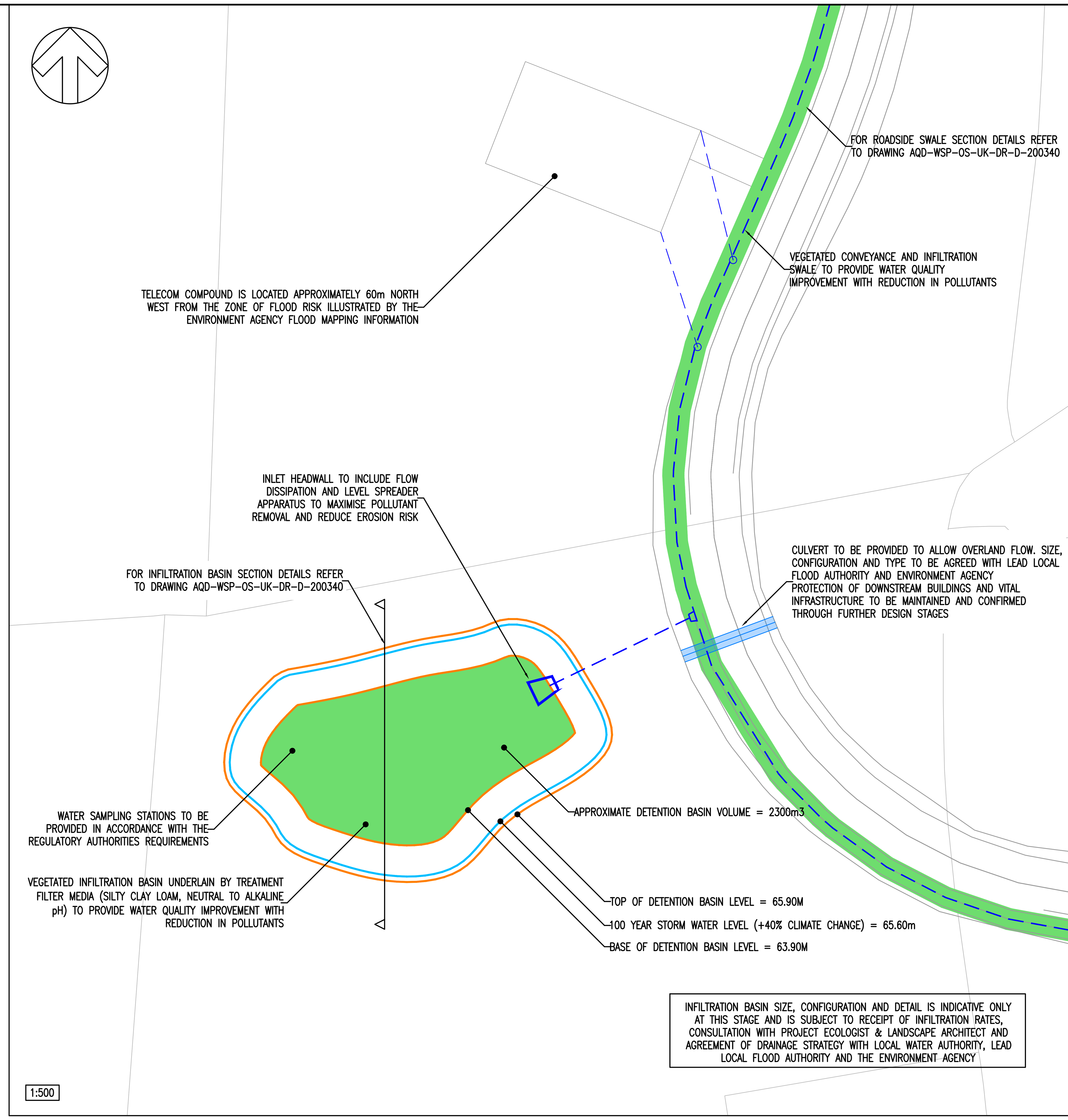
SITE/PROJECT: AQUIND Interconnector

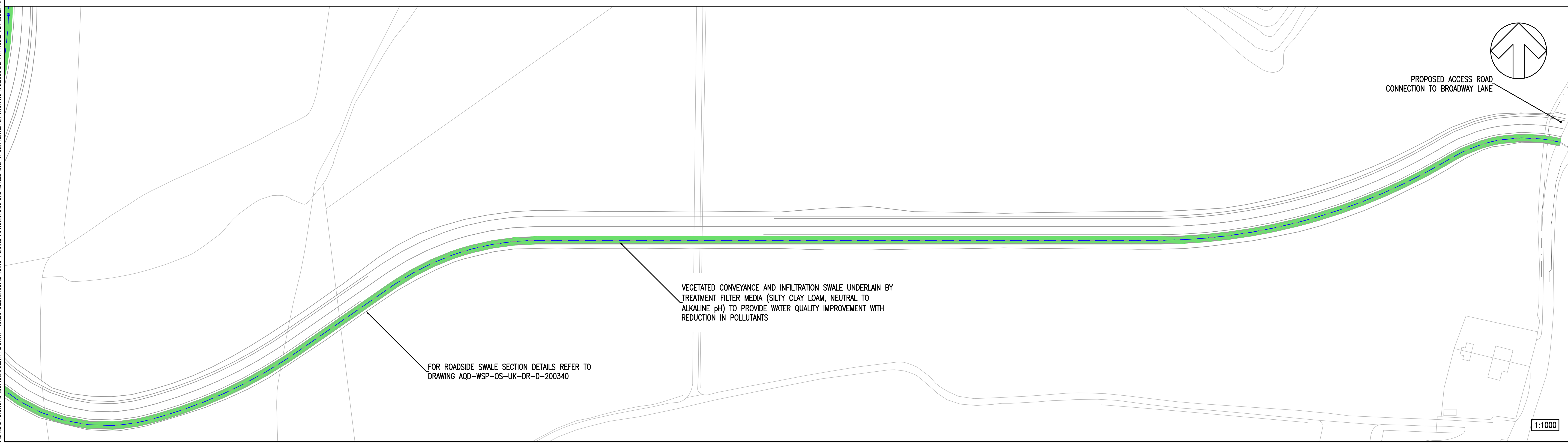
TITLE: BELOW GROUND DRAINAGE LAYOUT (SHEET 1 OF 2)

SCALE @ A1:	CHECKED:		APPROVED:
1:500m	MD		PWW
PROJECT NO: EN020022	DESIGNED: KR / PWW	DRAWN: KR	DATE: 13/11/2019

DRAWING No: AQD-WSP-OS-UK-DR-D-200140 REV: 01







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   - AQD-WSP-OS-UK-DR-D-200140 BELOW GROUND DRAINAGE LAYOUT (SHEET 1 of 2)
   - AQD-WSP-OS-UK-DR-D-200340 BELOW GROUND DRAINAGE TYPICAL DETAILS

KEY:

- SURFACE WATER DRAINAGE
- SURFACE WATER FILTER DRAIN (SITE)
- SURFACE WATER FILTER DRAIN (EARTHWORKS)
- SURFACE WATER DRAINAGE CHANNEL
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- OILY WATER DRAINAGE CHANNEL
- OILY WATER DRAINAGE AREAS
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- SUDS - INFILTRATION BASIN
- SUDS - SOAKAWAY
- KARST FEATURES

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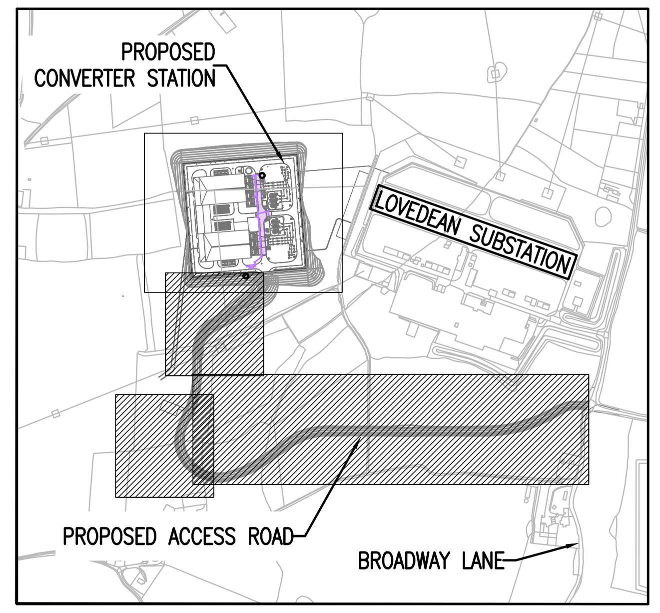

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01	13/11/2019	KR	FIRST ISSUE	MD	PW

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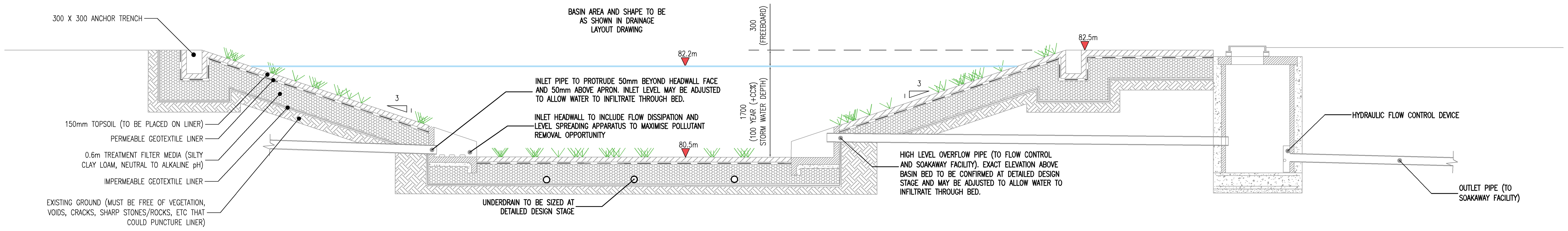
ARCHITECT: -

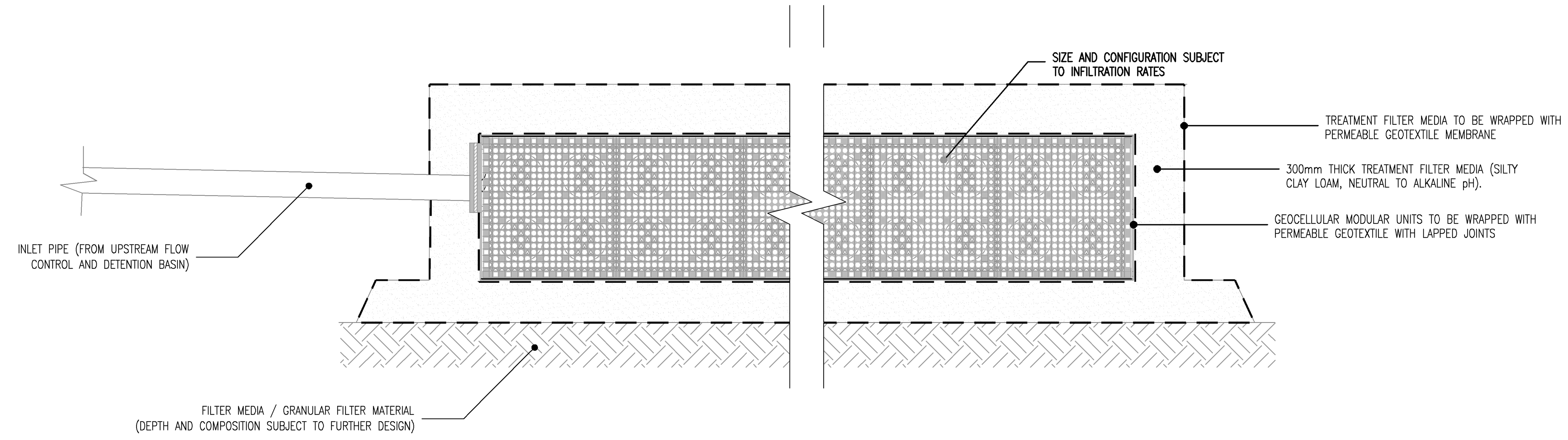
SITE/PROJECT: AQUIND Interconnector

TITLE: BELOW GROUND DRAINAGE LAYOUT (SHEET 2 OF 2)

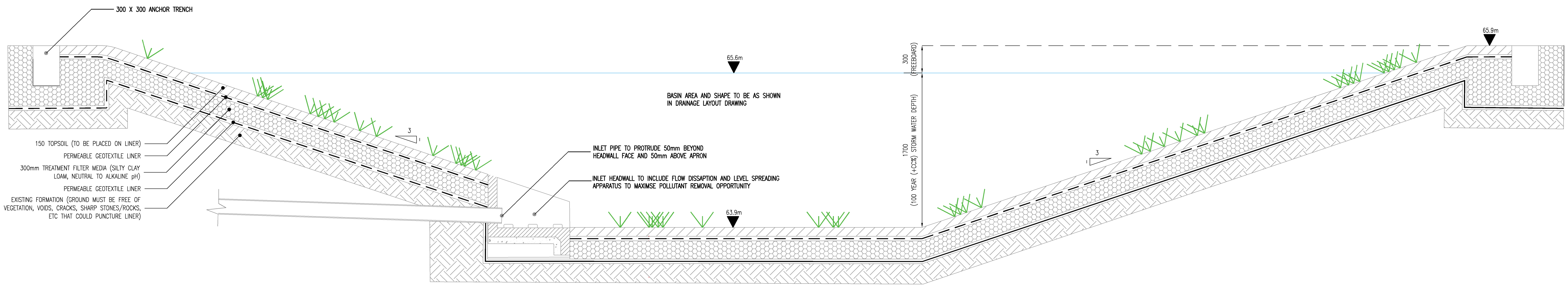
SCALE @ A1: AS SHOWN	CHECKED: MD	APPROVED: PWW
PROJECT NO: EN020022	DESIGNED: KR / PWW · DRAWN: KR	DATE: 13/11/2019
DRAWING No: AQD-WSP-OS-UK-DR-D-200141		REV: 01



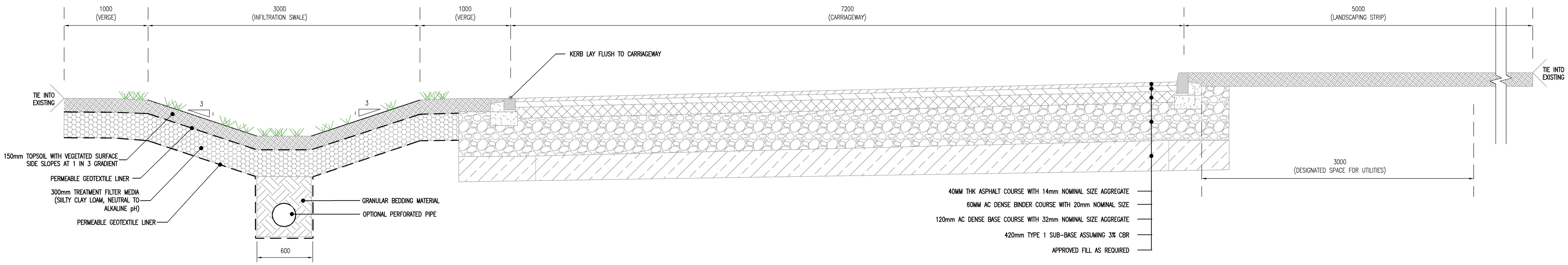
DETENTION BASIN
(NTS)



GEOCELLULAR SOAKAWAY
(NTS)



INFILTRATION BASIN
(NTS)



ACCESS ROAD WITH INFILTRATION SWALE
(NTS)

DO NOT SCALE

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS, SCHEDULES AND SPECIFICATIONS INCLUDING:
   - AQD-WSP-OS-UK-RP-D-200001 AQUIND UK AQUIFER CONTAMINATION PREVENTION STRATEGY
   - AQD-WSP-OS-UK-DR-D-200140 BELOW GROUND DRAINAGE LAYOUT (SHEET 1 OF 2)
   - AQD-WSP-OS-UK-DR-D-200141 BELOW GROUND DRAINAGE LAYOUT (SHEET 2 OF 2)
2. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. FOR ACCESS ROAD CONSTRUCTION IT IS ASSUMED THAT THESE ROADWAYS WILL BE REGULARLY USED BY HEAVY VEHICLES.

   DETAIL PROVIDED IS APPLICABLE FOR SUBGRADE CBR VALUES OF 3.0%. ADVICE TO BE SOUGHT IF SUBGRADE IS FOUND TO BE WEAKER THAN 3.0%.

   ACCESS ROAD IS NOT TO BE USED BY CONSTRUCTION TRAFFIC ACCESSING THE SITE WHILST IN A TEMPORARY STATE UNTIL THE DENSE BINDER CAUSE IS APPLIED TO THE ROAD CONSTRUCTION.
4. FINAL DESIGN, SELECTION OF MATERIAL AND CONSTRUCTION IS TO BE IN ACCORDANCE WITH CIRIA C753 GUIDANCE AND DESIGN REQUIREMENTS FOR WATER QUALITY TREATMENT (CHAPTER 26) AND MAINTENANCE:

   TREATMENT FILTER MEDIA TO BE AS SPECIFIED IN AQD-WSP-OS-UK-RP-D-200001 AQUIND UK AQUIFER CONTAMINATION PREVENTION STRATEGY: SILTY CLAY LOAM (HOST CLASS 18), WITH A NEUTRAL OR ALKALINE pH. ACIDIC SOIL IS NOT SUITABLE AND SHOULD NOT BE USED. NITROGEN OR OTHER SUBSTANCES SHOULD NOT BE ADDED TO THE SUDS OR THE TREATMENT FILTER MEDIA. THE DEPTH AND TYPE OF TREATMENT FILTER MEDIA SHOULD BE AS SPECIFIED AND NOT REDUCED OR CHANGED WITHOUT AGREEMENT FROM WSP, PORTSMOUTH WATER AND THE ENVIRONMENT AGENCY. SHOULD ANOTHER TYPE OF FILTER MEDIA BE REQUIRED THIS SHOULD BE IN ADDITION TO THE TREATMENT FILTER MEDIA AND SHOULD NOT REPLACE THE MATERIAL.

REV	DATE	BY	DESCRIPTION	CHK	APP
01	13/11/2019	RF	FIRST ISSUE	MD	PWW

DRAWING STATUS: FINAL

wsp

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CLIENT: AQUIND

ARCHITECT: -

SITE/PROJECT: AQUIND Interconnector

TITLE: BELOW GROUND DRAINAGE TYPICAL DETAILS

SCALE @ A1: NTS	CHECKED: MD		APPROVED: PWW
PROJECT NO: EN020022	DESIGNED: KR / PWW	DRAWN: RF	DATE: 13/11/2019

DRAWING No: AQD-WSP-OS-UK-DR-D-200340 REV: 01