CONTENTS

FIGURES

APPENDICES

APPENDIX M	Free Wharf, Shoreham MMPv3, 23rd September 2019
APPENDIX N	Geo-Environmental Watching Brief and In-Situ Analysis Report, GE18319/WH01/200403, 3rd April 2020
APPENDIX O	Geo-Environmental Verification Report (Zones E&F8 – E15), GE18319/VR/FEB21, 18th February 2021
APPENDIX P	QP Declaration Receipt (Ref: 30/09/2019 15:48:37)

1.0 INTRODUCTION

1.1 General

Geo-Environmental Serviced Limited (Geo-Environmental) was instructed by Wates Construction Limited to prepare an Interim Material Management Plan Verification Report (INTMMPVR) for the enabling works and proposed development site at Free Wharf, Brighton Road, Shoreham-by-Sea, BN43 6SA (see Figure 1 and Figure 2), herein referred to as 'the site'. This report sets out the works undertaken to date to in relation to the enabling works and development to compile together the relevant records and provide independent verification of the site status and works carried out to date by the various parties. It is understood Wates Construction Limited has been requested to suspend enabling works by Southern Housing Group on 23rd October 2020, as final development plans are in review. As such further works and verification maybe required in due course under the Materials Management Plan subject to the outcome of that review.

The Material Management Plan (MMP) was written by Wates Construction Limited and the Qualified Person (QP) who undertook the independent review and submitted the QP declaration was David Hooton (QP223) from GeoDyne Limited. The MMP declaration receipt time stamp is 30/09/2019 15:48:37 and a copy is available in Appendix P.

This report sets out to compile the relevant data obtained from the Groundworks Contractor (Erith Demolition and Construction Company Ltd), and Specialist Marine Contractor (J T Mackley & Co Ltd) and from the Client (Wates Construction Ltd). Where data is provided to Geo-Environmental for inclusion and completeness in the verification report. Where third party data is presented, no independent verification of this information or independent inspections in relation to these elements has been undertaken by Geo-Environmental, and Geo-Environmental takes no liability for any inaccuracies, mis-reporting or omissions in the data provided by the Client or their contractors in this respect. The data is presented herein for completeness.

The planning permission granted for this site included for the construction of ten mixed commercial and residential blocks, with associated landscaping, parking and a large central basement (see Figures 3a to 3c). Phase 1 comprised the enabling works to which the MMP and Interim Verification Report relate. Phases 2 and 3 (construction of the basement and blocks) are beyond the scope of works for which Wates Construction Limited are currently responsible and outside of the proposed works under the Materials Movement Plan for the site.

1.2 Project Description

The proposed development was understood to comprise the construction of ten residential blocks, some of which will house commercial units on the lower floors. These would have associated infrastructure, soft landscaping and parking. A large basement would occupy the centre of the site beneath multiple blocks. This would comprise parking, storage and plant rooms. A river wall with board walk and mooring points is proposed for along the River Adur. The enabling works and construction of the future river wall constitutes Phase 1. The steel sheet piles (SSP) will get cut down in Phase 2/3 at which point the reinforced concrete (RC) structures becomes the river wall. The construction of the blocks and basement comprise Phases 2 and 3, which are noted to be outside the scope of works to be undertaken by Wates Construction Limited.

A cut and fill exercise was required associated with the basement development and the requirements for materials for use within proposed roads and piling mats, as such it was proposed to re-use material on under the in line with a Materials Management Plan under the Site of Origin scenario under the CL:AIRE Definition of Waste Code of Practice (DOWCOP, Version 2), to include re-use of the Made Ground where required and deemed geotechnically suitable for use, in line with the agreed Discharge of Condition 3 report produced by HOP, Ref: 14576-HOP-EN-XX-RP-S-5003, dated 17th August 2018 and Remediation Method Statement produced by GeoDyne, Ref: 31149, dated

30th May 2019. The HOP report was approved by the Local Planning Authority (see Section 1.5). The GeoDyne report was a supplementary detailed report commissioned by Wates Construction Ltd.

Multiple ground investigations undertaken by GeoDyne identified the presence of potential hazards and through a risk assessment process a series of pollutant linkages were identified which required action to mitigate or otherwise reduce the risk as part of the overall development. The Discharge of Condition 3 report produced by HOP (Ref: 14576-HOP-EN-XX-RP-S-5003, 17th August 2018) and Remediation Method Statement produced by GeoDyne (Ref: 31149 RMS, 30th May 2019) set out the measures which were to be included within the construction of the development and to protect end users and surrounding environs thereof. This Interim MMP Verification Report (INTMMPVR) includes records of the works undertaken on site by Wates Construction Limited throughout the period 28th August 2019 to 3rd July 2020 (excluding 5th March 2020 to 27th April 2020 as no excavation occurred during this time) in order to demonstrate that the risk mitigation measures were implemented and that works undertaken are in line the site Materials Management Plan. Geo-Environmental undertook an overseeing role on the site in line with the Discovery Strategy, and independent validation via in-situ testing, laboratory analysis. Figures regarding the areas sampled and tested can be found the appendices of Geo-Environmental's Watching Brief and In-Situ Analysis Report (Appendix N), and Geo-Environmental's Verification Report (Zones E&F8 – E15) (Appendix O). Further documentation for inclusion and tracking of works has been provided by Wates Construction Limited (The Client) and Erith Demolition (Groundworks Contractor). A final site walkover was undertaken on 18th January 2021 by Geo-Environmental to record the current site status relating to the re-use of materials under the DoWCoP. As such confirmation of works undertaken and presented herein are up to and including the 18th January 2021.

The works undertaken and reported here in relate to the works at the point of inspection. Geo-Environmental accepts no liability for works subsequently carried out in the areas of validation/inspection following the point of inspection, that may in any way alter or affect the validation works inspected/recorded and reported herein.

1.3 Reference Documents

The following reports have been prepared to date and reviewed by Geo-Environmental in relation to the land at Free Wharf, Shoreham-by-Sea:

- Phase I Desk Study and Phase II Investigation Report for Brighton Road, Shoreham, undertaken by GeoDyne, on behalf of Optimisation Developments Ltd. Ref: 31149 Combined Report, 28th September 2012.
- Combined Ground Investigation and Geophysical Survey Report for Tarmac Wharf/Minelco Site, Brighton Road, Shoreham, undertaken by GeoDyne, on behalf of BSCP Ltd and WM Morrisons'. Ref: 31149 Ground Anchor Report, 9th July 2013.
- Review of Previous Reports and Supplementary Phase II Exploratory Investigation for Brighton Road, Shoreham, undertaken by GeoDyne, on behalf of The Newbridge Group/Southern Housing Group. Ref: 31149 Report 2015, 30th June 2015.
- Remediation Method Statement for Site off Brighton Road, Shoreham, undertaken by GeoDyne, on behalf of Wates Construction Ltd. Ref: 31149 RMS Report, 30th May 2019. Appendix J.
- HOP Discharge of Planning Condition 3 and associated Drawings 104 & 105. Ref: 14576-HOP-EN-XX-RP-S-5003, 17th August 2018. Appendix L and Figure 4a and 4b
- Materials Management Plan (MMP) Form version 3 for Free Wharf, Shoreham by Sea, undertaken by Wates Residential. Ref: Shoreham MMP v3, 23rd September 2019. Appendix M.
- Groundwater Monitoring Report, Free Wharf, Shoreham Phase I undertaken by OGI for Wates Construction Lr. Ref: J19-707-004R-Rev0, 2nd July 2019. Appendix K.
- Watching Brief and In-Situ Analysis undertaken by Geo-Environmental on behalf of Wates Ltd. Ref: GE18319/WH01/200403, 3rd April 2020. Appendix N.

- Verification Report (Zones E&F8 – E15) undertaken by Geo-Environmental on behalf of Wates Ltd. Ref: GE18319/VR/FEB21, 18th February 2021. Appendix O.

1.4 Objectives

A ground investigation undertaken by Geo-Dyne (ref: 31149 Combined Report) identified the presence of potential hazards and through a risk assessment process a series of pollutant linkages were identified which require action to mitigate or otherwise reduce the risk. The Remediation Method Statements ref: 31149 RMS Report, 30th May 2019) set out the measures which were to be included within the construction of residential development to protect the development and end users thereof. This was in addition to the Discharge of Condition 3 report produced by HOP (ref: 14576-HOP-EN-XX-RP-S-5003, 17th August 2018)

A cut and fill exercise was required associated with the basement development and the requirements for materials for use within proposed roads and piling mats, as such it was proposed to re-use material on under the in line with a Materials Management Plan under the Site of Origin scenario under the CL:AIRE Definition of Waste Code of Practice (DOWCOP, Version 2), to include re-use of the Made Ground where required and deemed geotechnically suitable for use, in line with the Remediation Method Statement produced by GeoDyne, Ref: 31149, dated 30th May 2019. As such the role of Geo-Environmental included oversight, tracking and compilation of relevant records (including from 3rd Parties where provided) as required in line with the MMP.

1.5 Planning Permission

The site is subject to a planning permission that has been granted for the site by Adur District Council under the Application Number AWDM/1497/17, dated the 2nd October 2017 (Appendix I). The following planning conditions were attached to the application which relate to the remediation and validation of land contamination on the site.

Condition 3: Prior to commencement of enabling works, full details shall be submitted to and approved in writing by the Local Planning Authority, which includes the following:

- *Replacement of river wall sheet piling and construction of new permanent concrete river wall including associated permanent piling;*
- *Marine piling for river moorings and jetty;*
- *Boundary retaining walls and associated fencing / barriers;*
- *Excavation; remediation of possible contamination (including watching brief) and reprofiling of ground levels and piling mat;*
- *Diversion and laying of primary services, ducting and primary drainage; and*
- *Base layers of spine roads to assist with provision of clean access during main construction phase.*

Reason: To ensure that the proposed development is satisfactorily provided with required infrastructure in accordance with paragraph 156 of the National Planning Policy Framework.

Condition 10: No works except Enabling Works shall take place until an investigation and risk assessment has been undertaken to establish if the site is contaminated and to determine the potential for pollution in accordance with the requirements of DEFRA and the Environment Agency's 'Model Procedures for the Management of Land Contamination, CLR 11'.

Where remediation is necessary a detailed remediation scheme to bring the site to a condition suitable for the intended use by removing unacceptable risks to human health, buildings and other property and to the natural and historical environment must be submitted to and approved in writing by the Local Planning Authority. Unless otherwise agreed in writing by the Local Planning Authority the remediation scheme must ensure that the site will not qualify as contaminated land under Part 2A of the Environmental Protection Act 1990 in relation to the

intended use of the land after remediation.

Following completion of measures identified in the approved remediation scheme a verification report must be submitted to and approved in writing of the Local Planning Authority.

Reason: To ensure that risks from land contamination to the future users of the land and neighbouring land are minimised, together with those to controlled waters, property and ecological systems, and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors in accordance with Policy 34 of the Adur Local Plan. These details are required prior to commencement in order that any changes to satisfy this condition are incorporated into the development before the design is too advanced to make changes.

Additionally, Environment Agency correspondence with Adur & Worthing Council, ref: HA/2017/119846/01-L01, dated 12th January 2018 (Appendix I) requested additional planning conditions.

Condition 4 – Site investigation and remediation

No development approved by this planning permission shall take place until a remediation strategy that includes the following components to deal with the risks associated with contamination of the site shall each be submitted to and approved, in writing, by the local planning authority:

1. A preliminary risk assessment which has identified:

- *all previous uses*
- *potential contaminants associated with those uses*
- *a conceptual model of the site indicating sources, pathways and receptors*
- *potentially unacceptable risks arising from contamination at the site.*

2. A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site.

3. The results of the site investigation and the detailed risk assessment referred to in (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.

4. A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (3) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.

Any changes to these components require the express written consent of the local planning authority. The scheme shall be implemented as approved.

Condition 5 – Verification report

No occupation of any part of the permitted development shall take place until a verification report demonstrating completion of works set out in the approved remediation strategy and the effectiveness of the remediation shall be submitted to and approved, in writing, by the local planning authority.

The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan to demonstrate that the site remediation criteria have been met.

Condition 6 – Long term monitoring and maintenance

No development should take place until a long-term monitoring and maintenance plan in respect of contamination including a timetable of monitoring and submission of reports to the Local Planning Authority, shall be submitted to and approved in writing by the Local Planning Authority. Reports as specified in the approved plan, including details of any necessary contingency action arising from the monitoring, shall be submitted to and approved in writing by the Local Planning Authority. Any necessary contingency measures shall be carried out in accordance with the details in the approved reports.

On completion of the monitoring specified in the plan a final report demonstrating that all long-term remediation works have been carried out and confirming that remedial targets have been achieved shall be submitted to and approved in writing by the Local Planning Authority.

Condition 7 – Unsuspected contamination

If, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise agreed in writing with the local planning authority) shall be carried out until the developer has submitted a remediation strategy to the local planning authority detailing how this unsuspected contamination shall be dealt with and obtained written approval from the local planning authority. The remediation strategy shall be implemented as approved.

Condition 8 – Piling

Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the local planning authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details.

HOP Consulting Ltd produced a submission for Discharge of Planning Condition 3 Planning Ref: AWDM/1497/17 regarding Free Wharf, Shoreham by Sea. Ref: 14576-HOP-EN-XX-RP-S-5003, 17th August 2018 (Appendix L). Pre-commencement conditions were subsequently discharge on 15th November 2018 by Adur District Council (Appendix I). These included conditions 3, 4 and 5.

This Interim Materials Management Plan Verification Report includes a compilation of the relevant information for the site for in respect to Adur & Worthing Councils Conditions 3 and 10 and the Environment Agency Conditions 4 through 8 up to the point of inspection in relation to the Phase 1 enabling works undertaken on the site.

2.0 BACKGROUND

As part of the MMP process this interim verification report has been prepared in relation to the Phase 1 enabling works undertaken to date. It is understood Wates Construction Limited has been requested to suspend enabling works by Southern Housing Group as final development plans are in review. As such further works and verification maybe required in due course under the Materials Management Plan subject to the outcome of that review.

2.1 Site History

The site's previous uses were shown by mapping to have comprised a series of industrial processes including a coal yard, timber ponds, warehousing, engineering works, tarmacadam works, aggregate processing, and oil storage depot.

The surrounding lands uses were shown to have comprised a mixture of industrial, commercial and residential uses.

2.2 Summary of Investigation Findings

The three phases of ground investigation undertaken by third parties and provided for review by Geo-Environmental reported a thickness of Made Ground (up to 4.80m bgl) overlying Tidal River Deposits (2.00 – 3.95m bgl), Storm Beach Deposits (1.90 – 6.90m bgl), and Head Deposits (2.65 - 5.00m bgl and greater). The White Chalk Subgroup was reported from 4.90 – 25.00m bgl (end of hole). The surface of the site comprised a mixture of concrete, tarmac and Topsoil.

The White Chalk Subgroup underlying the site is classified as a Principal Aquifer. The site was identified not to be located within a Source Protection Zone (SPZ).

The updated ground gas assessment presented within the 2019 RMS undertaken by GeoDyne classified the site as Characteristic Situation 2, and gas protection measures were reported to be required. The exact requirements were reported to be dependent on the final ground floor use.

As such, as part of the Remediation Method Statement for the site it was highlighted that it would be prudent to re-assess the risk of ground gases with respect to the proposed development following the proposed earthworks/Phase 1 enabling works on site to account for any changes within the gassing regime as a result of unexpected ground conditions or remediation works undertaken in relation to the Phase 1 enabling works. This falls outside the scope and works presented herein.

The 2012 GeoDyne report reported that the site was broadly uncontaminated. Benzo(a)pyrene and lead hotspots were reported in the north east portion of the site. No elevated Total Petroleum Hydrocarbons (TPH) were reportedly identified. No visual or olfactory contamination was reportedly identified during the 2013 GeoDyne investigation.

The 2015 GeoDyne investigation reported that Made Ground on the site was impacted by arsenic, lead, Polyaromatic Hydrocarbon (PAH), individual PAH compounds, and localised Semi-Volatile Organic Compounds (SVOC) compounds. Visual and olfactory TPH contamination was noted within WS1, WS2, WS4, WS10 and TP1. Free product was also noted in WS33. However, laboratory testing did not report any significantly elevated concentrations of TPHs.

It was considered by GeoDyne that remedial action would be warranted to protect end users of a residential development on this site in relation to the general site wide concentrations of lead, arsenic, and PAHs identified within the Made Ground on site where the material was present and/or to be re-used. However, this is beyond the scope of the Phase 1 enabling works undertaken by Geo-Environmental and reported. Suitable capping

systems for soft landscaping, suitable ground gas protection measures, and their respective validation are beyond the remit of this report and will be required for Phase 2 and 3 works and reported by others in due course.

For Made Ground soils remaining on site, Site Acceptance Criteria (SAC) were produced for a range of determinands as Clean Up Goals (CUG) by GeoDyne and detailed within the RMS produced by GeoDyne. Where the contaminant concentrations identified within the Made Ground on the site were below those required for SACs it is deemed that the soils may remain in-situ if required, and the risk was deemed to be acceptable, be re-used on site.

2.3 Conceptual Site Model

The conceptual site model (CSM) developed as part of the risk assessment identified particular hazards, or potential hazards which were considered to require intervention (remediation) to mitigate the risk of harm.

2.4 Approach for Remediation and Re-Use

The approach for remediation and re-use of materials for the Phase 1 enabling works to be undertaken by Wates Construction Limited as detailed within the HOP Discharge of Condition 3 report and the GeoDyne RMS and Wates Construction Limited MMP and comprised the following works:

- Identification, excavation, removal and validation of tanks (USTs and ASTs).
- Identification, excavation, removal and validation of any potentially unacceptable contamination hotspots.
- Watching brief for unforeseen ground conditions.
- Reuse of crushed materials to form the piling mats.

The aim of the remediation was not necessarily to remove all contamination from the site but to reduce the risk on future phases of the project, to provide betterment and to reduce the identified risk to an acceptable level with respect to relevant receptors, e.g. human health, the built environment and controlled waters.

3.0 DEFINITION OF WASTE CODE OF PRACTICE

Works were carried out under the Materials Management Plan developed for the site in line with the Definition of Waste Code of Practice (DOWCOP Version 2), overseen and run by CL:AIRE and associated Qualified Person declaration (a copy of the declaration for the site is provided in Appendix P). The development to be carried out comprised the excavation and reuse of materials already at the site i.e. Made Ground under the Site of Origin Scenario. It was proposed to re-use 16,090m^3 of material without treatment to construct the piling mats. This comprised 7,175m^3 of materials to be crushed and 8,915m^3 of Made Ground/Natural soils. Crushed material was to be used to form 6F2 aggregate, or 'crush'.

Figure 4a and 4b present the works that were required as part of the proposed Phase 1 enabling/development. The drawings identify where material was proposed to be cut and where it was proposed to be re-used as detailed within the MMP.

3.1 Removal or reuse of Made Ground

Geo-Environmental was present on site during the reduced dig and removal and/or re-use of materials on site performing a watching brief for unforeseen ground conditions. Where the material's geotechnical properties were deemed suitable, Made Ground was proposed for reuse. Additionally, existing concrete structures and slabs were recovered and crushed.

A copy of the materials and waste excavation tracker for the site is presented in Appendix E and Appendix F and a copy of the Erith WAC Analysis undertaken for materials to be removed from site undertaken prior to the disposal of this material are presented in Appendix G. Waste disposal and transfer certificates for the materials disposed of from site and referenced within the Waste Transfer Register are available from Erith Demolition (Earthworks Contractor) and Wates Construction Limited (Client) on request. Many consignment notes were provided to Geo-Environmental, and the remainder have been requested. The comprehensive details presented within the trackers provided to Geo-Environmental included the number of transfers. These have not been included independently as a separate appendix at this time. It should be noted it is a legal requirement to keep copies of all waste transfer notes/ waste transfer information for at least **two years**. Hazardous waste documentation must be retained for 3 years.

In accordance with the MMP records were kept pertaining to the areas where materials were excavated, stockpiled and re-used. The crushed concrete was used in the piling mat placement. Figure 6 shows the current levels completed to date. Appendix D presents the DoWCoP MMP materials movement log for works undertaken and overseen by Geo-Environmental for the site to date. Appendix A presents photos by Geo-environmental during tank removal between 3rd July 2019 and 18th July 2018. Appendix B presents the site diaries undertaken by Geo-Environmental during the watching brief between the 28th August 2019 and 4th March 2020, the 28th April 2020 and 3rd July 2020. Appendix C encloses the final site visit record following discontinuation of the works under the MMP undertaken on the 18th January 2021 by Geo-Environmental.

In total as part of the redevelopment work to date 4,579m^3 of crush was re-used under the DOWCOP Site of Origin scenario with works undertaken between the 28th August 2019 and 18th January 2021. This volume does not include the use of crush materials re-used to construct the crane mat along the river front to facilitate the works to be undertaken by J T Mackley & Co Ltd (Specialist Marine Contractor). Figure 7 shows the locations and volumes of crush materials re-used. A stockpile remains on site, volumes of which are yet to be confirmed by Erith. The location of which is presented in Figure 9.

In total as part of the redevelopment 1,250m^3 of white blast sand was re-used under the site of origin scenario with works undertaken before Geo-Environmental began the watching brief. Figure 8 shows the locations and volumes of white blast sand re-used. A stockpile remains on site, volumes of which are yet to be confirmed by Erith. The location of which is presented in Figure 9.

In total as part of the development 48,253tonnes of materials were removed from the site by Erith Demolition as waste comprising 45,726tonnes of tarmac, concrete and soils (inert and non-hazardous), assuming an average load per lorry of 17.5tonnes, and ~2527tonnes of hazardous soils (volumes provided by Erith Demolition). Removal of material as part of the development works was undertaken between the 23rd April 2019 and the 13th November 2020, tracking records for which have been provided by Erith Demolition and are presented in Appendix E and Appendix F. Figure 10 displays the current topographical survey of the site as of the 8th January 2021 (ref: ASS-4008-T-001).

4.0 CONTROLLED WATERS

At the time of writing, no detailed quantitative groundwater risk assessment (DQRA) is understood to had been undertaken for the site from which to derive remedial targets with respect to controlled water. With reference to the GeoDyne RMS, Section 3.2.2.5 of the report states:

"The concentrations of determinands revealed in the soils and water at the site are not considered to represent a significant risk to Controlled Waters i.e. the Aquifer beneath the site and the estuary of the adjacent River Adur.

Water test results have verified metal, PAH and TPH impaction in the shallow water samples, but only metal (Arsenic and Selenium) within the deeper samples recovered from the Chalk aquifer, when assessed against conservatively adopted Drinking Water/EQS standards.

Taking account of the site's long history of industrial usage, and the current setting of the site the levels of contamination within the shallow perched water may be considered to be relatively low, with the levels of contaminants within the deeper Chalk Aquifer to have been demonstrated to be very low with only exceedances with respect to Arsenic and Selenium.

Therefore, at this stage, although localised removal of impacted soils/water around identified TPH impaction may be considered (to enable pile foundation installation), no significant widespread remedial measures are recommended with respect to perched waters and deeper groundwater. This conclusion is further mitigated by the final development proposals with will be predominantly hard surfaced and therefore minimal percolation of storm water into the ground would occur.

We consider that the foregoing comments continue to apply, subject to EA approval etc. Recent comments from the EA provided by the Client should be taken into account and any supplementary works agreed with the LPA and EA as part of the redevelopment of the site.

We would further note that Phase 1 Enabling works should suitably remove and validate any identified ASTs and USTs at the site, whilst also removing any potentially unacceptable hotspots. This will provide substantial betterment at the site, further mitigating any potential risk."

For full details please refer to the completed Geo-Dyne RMS referenced Project No: 31149.

Groundwater monitoring was undertaken by OGI Groundwater Specialists, demonstrating a tidal influence on the site, with tidal waters reported to be in continuity with shallow groundwater identified in the Made Ground on site. Monitoring was undertaken by OGI between 28th March 2019 and 13th May 2019. For full details please refer to the completed OGI report referenced J19-707-004R-Rev0.

Wates requested water sampling and analysis was undertaken by Geo-Environmental during the Phase 1 enabling works from the retained boreholes, from OGI, on two separate occasions, on the 25th November 2019 and 16th December 2020. Not all the anticipated wells were sampled as some had been covered or destroyed during the enabling works prior to Geo-Environmental being requested to undertaken sampling. See Appendix K for well locations and specifications. These were sampled for monitoring and geochemical purposes.

In the first instance the results have been compared against the 'The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions' (2010). Where thresholds were not available within this publication, the results were then compared against the Water Supply Regulations 'Drinking Water Standards' (2016). The Drinking Water Standards are considered to be highly conservative as they relate to potable water supplies and the point of compliance is the consumer's tap. The 'Atkins Water Screening Values for a Residential Land Use' (2011) values assess the risk to end users from vapours

from a migrating plume.

Exceedances of selenium, and PAHs including benzo(a)pyrene were noted, summarised in Table 4.1. The depth at which these samples were collected would indicate that these represent groundwater rather than perched water beneath the site. During previous investigations carried out by GeoDyne, exceedances of Arsenic and Selenium were identified within boreholes (see GeoDyne report 31149 Report 2015, 30th June 2015, Section 6.14.3). Selenium concentrations were similar to those detailed below.

Standard	Determinad	Threshold (µg/l)	Location (µg/l)					
			25/11/2019			16/12/2020		
			BH1 (5.5m bgl)	BH2 (5m bgl)	BH3 (6m bgl)	BH3 (9m bgl)	BH5 (10m bgl)	BH9 (10m bgl)
WFD 2010	Benzo(a)pyrene	0.075	0.02	0.05	<0.01	<0.01	0.01	2.77
DWS 2016	Benzo(a)pyrene	0.010						
	PAH*	0.1	0.09	0.15	0.01	<0.01	0.03	7.56
	Selenium	10	121	44	<5	<5	<5	<5

* sum of 4 of the concentrations of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene and indeno(123-cd)pyrene.

Table 4.1 Summary of Laboratory Analysis

While exceedances have been identified, the standards used are considered to highly conservative for the site setting and background concentrations. For the location of the site, these values are not considered to be excessive, and in addition to the unlikelihood of any future water abstractions in the area it is considered that the enabling works been undertaken so far have had no impact on groundwater, and no further action is required at this time. In addition, the removal of contamination sources and grossly impacted soils under the watching brief as part of the enabling works on site would also further provide a betterment to the site in terms of potential source of contamination and mobilisation to groundwater.

Geochemical laboratory results can be seen in Appendix H.

Where existing wells remain on site they should be decommissioned once they are no longer required in line with Environment Agency best practice, in order to minimise the potential for pathways to remain on site and not just allowed to be destroyed or damaged on site as part of the further works. It is anticipated that this will fall into subsequent phases of works on this site that are outside the scope of the works reported herein and being undertaken by Wates Construction Limited.

As per the Geo-Environmental Verification Report (Zones E&F8 – E15), Section 4.0, it is considered by the Environment Agency that a DQRA was not required with respect to groundwater at this time (see Appendix O). Subject to the timescales between the Phase 1 and Phase 2 and 3 works in due course, further groundwater monitoring and risk assessment may be required by the regulators in due course.

5.0 GROUND GAS

The updated ground gas assessment for the site presented within the 2019 GeoDyne RMS classified the site as Characteristic Situation 2 with respect to ground gases and vapour risk, and the inclusion of gas protection measures were reported to be required as part of the proposed development. The exact mitigation measures and requirement of which will be dependent on the final ground floor use.

With reference to the GeoDyne RMS, Section 3.2.3.9 of the report state:

"We would further note that should ground conditions after completion of the Phase 1 enabling works differ significantly from those present at the time of our works, it may be necessary to remonitor and reassess the site or areas of the site.

Similarly, should remediation works following tank removal/validation etc, result in the presence of locally elevated levels of volatile organics/hydrocarbons in the ground (for example where the practical limit of excavation is reached leaving contamination in the ground) it may be necessary to upgrade the ground gas membrane to a ground gas and hydrocarbon/vapour resistant membrane to address residual contamination."

For full details please refer to the completed Geo-Dyne RMS referenced Project No: 31149.

Areas of hydrocarbon impacted soils were left in-situ within the Zone E&F8-15 where they were located beneath the formation layer and were recorded to below the SAC guidance. However, other areas of hydrocarbon impacted soils were identified as part of the watching brief across the wider site and it was considered that remedial measures would be required to address these soils in order to ensure that the risk posed to human health is within acceptable limits with respect to vapour hazards. Where the hydrocarbon impacted soils were removed, then the vapour hazard may also have been removed, thereby mitigating any vapour risk, subject to residual concentrations and impact to groundwater. It is noted that residual concentrations of hydrocarbons may still remain on site following excavation of the grossly impacted soils however this would be assessed against respect screening levels with respect to any potential vapour risk. Further assessment will be required once development proposals are finalised.

6.0 DISCOVERY STRATEGY

A discovery strategy remained in place throughout the development works on this site. No additional discoveries beyond those covered under the watching brief associated with the enabling works have been made to date in relation to Zones E&F8-E15 of the site and thus the discovery strategy, as set out in the RMS (see Section 3.1.4), did not require enacting. The discovery strategy must remain in place throughout the ongoing development works.

It should be noted that this verification report does not apply to the presence of asbestos and ACMs encountered within Made Ground soils on the site which was completed by Erith Group.

7.0 VERIFICATION

In accordance with the Client's instruction, Geo-Environmental undertook a watching brief of the enabling works with regard to soil contamination. Erith Demolition and Construction Company Limited completed the Asbestos watching brief. The works overseen by Geo-Environmental included a period of in-situ testing (see Appendix N) to delineate contamination where identified. Geo-Environmental have compiled its own records of works overseen on site and included and reviewed the information provided by others (the groundworker Erith Demolition and Construction Company Ltd, Specialist Marine Contractor J T Mackley & Co Ltd, and Wates Construction Ltd) in relation to other works undertaken on the site during key stages of the re-use of soils under the MMP in line with the DOWCOP. It should be noted that an area of grossly contaminated soils was removed from the site including the removal of Made Ground and these works have been validated under separate cover (see Appendix O, GE18319/VR/FEB21, 18th February 2021). Additionally, enabling works have been suspended by Southern Housing Group on the 23rd October 2020, as development plans are in review.

As such further works and validation may be required in due course to complete these works and subsequent development and this will be reported by others under separate cover. When Phase 1 enabling works continue as initially proposed, there are several areas of concern remaining on the site and additional works will be required:

- Elevated hydrocarbons were identified within the haulage road, D9 – 12 (see Figure 2 for the site grid).
- Hydrocarbon contamination encountered within the E9 – E15 area, and heavy metal contamination within E11 (see Appendix O) are likely to continue further south beneath the haulage road. Geochemical laboratory results can be seen in Appendix H.
- Further unexpected hotspots and ground conditions should be anticipated on site.

Areas of asbestos contamination are known to be present/have been encountered on site (see Figure 11). For further details reference can be made to the watching brief carried out by Erith, no independent review of oversight of this element has been undertaken by Geo-Environmental.

A final site visit was completed by Geo-Environmental on 18th January 2021 which recorded the final site conditions. The Phase 1 enabling works have been put on hold while Southern Housing Group review development plans. The works under the DOWCOP MMP includes for the reuse of crushed concrete for the piling mat. The final site inspection report undertaken on the 18th January 2021 by Geo-Environmental is included in Appendix C. Details of the final levels can be found in Figure 10. Based on a review of the information and site records provided by Wates Construction Ltd and Erith Demolition and Geo-Environmental's own data it is considered that the enabling works to date have been undertaken within the requirements of the design, Remediation Method Statement and Materials Management Plan for the site.

Where third party data is presented, no independent verification of this information or independent inspections in relation to these elements has been undertaken by Geo-Environmental, and Geo-Environmental takes no liability for any inaccuracies, mis-reporting or omissions in the data provided by the Client or their contractors in this respect. The data is presented herein for completeness.

Works undertaken and reported here relate to the observations and testing only. Geo-Environmental accepts no liability for works subsequently carried out in the areas of validation following the point of inspection, that may in any way alter or affect the validation works inspected and reported herein.

FIGURES

Project:	Free Wharf, Brighton Road, Shoreham-by-Sea, BN43 6SA			**Title**	Site Location Plan
Client:	Wates Construction Ltd			**Geo-Environmental Services Ltd** **Unit 7 Danworth Farm, Cuckfield Road** **Hurstpierpoint, West Sussex BN6 9GL** **+44(0)1273 832972 www.gesl.net**	Geo-Environmental
Ref No:	GE18319	**Revision:**	1.0		
Drawn:	WH	**Date:**	26/01/2021		
Figure:	1	**Scale:**	Not To Scale		

HOP
CONSULTING CIVIL AND STRUCTURAL ENGINEERS

FREE WHARF, SHOREHAM BY SEA

DISCHARGE OF PLANNING CONDITION 10 - CONTAMINATION
PLANNING REF: AWDM/1497/17

JANUARY 2019

Ref: 14576-HOP-EN-XX-RP-S-5003

HOP Consulting Limited
HOP House, 41 Church Road
Hove, BN3 2BE
Registered 4402211 England
T: +44 (0)1273 223900
E: ask@hop.uk.com
W: www.hop.uk.com

CONTENTS

APPENDICES

Client : Southern Housing
Spire Court
Albion Way
Horsham
RH12 1JW

Prepared by	Checked by	Approved by	Revision
Alex Cook	**John Spearman**	**John Spearman**	**08.02.19**

1.0 INTRODUCTION

This report has been produced pursuant to the discharge of condition 8 of the approved planning permission by Adur District Council for Free Wharf, Shoreham-by-Sea Hove ref: AWDM/1497/17.

Planning permission was granted on 9th August 2018 for 'The redevelopment of the site to provide ten buildings, containing 540 new homes (of which two will be studios, 179 x one bed, 323 x two bed and 38 x three bed), 2,707sqm of commercial floor space at ground floor level within use classes, a1 (retail), a3 (cafes and restaurants), b1 (business) and d1 (non-residential institutions). the development also includes 512 parking spaces, of which 438 will be for residents and 74 will be for the commercial space/visitors, reconstruction of the river wall, construction of mooring pontoons and observation platform at the end of Humphrey's gap, provision of a riverside pedestrian/cycle route, areas of semi-private and publicly accessible open space, internal access roads, 596 cycle parking spaces and associated ancillary areas.'

2.0 DETAILS OF PLANNING CONDITION

(10) No works except Enabling Works shall take place until an investigation and risk assessment has been undertaken to establish if the site is contaminated and to determine the potential for pollution in accordance with the requirements of DEFRA and the Environment Agency's 'Model Procedures for the Management of Land Contamination, CLR 11'.

Where remediation is necessary a detailed remediation scheme to bring the site to a condition suitable for the intended use by removing unacceptable risks to human health, buildings and other property and to the natural and historical environment must be submitted to and approved in writing by the Local Planning Authority. Unless otherwise agreed in writing by the Local Planning Authority the remediation scheme must ensure that the site will not qualify as contaminated land under Part 2A of the Environmental Protection Act 1990 in relation to the intended use of the land after remediation.

Following completion of measures identified in the approved remediation scheme a verification report must be submitted to and approved in writing of the Local Planning Authority.

Reason: To ensure that risks from land contamination to the future users of the land and neighbouring land are minimised, together with those to controlled waters, property and ecological systems, and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors in accordance with Policy 34 of the Adur Local Plan. These details are required prior to commencement in order that any changes to satisfy this condition are incorporated into the development before the design is too advanced to make changes.

3.0 INFORMATION PRODUCED PURSUANT TO CONDITION DISCHARGE

Initially, attention is drawn to GeoDyne Geotechnical & Environmental Consultants Site Investigation report ref 31149 dated 30th June 2015 (previously submitted in pursuit of Planning Permission and the similar enabling works condition 3).

Ground investigations carried out to date have found the Made Ground at the site to have varying levels of contamination. Contaminants included: Arsenic, Lead, Hydrocarbons and Asbestos. The locations and depths of contaminated samples have been reproduced on HOP drawing 14576-HOP-EN-XX-DR-S-0103.

The GeoDyne report advised that made ground should not be left exposed and should be capped with hard standing or 600mm clean imported top soil within soft landscaped areas. Made ground containing asbestos may require licenced disposal off site, or may remain in-situ beneath a suitable remedial cap or beneath hard standing areas in accordance with a suitable site specific risk assessment and materials management plan.

Testing in the vicinity of fuel storage tanks on the site revealed perched water samples containing marginally elevated concentrations of Total Petroleum Hydrocarbon.

Continuous Flight Auger (CFA) piles are currently proposed to be employed throughout the site. Any impacted area where piling is required should be suitably remediated to prevent the introduction of a downward pathway for contamination into the principle aquifer below the site. The natural head deposits were considered uncontaminated for the proposed end use.

A watching brief is required during initial slab removal and earthworks for visual or olfactory evidence of gross TPH contamination especially beneath locations where former tanks have been removed. Any revealed grossly impacted soils should be remediated to suitable hard cover requirements; or as a last resort removed from site. The sides and base of the resultant excavation should be sampled and the test results validated against current Tier 1 GACs for a residential (POS1) end use.

Should any areas of potentially contaminated soil be encountered during site construction works, further environmental consultation should be sought to ensure any potentially contaminated soils can be left in-situ and subjected to further assessment to potentially include further chemical testing and risk assessment, with remediation if necessary.

4.0 CONCLUSION

Ground Investigations to depth have been carried out throughout the site. These investigations have identified areas of contamination that will be suitably remediated prior to construction taking place.

Any impacted areas where CFA piling is proposed to be advanced will be suitably remediated prior to construction to prevent downward pathways for contamination.

A watching brief will be undertaken by GeoDyne to monitor excavation works in line with the strategy above, with testing as necessary such that a final verification report can be issued at completion of excavation works to the LPA and close out the condition.

APPENDIX I – GeoDyne Site Investigation Report

APPENDIX II – HOP Contamination Summary Drawing

GeoDyne

Geotechnical &
Environmental
Consultants

Site off Brighton Road
Shoreham

Remediation Method Statement
For
Wates Construction Ltd

GeoDyne Limited
Clarendon House, Clarendon Park,
Clumber Avenue, Nottingham, NG5 1AH
Tel: 0115 962 0001 email: info@geodyne.co.uk

Contents

Appendices

Project No: 31149		**Date: 30th May 2019**	
Issue/revision	Prepared by	Checked by	Approved by
	Jason Hollands BSc (Hons) MSc MIEnvSc CGeol FGS **Director**	Chris Paling BSc (Hons) FGS **Senior Engineer**	Jason Hollands BSc (Hons) MSc MIEnvSc CGeol FGS **Director**
Comments			

1.0 INTRODUCTION

1.1 Introduction

GeoDyne Ltd has been instructed by the Client, Wates Construction Ltd to produce a Remediation Method Statement for a site located off Brighton Road, Shoreham. The site location is indicated on Figure No. 31149/RMS/1 (in Appendix I).

1.2 Previous Reports

GeoDyne Ltd has previously produced the following reports for the site:

- GeoDyne Ltd report '*Brighton Road, Shoreham – Combined Phase I Desk Study and Initial Phase II Exploratory Investigation For Optimisation Developments Ltd',* dated 28th September 2012, Ref: 31149.
- GeoDyne Ltd letter report *'Proposed Development – Brighton road, Shoreham-by-Sea – Final Ground Gas Assessment Report',* dated 15th October 2012, Ref: 31149/CJP.
- GeoDyne Ltd report *'Brighton Road, Shoreham – Combined Ground Investigation at Tarmac Wharf/Minelco Site, Brighton Road, Shoreham – Combined Ground Investigation and Geophysical Survey Report for BSCP Ltd and WM Morrisons',* dated 9th July 2013, Ref: 31149.
- GeoDyne Ltd report *'Brighton Road, Shoreham – Review of Previous Reports and Supplementary Phase II Exploratory Investigation For The Newbridge Group/Southern Housing Group',* dated 30th June 2015, Ref: 31149.

Since production of our previous report in 2015, GeoDyne Ltd has not had any substantive involvement with the site.

1.3 Project Understanding

GeoDyne Ltd was recently contacted by Wates Construction Ltd (Wates), who we understand has successfully won Phase 1 enabling works at the site. We understand that Wates has won these works on the behalf of the Southern Housing Group.

We further understand that HOP Consulting Civil and Structural Engineers are involved with the project delivering the design to Wates under a Novated Appointment. We also understand that Erith are undertaking demolition and site clearance works on the behalf of Wates.

Enabling Works

We understand that Planning Permission Ref: AWDM/1497/17 (from Adur & Worthing Councils) relates to the site (a copy of the planning permission is included in Appendix III). HOP has previously submitted a report relating to the discharge of (pre-commencement) Planning Condition 3 for the site (dated 17th August 2018). The report states the following with respect to redevelopment proposals at the site.

'Planning permission was granted on 9th August 2018 for 'The redevelopment of the site to provide ten buildings, containing 540 new homes (of which two will be studios, 179 x one bed, 323 x two bed and 38 x three bed), 2,707sqm of commercial floor space at ground floor level within use classes, a1 (retail), a3 (cafes and restaurants), b1 (business) and d1 (non-residential institutions). The development also includes 512 parking spaces, of which 438 will be for residents and 74 will be for the commercial space/visitors, reconstruction of the river wall, construction of mooring pontoons and observation platform at the end of Humphrey's gap,

provision of a riverside pedestrian/cycle route, areas of semi-private and publicly accessible open space, internal access roads, 596 cycle parking spaces and associated ancillary areas.'

We understand that much of the car parking to be provided at the site will comprise basement car parking.

Planning Condition 3 (pre-commencement) states the following:

'Prior to commencement of enabling works, full details shall be submitted to and approved in writing by the Local Planning Authority, which includes the following:

- *Replacement of river wall sheet piling and construction of new permanent concrete river wall including associated permanent piling;*
- *Marine piling for river moorings and jetty;*
- *Boundary retaining walls and associated fencing / barriers;*
- *Excavation; remediation of possible contamination (including watching brief) and reprofiling of ground levels and piling mat;*
- *Diversion and laying of primary services, ducting and primary drainage; and*
- *Base layers of spine roads to assist with provision of clean access during main construction phase.*

Reason: To ensure that the proposed development is satisfactorily provided with required infrastructure in accordance with paragraph 156 of the National Planning Policy Framework.'

Taking account of the time that has passed since our earlier involvement with the site, a Director from GeoDyne Ltd attended a meeting with Mr M Wellbelove (Senior Design Manager at Wates Construction Ltd) on site on 15th May 2019. The purpose of the meeting was to attempt to understand the redevelopment proposals at the site and Wates role in delivering the development.

We understand that Phase 1 enabling works will comprise the following:

- Demolition of structures formerly present at the site.
- Complete removal of all slabs (including slab and slab construction) across the site with materials crushed and screened for re-use on site or at a suitable off site location (subject to necessary permissions etc).
- Removal of former ground anchors.
- Removal (and infilling the void) of a former underground conveyor system.
- Removal of tanks and associated infrastructure.
- Construction of a new river wall (inclusive of piled foundations).
- Construction of a piling matt for subsequent piled foundations (approximately 2000No.) for proposed structures/basement car park at the site.

We understand that completion of these works will constitute completion of the Phase 1 enabling works at the site, for which Wates has been instructed. We understand that the HOP report prepared to discharge pre-commencement Planning Condition 3 has been successful in the discharge of the condition.

Within the HOP report, Section 3.4 relates to '*Excavation: remediation of possible contamination (including a watching brief) and re-profiling of ground levels and piling mat'.*

Section 3.4 of the HOP report states the following:

'The site is to be suitably reduced / filled to formation level and a working platform installed using the existing crushed material stockpiled on site and from the slab/foundation demolition, ready for piling works to commence in the main contract.

A copy of the Phase II Intrusive Site Investigation report and Contamination Assessment is attached as part of this package of information. It should be noted that the report identifies a number of areas of minor contamination that will need to be monitored on site via the engagement of a suitably qualified Environmental / Geotechnical Consultant in accordance with the recommendations of the report. Detailed construction plans have been prepared highlighting all the areas currently identified for likely remediation, further investigation and assessment.

Contaminated material on site is required to be identified, remediated, removed or placed beneath areas of future buildings/hard-standings.

A watching brief is required during initial slab removal and earthworks for visual or olfactory evidence of gross TPH contamination especially beneath locations where former tanks have been removed. Any revealed grossly impacted soils should be remediated to suitable hard cover requirements; or as a last resort removed from site. The sides and base of the resultant excavation should be sampled and the test results validated against current Tier 1 GACs for a residential (POS1) end use.

Should any areas of potentially contaminated soil be encountered during site construction works, further environmental consultation should be sought to ensure any potentially contaminated soils can be left in-situ and subjected to further assessment to potentially include further chemical testing and risk assessment, with remediation if necessary.

It is hoped with the enabling package, to include probing at all future main works pile positions prior to installing the piling mat.

The existing below ground obstructions, areas of envisaged minor contamination and details of the proposed earth works are detailed on drawings 14576-HOP-EN-XX-DR-S-0101 to 0105.'

A copy of the text of the HOP report is included in Appendix IV together with correspondence from Adur & Worthing Councils dated 15th November 2018 confirming discharge of pre-commencement conditions 3, 4 and 5. HOP Drawing No. 14576-HOP-EN-XX-DR-S-0104 dated 2nd July 2018 is also included in Appendix II provides details relating to proposed earthworks summary/piling mat. Other relevant drawing are also included in Appendix II.

Pre-Commencement Main Site Works Excluding Enabling Works

Phase 2 works onwards will comprise the actual construction of the proposed buildings at the site. We understand that Wates intend to tender for these works in due course. We understand that Planning Condition 10 (Pre-Commencement Main Site Works Excluding Enabling Works) states the following:

'No works except Enabling Works shall take place until an investigation and risk assessment has been undertaken to establish if the site is contaminated and to determine the potential for pollution in accordance with the requirements of DEFRA and the Environment Agency's 'Model Procedures for the Management of Land Contamination, CLR 11'.

Where remediation is necessary a detailed remediation scheme to bring the site to a condition suitable for the intended use by removing unacceptable risks to human health, buildings and other property and to the natural and historical environment must be submitted to and approved in writing by the Local Planning Authority. Unless otherwise agreed in writing by the Local

Planning Authority the remediation scheme must ensure that the site will not qualify as contaminated land under Part 2A of the Environmental Protection Act 1990 in relation to the intended use of the land after remediation.

Following completion of measures identified in the approved remediation scheme a verification report must be submitted to and approved in writing of the Local Planning Authority.

Reason: To ensure that risks from land contamination to the future users of the land and neighbouring land are minimised, together with those to controlled waters, property and ecological systems, and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors in accordance with Policy 34 of the Adur Local Plan. These details are required prior to commencement in order that any changes to satisfy this condition are incorporated into the development before the design is too advanced to make changes.'

CZWG Drawing No. 2052-00-DR-0110 dated 31-07-18 (Rev T01) included in Appendix II details the site wide groundfloor plan.

Discussion

Our understanding of the project is that Wates Construction Ltd have been successful in winning the Phase 1 Enabling works at the site on behalf of the Southern Housing Group. The elements of the enabling works are detailed in Planning Condition 3, which has been addressed in a report prepared by HOP. We understand that Planning Condition 3 has been discharged.

Nevertheless, Wates has requested GeoDyne Ltd to prepare a more detailed Remediation Method Statement (RMS) for the site. Specifically, Wates requested that GeoDyne provides a more detailed summary of validation works necessary following the removal of any former above ground storage tanks (ASTs) or underground storage tanks (USTs) at the site. Further details of a watching brief for unforeseen circumstances will also be provided.

The actual development of the site, i.e. Phase 2 onwards, will comprise the construction of piled foundations for the proposed buildings, many of which will incorporate basement car parking.

GeoDyne Ltd has, in addition to being provided with a copy of planning permission relating to the site, also been provided a copy of correspondence issued by the Environment Agency to Adur & Worthing Council dated 12th January 2018 (copies of the planning permission and EA comments are included in Appendix III). The EA suggested a number of planning conditions, with suggested planning condition 4 relating to site investigation and remediation. Suggested condition 4 stated the following:

'No development approved by this planning permission shall take place until a remediation strategy that includes the following components to deal with the risks associated with contamination of the site shall each be submitted to and approved in writing, by the local planning authority.

1. *A preliminary risk assessment which has identified:*
    - *All previous uses*
    - *Potential contaminants associated with these uses*
    - *A conceptual model of the site indicting sources, pathways and receptors*
    - *Potentially unacceptable risks arising from contamination at the site.*

2. *A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site.*

3. *The results of the site investigation and the detailed risk assessment referred to in (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.*

4. *A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (3) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.*

Any changes to these components require the express written consent of the local planning authority. The scheme shall be implemented as approved.

Condition 5 – Verification report

No occupation of any part of the permitted development shall take place until a verification report demonstrating completion of works set out in the approved remediation strategy and the effectiveness of the remediation shall be submitted to and approved, in writing, by the local planning authority.

The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan to demonstrate that the site remediation criteria have been met.

Condition 6 – Long term monitoring and maintenance

No development should take place until a long-term monitoring and maintenance plan in respect of contamination including a timetable of monitoring and submission of reports to the Local Planning Authority, shall be submitted to and approved in writing by the Local Planning Authority. Reports as specified in the approved plan, including details of any necessary contingency action arising from the monitoring, shall be submitted to and approved in writing by the Local Planning Authority. Any necessary contingency measures shall be carried out in accordance with the details in the approved reports.

On completion of the monitoring specified in the plan a final report demonstrating that all long-term remediation works have been carried out and confirming that remedial targets have been achieved shall be submitted to and approved in writing by the Local Planning Authority.

Condition 7 – Unsuspected contamination

If, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise agreed in writing with the local planning authority) shall be carried out until the developer has submitted a remediation strategy to the local planning authority detailing how this unsuspected contamination shall be dealt with and obtained written approval from the local planning authority. The remediation strategy shall be implemented as approved.

Condition 8 - Piling

Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the local planning authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details.

Reasons for contaminated land conditions

The site lies above Tarrant Chalk Member which is designated a Principal Aquifer. This designation indicates aquifers that provide significant quantities of water for people and may also sustain rivers, lakes and wetlands.

We have reviewed the Phase I and II land contamination reports (Environmental Statement Volume 4: Technical Appendices part 2.3) produced by Geodyne. The investigations have identified previous historical uses on site that have the potential to cause soil and groundwater pollution.

Policy 34 'Pollution and contamination' of the Adur Local Plan requires that development does not result in pollution of the water environment. Policy 34 requires that adequate investigation and assessment, and if required mitigation, will be needed to ensure that unacceptable pollution does not take place.

This is also supported by paragraphs 109 and 121 of the NPPF.

The site investigation included a limited number of exploratory holes, and soil samples were sampled and analysed. Heavy metals and hydrocarbons were identified across the site. Investigations were limited at the time as access was not gained in all areas.

The report has made some initial remediation proposals relating to the limited information obtained during the investigations. The report also states that groundwater is unlikely to impacted.

We recommend that additional investigations are carried out including groundwater sampling and testing including risk assessment to identify whether water resources are at potential risk and the development of soil and groundwater remediation if applicable. In addition to this, the proposed piling scheme has the potential to create pathways and drive contamination down in to groundwater if these areas are not adequately assessed or remediated.

Therefore the above conditions are required for any planning permission in order to ensure that the risks to groundwater quality from the proposed development are adequately understood, and that any remediation required is carried out and verified.'

<u>Comments on Environment Agency Correspondence</u>

The Environment Agency comments were received as part of the planning consultation process before the planning decision notice was issued.

We would recommend that the possible need for and scope of any supplementary works is agreed with the regulatory authorities (LPA and EA) with works undertaken at an appropriate time.

Phase 2 and subsequent phases of the development may therefore include further elements of site investigation and risk assessment works as agreed with the LPA and EA. The Phase 2 development works will also require remediation works and validation works including the following:

1. Provision of a suitable remedial capping in areas of soft landscaping and validation of these works.
2. Provision of suitable ground gas protection measures to buildings (design to be confirmed in a Verification Plan) and validation of these works.

We note that Wates has not yet been instructed for these works. Therefore, whilst we have been requested to provide further guidance on construction phase remediation works, this has been provided for guidance purposes only. The guidance provided will be subject to review and revision by the Consultant taking these works forward and we do not wish to prejudice the ability of the development team to revisit and revise remediation works (including any necessary intrusive investigation and risk assessment works) following completion of the Phase 1 enabling works.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made based on the findings of the investigation. Where comments are made based on information obtained from third parties, GeoDyne Limited assumes that all third party information is true and correct. No independent action has been undertaken to validate the findings of third parties.

This report has been prepared in accordance with our understanding of current good practice. However changes to good practice, guidance or legislation may necessitate revision of this report after the date of issue.

GeoDyne Limited has prepared this report for the exclusive use and reliance of the Client, Wates Construction Ltd, in accordance with our Standard Conditions and Limitations (included in Appendix VIII). This report may not be used or relied upon by any unauthorised third party without the explicit written agreement of GeoDyne Limited.

1.5 Confidentiality

The assessment herein remains the intellectual property and trade secret of GeoDyne Limited. The information contained within this report must not be disclosed or divulged to any commercial Consultant or other third party without the prior written agreement of GeoDyne Limited.

2.0 SITE SUMMARY

2.1 Site Summary

The following site description was provided in our 2015 report.

'The site is an irregularly shaped parcel of land the centre of which may be located around approximate Ordnance Survey National Grid Reference 522180E 105080N.

The site lies in a mainly commercial setting with a Vauxhall Dealership (Frosts) to the west, an aggregate distributing company to the east and Brighton Road adjacent to part of the northern boundary with several national companies beyond including Dunelm Mill, B&Q, McDonald's, Kwik-Fit, a car wash facility, Council Offices and a row of small shops and cafes. A row of industrial units, the Ham Business Centre, was present between the centre of the site and Brighton Road. The southern boundary was formed by Free Wharf adjacent to the River Adur (tidal), the western extent of which is also known as Tarmac Wharf. Beyond the River Adur a residential development was present with mudflats to the southwest of the site. The majority of this section of the river was historically used as a wharf, and until recently, was in use as such by Minelco Ltd (trading ceased approximately two years ago), who received deliveries of aggregates and scallop shells by ship. The wharf wall was constructed as a retaining wall supported by steel sheet piles with the height of the retaining wall being approximately 7.00m above the low tide mudflat level of the River Adur.

The steel pile retaining wall is thought to be reinforced with ground anchors which were evident from securing bolts located approximately 2.00m below the level of the wharf, and spaced at approximately 1.00m centres along the length of the southern boundary. Further securing bolts were also visually evident on the southern bank of the River Adur. Larger bolts occur more widely spaced which may represent bolting points for ground anchor cables.

The entire site comprised the former Minelco Ltd business accessed from Humphreys yard (a public access way) located off Brighton Road. The access road lead into a concrete covered receiving area with a small reception office and a weigh bridge. An electricity sub-station was present to the rear of the reception. To the west of the weigh bridge there was an area of concrete surfacing formerly used for car parking, now vacant and the gates secured with a chain/lock and with concrete blocks. The southern extent of the car park was delineated by a raised section of concrete with five or six steel plates located along the length of the raised concrete. We were verbally informed during our previous works by site staff that the raised section of concrete comprised a former underground conveyor tunnel that once used to serve a tarmacadam works that historically occupied this section of the site.

We were further informed during our previous works that the steel plates covered old hopper inlets into the conveyor system, which was anecdotally infilled by Minelco to render the structure safe. We are not aware of the full extent, depth and condition of the underground conveyor system. An employee of Minelco removed and replaced a steel plate which revealed that the underground structure was infilled.

The main Minelco processing and distribution works was present to the east of the access road. Several structures were present across the northern half of the Minelco site and largely comprised steel framed warehouse structures, of varying sizes and three silos for storage of fine dust materials. Many of the structures appeared to be cladded with corrugated materials that may be Asbestos Containing Materials (ACMs). Various processes were undertaken within the structures, from riffling, grading, packaging and storage of aggregates (seven grades were produced by Minelco down to fine dust grade), and crushing of scallop shells into a powder consistency (used in the oil drilling industry as a drilling mud). One shed structure was used as

a general maintenance and storage shed. Only limited access was gained into the structures during our previous works for reference purposes only.

At the current time, the entire site was vacant/unused although the current Landowners (LKAB Minerals), kept the site secured and provided personnel with keys to allow access for our works. All of the structures were largely accessible for the current works.

Three Above Ground Storage Tanks (ASTs) were identified across the Minelco site immediately south and east of the former Packing Shed. The main fuel oil tank was of steel construction and located in the central section of the site and was placed within a bund (still present at the current time). The internal area of the bund appeared to be relatively clean. A fuel inlet/outlet pipe in front of the bund was noted to have local oil staining at the ground surface. A second bunded AST was located adjacent to the easternmost warehouse structure (grading shed) located above ground surface level on a brick wall. This tank was constructed of double skinned polyethylene and had been removed at the time of our current works. Other ASTs comprised two double skinned polyethylene tanks placed in a raised steel frame located adjacent to the sites maintenance shed (still present at the current time). No visual evidence of staining was noted beneath the tanks.

The southern extent of the Minelco site comprised a large area of concrete apron from the buildings southward toward the southern wharf boundary. This area was used to offload deliveries from ships, temporary storage and distribution. A mobile conveyor and washing area was present at the eastern end of the concrete apron which was used to wash fines from gravel and shells processed at the site. The wash fines were deposited in a small rectangular settling lagoon, and removed by motorised shovel to a waste stockpile at the southeastern corner of the site.

The concrete apron continued to the eastern end of the site where two very large rectangular shed structures were present, mainly used for storage. An access road was present between the two sheds leading to an enclosure at the sites northeastern corner. This was secured by a locked blue double gate within the site, and by a further locked double gate at the sites northern boundary. This area was used for parking of cars and lorries at the time of our previous works, and also had a weigh bridge (but it is unknown if the weigh bridge was in operation), and contained many 1 tonne bags of apparently excess or unused aggregates and other sundry items such as old tyres, pipework etc. A manhole cover within this compound was found to be a foul sewer pumping station, pumping toward Brighton Road.

A second electricity sub-station was noted beyond the northeastern site boundary at the northern extent.

To the west of the compound a two storey derelict brick structure was present, which was secured with boarding. The use of this building is not known. To the west of this, a third access into the site was present entering between the site and the adjacent Kwik-Fit outlet and car wash facility.'

2.2 Executive Summary

The following Executive Summary was provided in our previous report.

Site Summary	*Initially, the site area was used for Timber Ponds. Free Wharf was constructed at the southern extent in the 1890s (including timber piled mooring points) which was expanded including warehouse structures into the 1920s. By the 1930s the majority of the site had been developed including warehouses in the eastern and central section of the site. The 1950s map indicates many of the structures present from the 1930s were used as engineering works, a garage, a timber store and possibly a tarmacadam works in the western extent (identified in the 1960s). This area contains a potential large underground concrete structure (conveyor system) and the southern extent had a travelling crane running parallel to the wharf. In the 1960s an oil storage depot is indicated in the southeast of the site in the vicinity of two tank farms (although anecdotally some or all of these tanks may have been used for wine storage). The 1990s map shows the site layout to be broadly similar to that present today with no significant changes evident shown on the most recent map viewed (2012).* *The site is underlain by an aquifer designated by the Environment Agency as a Principal Aquifer. The site does not lie within a SPZ.*
Ground Conditions	*<u>Made Ground</u>* *Beneath the surface materials which typically comprised reinforced concrete or localised Macadam and granular sub-grade, Made Ground deposits were encountered comprising the following:* • *Soft green sandy gravelly clay.* • *Loose and dense brown clayey gravel of brick and flint.* • *Loose grey locally clayey gravel of ash, slag, chalk, ceramic and glass. Locally with small timber fragments.* • *Loose white clayey gravelly silty Chalk with flints, brick, locally mixed with concrete screed. Also present as soft brown chalky clay or soft putty chalk.* *The Made Ground (where penetrated) was encountered to depths ranging between 1.45m to 3.85m begl and may be broadly considered to comprise reclaimed land materials.* *Within trial pit TP1 large sections of tree trunk and a root ball was identified (potentially left over from the timber ponds identified in the 1870s) and within Trench C a large concrete block with a mooring chain was identified. Several trenches also revealed large fragments of concrete slab within the Made Ground.* *Within borehole WS33 hydrocarbon odours were noted, with free product and staining at 2.20m begl. Hydrocarbon odours and staining were also revealed in TP1 at approximately 2.00m begl.* *<u>Natural Strata</u>* *Beneath the Made Ground, Natural Strata was encountered comprising four elements of Head Deposits, Tidal River Deposits, Storm Beach Deposits and Chalk. The Natural Strata units may be described as follows.* • *Tidal River Deposits – Present as very soft and soft grey or black and locally brown and green slightly silty CLAY with an organic and hydrogen sulphide odour, and extending to depths ranging between 2.00m to 3.95m begl.* • *Storm Beach Deposits – Present as medium dense greyish brown slightly clayey Sand locally and/or medium dense, locally becoming loose brown sandy fine to coarse grained flint and chalk GRAVEL extending to penetrated depths of between 1.90m to 4.90m begl and to depths in excess of 5.00m, but locally not fully penetrated.* • *Head Deposits – Broadly encountered across the northern extent of the site comprising locally soft and stiff silty CLAY with chalk and flint gravel which extended to depths to in excess of 4.00m begl.* • *Tarrant Chalk Member – Encountered in borehole WS22 only as light brown and white gravelly putty Chalk (gravel comprised chalk fragments) which was proven to a maximum depth of 5.00m begl but not fully penetrated.* *Our previous works included deep cable percussive boreholes which penetrated into the Tarrent Chalk Member to 26.00m begl but was not fully penetrated.*
Ground Anchors	*Trenching works at the Free Wharf has revealed steel ground anchor cables at varying depths ranging between 1.05m to 2.05m begl, the majority being approximately 1.75m to 2.05m begl that tie into approximately square shaped anchor blocks which appear to be up to 2.00m in dimension, and approximately 0.44m wide. The revealed anchor cables were approximately 2.30m and 2.60m apart.* *The anchor blocks were encountered at depths ranging between 0.65m and 1.10m begl and were approximately 15.20m to 15.55m distant from the sea wall to the south.* *Previous works at the former Tarmac Wharf revealed 4No. ground anchor ties at intervals of 3.45m, 3.10m, 3.20m and 3.15m respectively. A concrete structure was encountered approximately 11.85m from the north elevation of the sea wall, at an approximate depth of 3.20m begl. The steel anchor cable was noted to enter the southern side*

	of the concrete. It was not possible to ascertain the width or base of the structure but it was deemed to potentially comprise a ground anchor block.
Foundation Design	*The most appropriate foundation solution for the site would be piles, potentially driven piles, founded within the Tarrant Chalk Member.* *The southern boundary of the site comprised a wharf which was retained by steel interlocking sheet piles. The potential presence of ground anchors should be taken into consideration during the site layout planning process. No additional loads should be imposed on the retaining wall at the southern extent of the site until a structural assessment of the retaining wall is undertaken to assess its suitability to accept additional loads.* *Alternatively, consideration may also be given to the use of ground improvement techniques i.e. vibro-stone or concrete columns, subject to consultation with specialist contractors in terms of ground condition acceptability and proposed column loadings. The columns could support either shallow spread foundations or a raft. The potential presence of ground anchors would also need to be taken into consideration in this instance.* *Obstructions were encountered during our previous works in boreholes BH2 and BH2A at depths of 2.90m and 1.70m begl, potentially associated with the anchors (these boreholes were visually positioned between the securing bolt spacing centres to attempt to avoid any ground anchors present). Additionally, a variety of underground obstructions were encountered including multiple slabs, concrete blocks, potential timber piles, railway sleepers and sections of tree trunk. Therefore, if a pile foundation option is adopted, the potential presence of obstructions, ground anchors and anchor blocks should be taken into consideration during the site layout planning process.*
Floor Slabs	*Suspended ground floor slabs are recommended. For any large commercial/industrial units a reinforced ground bearing floor slab may be feasible subject to appropriate preparation/treatment of the formation soils and engineer design.*
Ground Gas Precautions	*A programme of 6No. ground gas monitoring at the site has revealed that the site falls within Characteristic Situation 2 (CS2) in accordance with CIRIA report C665 by virtue of the presence of methane in excess of 1% and carbon dioxide in excess of 5% and relatively high positive gas flow rates (potentially due to tidal effects).* *Therefore, suitable CS2 ground gas protective measures should be incorporated into the proposed structures.* *In summary, residential buildings should be provided with passive sub slab ventilation. In addition, all buildings should be provided with a suitable, certificated, ground gas resistant membrane from a suitable manufacturer/supplier in the floor slab design. The membrane should have suitable tensile strength and puncture resistance, may include an aluminium core (as appropriate) and be of a sufficient thickness to allow any welding to take place without damaging the membrane. The membrane must be suitably lapped and taped and should be extended across wall cavities to effectively exclude ground gases from the footprint of the proposed building.* *Service penetrations through the membrane should be kept to a minimum and should be suitably sealed to the membrane.*
Radon	*No precautions required.*
Building Near Trees	*A medium volume change potential classification should be assumed for the natural cohesive strata. However, the clay soils were predominantly present at depth and therefore may not influence foundation design.*
Coal Mining Precautions	*No investigations or precautions are required.*
Water	*The depth to water beneath the site may be largely dependent upon seasonal and tidal variations.* *Significant dewatering of shallow excavations (i.e. less than 1.00m depth) is considered unlikely to be necessary based on the site observations undertaken to date, but localised removal of perched water may be required.* *Deeper excavations for sewers are likely to encounter significant water ingress, particularly where in excess of 3.00m. Deep excavations into the Gravel stratum could, theoretically encounter base instability due to positive hydrostatic pressure within the gravel deposits during periods of rising tide.*
Excavations and Stability	*Shallow foundations may require sidewall support for both construction and health and safety purposes.* *Deeper excavations at the site are potentially liable to encounter obstructions (former foundations potentially including piles) and underground structures i.e. the conveyor tunnel beneath the western extent of the site, unstable ground and locally shallow groundwater, therefore deep excavations are likely to require trench support and an allowance should be made for breaking out of obstructions.*
Sulphate Classification	*The site is indicated to fall into Design Sulfate Class DS-2 and an Aggressive Chemical Environment for Concrete (ACEC) classification of AC-2.*
CBRs and Pavements	*Typically, CBR values of less than 2% would be anticipated for near surface Made Ground materials.* *All CBR values would be subject to confirmation at sub-base level after services construction and proof rolling of the formation, where an improved CBR value may be achieved. Pavement construction may include geotextile reinforcement to reduce capping thickness and improve ground stability.*
Soakaways	*The use of soakaways for the disposal of surface water is unlikely to be feasible across the site.*
Contamination Assessment	*Soils*

	The assessment of soil test results has revealed the Made Ground at the site to be contaminated with respect to Arsenic, Lead and total PAH, individual PAH compounds, and locally potentially SVOC compounds assuming a residential (POS1) end use. *Asbestos fibres were revealed in two samples of Made Ground comprising chrysotile (white) asbestos and amosite (brown) asbestos.* *Based on the testing undertaken the Natural Strata may be regarded as being uncontaminated for the proposed end use.* *Hydrocarbons* *Whilst visual and olfactory evidence of TPH contamination was revealed in boreholes WS1, WS2, WS4 and WS10 (located adjacent to the USTs within the Frost site, and an AST south of the former packing shed), no significantly elevated concentrations of TPH were identified in the soil samples tested.* *In addition, samples obtained during the current works were screened with a PID and samples selected for TPH testing. No significantly elevated concentrations of TPH were identified in the soil samples tested.* *Perched Water and Ground Water* *Testing on water samples recovered from shallow monitoring points within the Made Ground/superficial deposits revealed elevated concentrations with respect to Arsenic, Lead and Selenium, total PAH, PAH compounds and total TPH, when compared to conservatively adopted Drinking Water Standards.* *The deeper groundwater samples recovered from installations within the deeper Chalk deposits have revealed slight exceedences with respect to Arsenic and Selenium only, with PAH, SVOC and TPH compounds being present below the Drinking Water Standards or less than the LOD.*
Remediation Proposals	*Proposed Soft Landscaped Areas* *The Made Ground was contaminated and noted to be generally aesthetically undesirable containing fragments of brick, concrete, timber, slag and ash. These materials should be covered with a 0.60m thick layer of clean imported topsoil in areas of Public Open Space. Where present beneath hardstanding, no capping would be required other than the hardstanding and geotechnical construction layer themselves.* *Asbestos* *Asbestos (Chrysotile and Amosite) has been found locally within the Made Ground at the site. Any Asbestos Containing Material (ACM) excavated during development works may require disposal off-site to a suitably licensed disposal facility. Alternatively, soils containing asbestos fibres may remain in-situ beneath a suitable remedial cap or beneath hard standing areas, placed in accordance with a suitable site specific risk assessment or a Materials Management Plan (MMP).* *Remediation measures undertaken in sites affected by asbestos should be undertaken to a CAR (Control of Asbestos Regulations 2012) compliant risk assessment in order to protect site staff and members of the public.* *Whilst we would comment that very little or no significant large quantities or fragments of ACM was revealed during our works within the soil, this does not mean that fragments of ACM sheeting, lagging etc are not present within the Made Ground. Therefore, careful consideration will be required including detailed CAR risk assessment and cost benefit analysis before any decision to remove asbestos impacted materials off-site is made.* *Above Ground Fuel Storage Tanks and TPH Impaction* *A watching brief is recommended during removal of any ASTs for visual or olfactory evidence of gross TPH contamination beneath the tanks. Any revealed grossly impacted soils should be removed from site. The sides and base of the resultant excavation should be sampled and the test results validated against current Tier 1 GACs for a residential (POS1) end use.* *Localised excavation of impacted soils may be required at the site. The perched water samples locally contained elevated concentrations of total TPH. Therefore, any impacted areas where piles are required to be advanced should be suitably remediated to prevent the introduction of a downward pathway for the hydrocarbon contamination into the Principal Aquifer.* *Perched water and Groundwater* *Localised removal of impacted water around identified TPH impaction may be considered (to enable pile*

	foundation installation), no significant widespread remedial measures are recommended with respect to perched waters and deeper groundwater.
Unforeseen Ground Conditions	*Should any areas of potentially contaminated soil be encountered during site construction works, we would recommend further consultation to ensure that our recommendations continue to apply. Any potentially contaminated soils should be left in-situ and subjected to further assessment, to potentially include further chemical testing and risk assessment.*
Construction Workers	*It is likely that gas protection measures, such as ventilated manhole covers etc, will be required at the site. Monitoring of excavations for ground gases should also be undertaken prior to, and during occupation of excavations/chambers by personnel.*
Licenses, Permits, Registrations and Approvals	*The Contractor/Developer is responsible for, and must ensure that, all necessary licenses, permits, plans, registrations and approvals are in place prior to commencing with the development of the site. We would be pleased to prepare a Materials Management Plan (MMP) upon request.*
Asbestos	*A pre-demolition asbestos survey should be undertaken in the existing structures to ascertain the presence of ACMs.*
Statutory Consultation	*A copy of this report should be sent to the Local Planning Authority in advance of construction to obtain written comments and approval of the contents presented herein.*
Further Works	*The following phased works are recommended for the site:* • *Additional works in the vicinity of borehole WS33 and TP1 (depending on where they lie in relation to the proposed development) to attempt to delineate the extent and degree of the hydrocarbon impaction.* • *A watching brief in the location of above ground storage tanks during their removal for any visual or olfactory evidence of gross TPH contamination which should be removed and validated.* • *A pre-demolition asbestos survey of existing buildings.* • *Preparation of a Materials Management Plan (if required).* • *Upon site clearance of the surface concrete, it may be possible to undertake Ground Penetrating Radar (GPR) works to attempt to further ascertain the presence and depths of ground anchor cables and blocks along the southern boundary of the site. This will assist in detailed foundation design.*

2.3 Site Visit

As part of our site visit on 15th May 2019, a representative of GeoDyne Ltd undertook a brief site walkover accompanied by Mr M Wellbelove of Wates. The purposes of the walkover was to assess the sites setting and progression of enabling works since our last involvement in 2015.

The site was found to have been substantially cleared of buildings which appeared to have been removed to slab level. Elements of the former structures appear have been subject to crushing and screening works resulting in the presence of mounds of material locally on the sites surface.

Works to uncover the sub-surface conveyor system were apparently ongoing, with covers removed (secured with Herras type fencing) and limited works commence to remove materials within the conveyor system, to attempt to prove the extent and depth of the system.

View of site looking east.

View from western extent of site looking east over subsurface conveyor system.

View into conveyor system

View of PFA (Pulverised Fuel Ash) type material recovered and stored.

3.0 REMEDIATION PROPOSALS

The following remediation proposals are considered appropriate for the site.

3.1 Enabling Earthworks

Enabling earthworks are currently being undertaken by Wates at the site. The enabling earthworks in the context of this RMS represents works detailed in HOPs report to discharge pre-commencement Planning Condition 3.

Specifically, works relate to:

- Identification, excavation, removal and validation of tanks (USTs and ASTS).
- Identification, excavation, removal and validation of any potentially unacceptable contamination hotspots.
- Construction of piling mat.
- Watching brief for unforeseen ground conditions.

Please note that GeoDyne Ltd has been requested by Wates to prepare an RMS specifically to address the foregoing. However, following discussions with Wates, taking account of the geographical distance of GeoDynes offices to the site (approximately 200 miles) it was agreed that alternative consultants located proximally to the site would be instructed to undertake any supplementary intrusive works, risk assessment, observation and validation works at the site.

3.1.1 Identification, Excavation, Removal and Validation of Tanks (USTs and ASTs)

Where former tanks are encountered beneath the site, the following protocol should be adopted.

- Inspect UST or AST and ascertain their size and contents. Undertake topographical survey of the tank location for subsequent inclusion in validation reports. In the event that any hydrocarbon or other product remains in the tanks this should be assessed, the tank de-gassed (as necessary) and product removed from the tank for off-site disposal. The tank should be made safe for subsequent excavation/removal.
- Remove the tank and any associated infrastructure/pipelines etc. Carefully remove any associated tank bunding etc.
- Remove any associated grossly visually contaminated surrounding soil. Dependent upon the contents of the tank, visual, olfactory or semi-quantitative assessment (for example of PID or suitable field testing equipment) may be used.
- A suitable Consultant to attend site and obtain representative samples from the sides and base of the excavations to be scheduled for suitable analysis (the suite of analysis should be based on the contents of the tank – for example speciated total petroleum hydrocarbons (TPH CWG) for fuel). Typically 3No. samples should be taken from the base and each side of the tank void. Where an AST is present the testing may be reduced to an area beneath the footprint of the tank in the first instance.
- At this stage it is recommended that the generic assessment criteria Suitable for Use Levels (S4ULs) published by LQM/CIEH are adopted as Clean Up Goals (CUGs) together with any further necessary screening levels adopting a UK (for example CL:AIRE GAC *'The Soil Generic Assessment Criteria for Human Health Risk Assessment* (2009) > Europe (for example RIVM) > United States (for example USEPA) > other hierarchy.
- Where levels of contaminants across a representative area are less than the CUGs, the excavations may be suitably backfilled. We would typically recommend calculating the Upper Confidence Level (UCL) for contaminants in an individual side or base of excavation to assess the results. If the UCL value of contaminants exceed CUGs, further excavation

should be undertaken in appropriate increments, with the excavation re-tested after each phase of excavation. Once the UCL values of contaminants are less than the CUGs (or an acceptable level if this is not possible), the excavations may be suitably backfilled with clean inert material such as suitably validated site won material or imported geotechnical fill (such as 6F2 or Type 1 etc.).

- Where the excavation of contamination approaches safe, practicable limits of excavation (for example site boundaries, retaining features, buried critical infrastructure) discussions should be held with the relevant regulatory authorities (LPA and EA) and a way forward agreed. Where further excavation is not possible for Health and Safety or other reasons, the cessation of excavation should be agreed with the relevant regulatory authorities.
- The final area of excavation should be recorded by topographical survey for subsequent validation reporting.
- Following satisfactory remediation, a Validation Report may be produced.

We would recommend that a supply of oil sorbent material is used to address the discharge of any free product encountered during remediation works (for example localised free product floating on water within excavations).

Any extensive contaminated water within the excavation should be assessed and suitably removed from site by a specialist contractor.

Where possible, an in accordance with the aspirations of the HOP report relating to Planning Condition 3, excavated contaminated materials may be suitably segregated on site, placed on impermeable surfacing (to minimise the downward migration of any mobile contamination), and subject to suitable ex-situ remediation to attempt to render the material suitable for re-use on site. Suitable method statements and appropriate Clean Up Goals (CUGs), typically Tier 1 GACs adopting a Residential POS1 end use (see Table 1 in Section 3.1.5), should be agreed with the relevant regulatory authorities should these works be required.

Where it is not possible to suitably treat materials, they should be removed from site. Removal of any contaminated soil/water from site should be undertaken by an appropriately licensed waste haulier under chain of custody documentation and disposed off-site at a suitably licensed waste disposal or treatment facility with suitable records retained.

3.1.2 Identification, Excavation, Removal and Validation of any Potentially Unacceptable Contamination Hotspots

Where any suspected contamination hotspots are encountered beneath the site, the following protocol should be adopted.

- Inspect hotspot. Undertake topographical survey of the hotspot location for subsequent inclusion in validation reports.
- Obtain visually representative samples of the hotspot. Commission samples (typically minimum 3No.) for suitable analysis (the suite of analysis should be based on the nature of the hotspot).
- At this stage it is recommended that the generic assessment criteria Suitable for Use Levels (S4ULs) published by LQM/CIEH are adopted as Clean Up Goals (CUGs) together with any further necessary screening levels adopting a UK (for example CL:AIRE GAC *'The Soil Generic Assessment Criteria for Human Health Risk Assessment* (2009) > Europe (for example RIVM) > United States (for example USEPA) > other hierarchy.
- Where levels of contaminants within the hotspot are less than the CUGs, the 'hotspot' may be retained in-situ. We would typically recommend calculating the Upper Confidence Level (UCL) for contaminants to assess the results. If the UCL value of contaminants exceed CUGs, the hotspot should be excavated and removed in suitable increments. Further samples should be obtained and subjected to suitable testing and reassessment. Once the

UCL values of contaminants are less than the CUGs (or an acceptable level if this is not possible), the hotspot excavation may be suitably backfilled with clean inert material such as suitably validated site won material or imported geotechnical fill (such as 6F2 or Type 1 etc.).

- Where the excavation of contamination approaches safe, practicable limits of excavation (for example site boundaries, retaining features, buried critical infrastructure) discussions should be held with the relevant regulatory authorities (LPA and EA) and a way forward agreed. Where further excavation is not possible for Health and Safety or other reasons, the cessation of excavation should be agreed with the relevant regulatory authorities.
- The final area of excavation should be recorded by topographical survey for subsequent validation reporting.
- Following satisfactory remediation, a Validation Report may be produced.

We would recommend that a supply of oil sorbent material is used to address the discharge of any free product encountered during remediation works (for example localised free product floating on water within excavations).

Any extensive contaminated water within the excavation should be assessed and suitably removed from site by a specialist contractor.

Where possible, an in accordance with the aspirations of the HOP report relating to Planning Condition 3, excavated contaminated materials may be suitably segregated on site, placed on impermeable surfacing (to minimise the downward migration of any mobile contamination), and subject to suitable ex-situ remediation to attempt to render the material suitable for re-use on site. Suitable method statements and appropriate Clean Up Goals (CUGs), typically Tier 1 GACs adopting a Residential POS1 end use (see Table 1 in Section 3.1.5), should be agreed with the relevant regulatory authorities should these works be required.

Where it is not possible to suitably treat materials, they should be removed from site. Removal of any contaminated soil/water from site should be undertaken by an appropriately licensed waste haulier under chain of custody documentation and disposed off-site at a suitably licensed waste disposal or treatment facility with suitable records retained.

3.1.3 Construction Piling Mat

We understand that Wates are responsible for the construction of a suitable, geotechnically competent piling mat at the site. We further understand that the piling mat is proposed to be left in-situ after completion of the piling.

The piling mat would typically represent a low risk to future end users of the site, as it will typically be present beneath the building (i.e. beneath hardstanding/floorslabs etc).

We would recommend that limited chemical testing of the piling mat should be undertaken to ensure that it is suitable for retention on the site, especially if the piling mat is to form the basal element of the subsequent remedial capping.

The rate of testing of the piling mat would be subject to agreement with the appropriate regulatory authorities, however typically a minimum testing regime of 1 test per 250m^3 to 500m^3 should be undertaken (subject to LPA approval where necessary). Where early results indicate that the material is suitable for the proposed use, it may be possible to agree a reduced rate of testing (for example 1 per 500m^3 to 1000m^3) provided that the material being re-used is from a consistent source.

The materials tested should be assessed against suitable screening criteria, reflecting the proposed positioning and re-use of the materials.

3.1.4 Unforeseen Ground Conditions

Should any areas of potentially contaminated soil, or anomalous features be encountered during site enabling or construction works we would recommend consultation with a suitable Consultant to ensure that the recommendations of this RMS continue to apply.

Any potentially contaminated soils should be left in-situ and subjected to further assessment, to potentially include further chemical testing and risk assessment.

The following procedure should be adhered to if any areas of previously unidentified suspected contamination are encountered during the development of the site:

i. Suspected contaminated material will remain in-situ.
ii. Consultant to be notified, and will inform the Local Authority Environmental Health Department and/or Environment Agency (if appropriate).
iii. Consultant will undertake a visual assessment of the possible contamination, followed by appropriate sampling/testing (as necessary) in accordance with Section 3.1.2 above, pending final decisions/sentencing regarding the retention, re-use, remediation or disposal of the materials.

3.1.5 Clean Up Goals

We understand that the site is proposed to be redeveloped with a high rise residential end use together with commercial floor space and ground floor level.

Our earlier report dated 2015 adopted a Residential (POS1) end use for the selection of Site Acceptance Criteria (SAC)/Clean Up Goals (CUGs). Based on our understanding of redevelopment proposals, we continue to consider that these end use criteria remain applicable, as external soft landscaping appears to comprise communal soft landscaping, rather than defined private garden areas where vegetables may be grown.

Suitable Tier 1 SAC/CUGs for the proposed development are detailed in Table 1 below.

TABLE 1 – PROPOSED SITE ACCEPTANCE CRITERIA FOR IMPORTED SOILS (POS RESIDENTIAL (POS1) END USE)

Determinand	Tier 1 SAC (mg/kg)
Metals	
Arsenic	79 S4UL
Cadmium	120 S4UL
Copper	12000 S4UL
Chromium III	1500 S4UL
Chromium VI	7.7 S4UL
Lead	630* C4SL
Mercury	120 S4UL
Nickel	230 S4UL
Selenium	1100 S4UL
Zinc	81000 S4UL
PAHs	
Acenaphthene	1500 S4UL
Acenaphthylene	1500 S4UL
Anthracene	74000 S4UL
Benzo(a)anthracene	29 S4UL
Benzo(a)pyrene	5.7 S4UL
Benzo(b)fluoranthene	7.1 S4UL

TABLE 1 – PROPOSED SITE ACCEPTANCE CRITERIA FOR IMPORTED SOILS (POS RESIDENTIAL (POS1) END USE)	
Determinand	Tier 1 SAC (mg/kg)
Benzo(ghi)perylene	640 S4UL
Benzo(k)fluoranthene	190 S4UL
Chrysene	57 S4UL
Dibenzo(ah)anthracene	0.57 S4UL
Fluoranthene	3100 S4UL
Fluorene	9900 S4UL
Indeno(123-cd)pyrene	82 S4UL
Naphthalene	4900 S4UL
Phenanthrene	3100 S4UL
Pyrene	7400 S4UL
Total Petroleum Hydrocarbons (TPH)	
Aliphatic C5-C6	570000 S4UL
Aliphatic C6-C8	600000 S4UL
Aliphatic C8-C10	13000 S4UL
Aliphatic C10-C12	13000 S4UL
Aliphatic C12-C16	13000 S4UL
Aliphatic C16-C35	250000 S4UL
Aliphatic C35 – C44	250000 S4UL
Aromatic C5-C7	56000 S4UL
Aromatic C7-C8	56000 S4UL
Aromatic C8-C10	5000 S4UL
Aromatic C10-C12	5000S4UL
Aromatic C12-C16	5100 S4UL
Aromatic C16-C21	3800 S4UL
Aromatic C21-C35	3800 S4UL
Aromatic C35 – C44	3800 S4UL
Others	
Asbestos	Absence

Key
S4UL – CIEH/LQM Suitable 4 Use Levels (2015). Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3026. All rights reserved.
* - Geometric mean
Note
Different end use specific criteria (for example protective of residential with plant uptake or protective of controlled waters) may need to be agreed with the LPA and EA dependent upon the proposed end use and assessment of critical receptor.

A table providing GAC for six Tier 1 end uses is included in Appendix VI. These may be adopted as appropriate dependent upon the end use adopted.

3.2 Main Development Phase Works

Main development phase works are currently beyond the remit of the Phase 1 Enabling works being undertaken by Wates.

The actual development of the site, i.e. Phase 2 onwards, will comprise the construction of piled foundations for the proposed buildings, many of which will incorporate basement car parking. Phase 2 and subsequent phases of the development may therefore include further elements of site investigation and risk assessment required by the LPA or EA as the site becomes fully accessible for investigation (with a view to partially discharging Planning Condition 10). Phase 2 works will also require remediation works and validation works specifically with respect to the following:

- Provision of a suitable remedial capping in areas of soft landscaping and validation of these works.

- Provision of suitable ground gas protection measures (design to be confirmed in a Verification Plan) to buildings and validation of these works.

We note that Wates has not yet been instructed for these works. Therefore, whilst we have been requested to provide further guidance on construction phase remediation works, this has been provided for information purposes only. The guidance provided will be subject to review and revision by the Consultant taking these works forward and we do not wish to prejudice the ability of the development team to revisit and revise remediation works following completion of the Phase 1 enabling works.

3.2.1 Contamination Assessment

Our previous report in 2015 provided the following summary of our contamination assessment for the site.

'Soils

The assessment of soil test results has revealed the Made Ground at the site to be contaminated with respect to Arsenic, Lead and total PAH, individual PAH compounds, and locally potentially SVOC compounds assuming a residential (POS1) end use.

Asbestos fibres were revealed in two samples of Made Ground comprising chrysotile (white) asbestos and amosite (brown) asbestos.

Based on the testing undertaken the Natural Strata may be regarded as being uncontaminated for the proposed end use.

Hydrocarbons

Selected boreholes were targeted to areas of potential concern i.e. USTs (undertaken during initial works in 2013 associated with the Frosts site but now without the site boundary), ASTs, the former oil storage yard and tarmacadam works. No visual or olfactory evidence of gross TPH contamination was evident in the vicinity of an AST (WS8) or the oil storage depot (WS15, BH3, WS22, WS23 and WS26). Tarry bitumen fragments were identified in the vicinity of the tarmacadam works (BH1), although no gross contamination was evident i.e. smells or free product.

In addition, whilst visual and olfactory evidence of TPH contamination was revealed in borehole WS10 (located adjacent to the AST south of the former packing shed), no significantly elevated concentrations of TPH were identified in the soil samples tested.

Samples obtained during the current works were screened with a PID and samples selected for laboratory testing, in particular from boreholes WS22, WS23, WS30, WS31, WS33 and trial pit TP1 which were also located adjacent to ASTs (around the packing shed area), the former oil storage area or where gross TPH impaction was revealed. No significantly elevated concentrations of TPH were identified in the soil samples tested.

Perched Water and Ground Water

Testing on water samples recovered from shallow monitoring points within the Made Ground/superficial deposits (WS10, WS15 and WS17) revealed elevated concentrations with respect to Arsenic, Lead and Selenium, total PAH, PAH compounds and total TPH, when compared to conservatively adopted Drinking Water Standards.

The deeper groundwater samples recovered from installations within the deeper Chalk deposits have revealed slight exceedences with respect to Arsenic and Selenium only, with PAH, SVOC and TPH compounds being present below the Drinking Water Standards or less than the LOD.'

3.2.2 Remediation Proposals

Our remediation proposals should be considered to be general guidance at this stage and for information purposes only, as Wates has not currently been instructed to undertake Phase 2 development works onwards. Our proposals are not intended to prejudice the ability of future consultancy teams to revisit detailed remedial proposals.

We would further note that remedial proposals may be revisited following completion and validation of Phase 1 enabling works, as appropriate.

3.2.2.1 Proposed Soft Landscape Areas

Our previous report noted the following:

'*The Made Ground beneath the site is contaminated with metals, PAH and SVOC compounds and was noted to be generally aesthetically undesirable containing fragments of brick, concrete, timber, slag and ash. These materials should not be left exposed at the surface and should be covered with a 0.60m thick layer of clean imported topsoil in areas of Public Open Space. Where present beneath hardstanding, no capping would be required other than the hardstanding and geotechnical construction layer themselves.'*

The foregoing proposals continue to apply to the site and are detailed in Table 2.

TABLE 2 – REMEDIAL CAPPING THICKNESS PROPOSALS (SOFT LANDSCAPING)

Land Use	Site Won Topsoil	Site Won Subsoil	Total Capping	Comments
Soft Landscaping (Residential POS)	0.15m	0.45m	0.60m	Basal 0.15m of subsoil may comprise piling mat subject to it being chemically suitable.

3.2.2.2 Topsoil & Subsoil

Where it is necessary to import Topsoil and Subsoil to site, they should be tested at source to ensure they are suitably clean in accordance with CLEA/generic guidance. Any imported topsoil should ideally conform to BS3882: 2015 '*Specification for topsoil*', with respect to the presence of deleterious material and nutrient levels etc.

We would recommend that proposed donor soils are tested at source prior to importation (minimum 3No. tests per source or suitable supplier certification). The testing suite adopted will be subject to the Conceptual Site Model for the donor site. The topsoil and subsoil should be tested and approved (by the consultant and LPA) for use prior to importation to site.

Delivery notes for any imported topsoil and subsoil should be retained by the client and a selection included in validation reports.

3.2.2.3 Asbestos

Asbestos (Chrysotile and Amosite) has been found within the Made Ground at the site. Any Asbestos Containing Material (ACM) excavated during development works may require disposal off-site to a suitably licensed disposal facility, undertaken by suitably qualified Contractors. Alternatively, soils containing asbestos fibres may remain in-situ beneath a

suitable remedial cap or beneath hard standing areas, placed in accordance with a suitable site specific risk assessment or a Materials Management Plan (MMP).

The CIRIA C733 document *'Asbestos in soil and made ground: a guide to understanding and managing risks'* (2014) recommends that remediation measures undertaken in sites affected by asbestos should be undertaken to a CAR (Control of Asbestos Regulations 2012) compliant risk assessment in order to protect site staff and members of the public.

The remediation of sites affected by Asbestos may involve licensable work, notified non-licensable work or simply non-licensable work. The CAR risk assessment for the site should be site specific and must cover all aspects of remediation involving ACMs.

The main risk associated with ACMs is the release of airborne fibres resulting from excavation, earth movements and primarily vehicle movements around the site (particularly during dry weather), the severity of which will depend upon the amounts and types of Asbestos present. Good site awareness, site management, Asbestos-specific mitigation measures and training will reduce worker exposure to airborne dust and fibres. In order to avoid subsequent civil liabilities, mitigation measures need to prevent exposure of neighbouring residents and public to levels which may be deemed significant in the future.

The CAR risk assessment in conjunction with the Client Health and Safety procedures will define the mitigation measures required at the site. Mitigation measures to avoid the spread of Asbestos fibres may include some or all of the following:

- Damping down of surfaces and stockpiles of demolition/crushed materials.
- Management of stockpiles and soil movements.
- Hand picking of visible ACM materials from the site surface or stockpiles.
- Segregated areas
- Potentially wheel washes, road wetting and road cleaning (as appropriate).

Monitoring around the sites perimeter for airborne Asbestos dust particles would ensure and confirm good site management of the Asbestos risk and further protect site workers and members of the public.

3.2.2.4 General Guidance on Asbestos as a Waste Material (after WM2, 2014)

The following comments may assist in determining the Clients options appraisal in the event that the Made Ground soils containing asbestos fibres are not to be retained on site beneath a suitable remedial cap (or hardstanding), and off-site disposal is being considered.

Comments taken from *'WM2 – Interpretation of the definition and classification of Hazardous Waste'* (2014) indicate.

'…it has become apparent that the many people in the waste industry are still unaware of how soils contaminated with asbestos should be classified for waste disposal purposes. WM2 now provides a specific example about how soil and other construction and demolition waste containing or contaminated with asbestos should be assessed…'.

'…Example 17 on page A59 of WM2 says that: "If the waste contains, in addition to any dispersed fibres, any asbestos in identifiable pieces they must be assessed as set out below. This would also apply to any dispersed fibres produced by deliberately breaking up such identifiable pieces.

Where the waste contains identifiable pieces of asbestos (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye),

then the asbestos must be assessed separately. The waste is hazardous if the concentration of asbestos in the pieces alone is 0.1%. The waste is regarded as a mixed waste (see example 1) and classified accordingly. The following codes should be assigned to the asbestos waste as appropriate:

- *17 06 05* Construction material containing asbestos MH*
- *17 06 01* Insulation material containing asbestos MH*
- *17 06 05* would normally be used in preference to 17 06 01* for the asbestos in asbestos contaminated soil and stones."*

Example 1 on page A37 says that: "If more than one separately identifiable waste is present then more than one list of waste code will be required. The general principle is that if 3 items of waste (one each of types A, B and C) are placed in a single container, then that container contains 3 wastes. Each of which must be separately assessed, described and coded."

Example 17 says that if the ***concentration of asbestos in the pieces alone is > 0.1%*** *then the waste is hazardous. All asbestos containing materials likely to be identifiable by the naked eye contain more than 0.1% of asbestos.*

There is no threshold indicated for this so currently a single piece of asbestos would be sufficient to classify several hundred tonnes of soil as hazardous. We [the document Authors] *have queried this with the Environment Agency and had confirmation that this is the correct approach to waste classification. We* [the document Authors] *also queried what size the piece of asbestos would have to be and was told that a piece the size of a 5p would be large enough.*

If there are visible pieces of asbestos then the waste ***must*** *be classed as hazardous on that basis alone.*

The waste would then have two EWC codes, one for the soil, probably 17 05 04 or 17 05 03 depending on any other contaminants in the material and one for the asbestos.

For asbestos from asbestos cement sheets then the code would normally be 17 06 05. I [the document Author] *think it important to note that, even if your laboratory results show less than 0.1% of asbestos in any soil samples, the soil should be classed as hazardous if there are any visible pieces (larger than a 5p) of asbestos containing material.*

In practice it is not practicable to pick over a soil to remove all pieces of asbestos containing material bigger than a 5p piece although based on considerations of occupational exposure it may well be advisable.

Mechanically screening a contaminated soil may deliberately break up such identifiable pieces and WM2 explicitly states that you would still have to classify the soil as hazardous'.

Whilst we would comment that very little or no significant large quantities or fragments of ACM was revealed during our works within the soil, this does not mean that fragments of ACM sheeting, lagging etc are not present within the Made Ground. Therefore, careful consideration will be required including detailed CAR risk assessment and cost benefit analysis before any decision to remove asbestos impacted materials off-site is made.

3.2.2.5 Controlled Waters

Our previous report stated the following:

'The concentrations of determinands revealed in the soils and water at the site are not considered to represent a significant risk to Controlled Waters i.e. the Aquifer beneath the site and the estuary of the adjacent River Adur.

Water test results have verified metal, PAH and TPH impaction in the shallow water samples, but only metal (Arsenic and Selenium) within the deeper samples recovered from the Chalk aquifer, when assessed against conservatively adopted Drinking Water/EQS standards.

Taking account of the sites long history of industrial usage, and the current setting of the site the levels of contamination within the shallow perched water may be considered to be relatively low, with the levels of contaminants within the deeper Chalk Aquifer to have been demonstrated to be very low with only exceedences with respect to Arsenic and Selenium.

Therefore, at this stage, although localised removal of impacted soils/water around identified TPH impaction may be considered (to enable pile foundation installation), no significant widespread remedial measures are recommended with respect to perched waters and deeper groundwater. This conclusion is further mitigated by the final development proposals with will be predominantly hard surfaced and therefore minimal percolation of storm water into the ground would occur.'

We consider that the foregoing comments continue to apply, subject to EA approval etc. Recent comments from the EA provided by the Client should be taken into account and any supplementary works agreed with the LPA and EA as part of the redevelopment of the site.

We would further note that Phase 1 Enabling works should suitably remove and validate any identified ASTs and USTs at the site, whilst also removing any potentially unacceptable hotspots. This will provide substantial betterment at the site, further mitigating any potential risk.

3.2.3 Ground Gas Protection Measures

The ground gas assessment undertaken by GeoDyne Ltd was detailed in our Combined Report in 2012. This was supplemented by a letter report in 2012 detailing the completed ground gas monitoring exercise. The original ground gas protection proposals were based on a commercial end use for the site.

Ground gas protection measures were revisited in our June 2015 report prepared for the Southern Housing Group assuming a residential end use.

We would note that a revised version of BS8485 *'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'* was published at the end of June 2015.

Further revisions to BS8485: 2015 +A1:2019 were published in 2019. Taking account of changes to good practice, it is considered appropriate to revisit ground gas protection measures at the site.

3.2.3.1 Gas Monitoring Results

A total of 6No. ground gas monitoring visits were completed at the site and reported in October 2015. The results of the ground gas monitoring are detailed in Table 3 below.

TABLE 3 – SUMMARY OF GAS MONITORING DATA		
Parameter	Minimum % by volume (v/v)	Maximum % by volume (v/v)
Methane	0.0	1.2
Carbon Dioxide	0.1	17.5
Oxygen	0.1	20.3
Flow (l/h)	-7.6 (Low Tide)	+12.3 (Rising Tide)

3.2.3.2 Appropriate Guidance

British Standard, CIRIA & NHBC

The results of the ground gas monitoring have been reviewed with reference to the following documentation:

- British Standard BS 8485 *'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*' (2015) and A1 (2019).
- CIRIA Report C665 '*Assessing risks posed by hazardous ground gases to buildings*' (2007).
- CIRIA Report C735 '*Good practice on the testing and verification of protection systems for buildings against hazardous ground gases*' (2014).
- NHBC & RSK Group publication 'Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present' (2007).

3.2.3.3 Gas Screening Value Calculation

BS 8485:2015 and CIRIA Report C665 recommend a risk-based methodology to ground gas assessment, the first step of which includes the calculation of a site-specific Gas Screening Value (GSV). The GSV of a particular ground gas regime equates to:

- GSV (L/h) = maximum borehole flow rate (L/h) x (maximum gas concentration/100).

The GSV should be calculated for both methane and carbon dioxide (where appropriate) to determine a site-specific Characteristic Situation for each gas. The higher the calculated GSV, the greater the risk posed by the presence of ground gas. The CIRIA guidance document notes that '*…the GSV is a guideline value and not an absolute threshold*'.

3.2.3.4 Site Classification

The next step in the assessment process is determining the sites classification. Table 2 of BS 8485:2015 (reproduced below) presents six Characteristic Situations (CS) to assist in the classification of the site, based on the calculated GSV for methane and carbon dioxide.

Table 2 — *CS by site characteristic GSV*

CS	Hazard potential	Site characteristic GSV [A] L/h	Additional factors
CS1	Very low	<0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	0.07 to <0.7	Typical measured flow rate <70 L/h (otherwise consider an increase to CS3)
CS3	Moderate	0.7 to <3.5	–
CS4	Moderate to high	3.5 to <15	–
CS5	High	15 to <70	–
CS6	Very high	>70	–

[A] The figures used in this column are empirical.

NOTE The CS is equivalent to the characteristic GSV in CIRIA C665 [6].

NOTE 2 The results from the models can be used to determine the scope of gas protection measures needed for a building and to design any necessary underfloor ventilation.

NOTE 3 This approach is of particular use where gas migrates through the ground from a source adjacent to the site (e.g. where landfill gas migration occurs).

NOTE 4 Further information on detailed quantitative risk assessment is provided in the Ground Gas Handbook [4].

3.2.3.5 Proposed Building Type

In accordance with BS 8485:2015, the CS classification for the site should be considered in conjunction with the proposed Building Type to determine the appropriate level of ground gas protection measures that should be installed to mitigate the risk posed by ground gases.

BS 8485:2015 notes '*The Building Type is determined based the proposed construction and use of the building, together with the control of future structural changes to the building and its maintenance (the building's management) should be assessed, since potential risks posed by ground gases are strongly influenced by these factors*'.

Subject to the development proposals, each building may be categorised as a whole, or for each different part of the building.

The Building Types presented in Table 3 of BS 8485:2015, are reproduced below.

Table 3 — *Building types*

	Type A	Type B	Type C	Type D
Ownership	Private	Private or commercial/ public, possible multiple	Commercial/ public	Commercial/ industrial
Control (change of use, structural alterations, ventilation)	None	Some but not all	Full	Full
Room sizes	Small	Small/ medium	Small to large	Large industrial/ retail park style

- **Type A building**: private ownership with no building management controls on alterations to the internal structure, the use of rooms, the ventilation of rooms or the structural fabric of the building. Some small rooms present. Probably conventional building construction (rather than civil engineering). Examples include private housing and some retail premises.
- **Type B building**: private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building, including the gas protection measures. Multiple occupancy. Small to medium size rooms with passive ventilation of rooms and other internal spaces throughout ground floor and basement areas. May be conventional building or civil engineering construction. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings (such as schools, hospitals, leisure centres) and parts of hotels.
- **Type C building**: commercial building with central building management control of any alterations to the building or its uses and central building management control of the maintenance of the building, including the gas protection measures. Single occupancy of ground floor and basement areas. Small to large size rooms with active ventilation or good passive ventilation of all rooms and other internal spaces throughout ground floor and basement areas. Probably civil engineering construction. Examples include offices, some retail premises, and parts of some public buildings (such as schools, hospitals, leisure centres and parts of hotels).
- **Type D building**: industrial style building having large volume internal space(s) that are well ventilated. Corporate ownership with building management controls on alterations to the ground floor and basement areas of the building and on maintenance of ground gas protective measures. Probably civil engineering construction. Examples are retail park sales buildings, factory shop floor areas, warehouses. (Small rooms within these style buildings should be separately categorized as Type B or Type C).

NOTE 2 Type A buildings are those where the risk of failure of the gas protection measures is likely to be most significant to the safety of the occupants and Type D buildings are those where this same risk is likely to be least significant.

3.2.3.6 Gas Protection Score (Number of Points to be Achieved)

Table 4 of BS 8485:2015, reproduced below, should be used to derive the minimum level of gas protection applicable to the Building Type, based on the CS determined from the calculated GSV. The Gas Protection Score in Table 4 below is used to determine the level and type of protection measures used.

Table 4 — *Gas protection score by CS and type of building*

CS	Minimum gas protection score (points)			
	High risk		Medium risk	Low risk
	Type A building	Type B building	Type C building	Type D building
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 [A]	5.5 [A]	4.5	3.5
5	— [B]	A1 6 A1 [A]	5.5	4.5
6	— [B]	— [B]	A1 — [B] A1	A1 6 A1

[A] Residential buildings should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

[B] The gas hazard is too high for this empirical method to be used to define the gas protection measures.

NOTE 3 The NHBC has published guidance [8] for use on residential developments, which utilizes an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilizing beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilizing this system would therefore need to refer to the NHBC [8] to assess compliance for specific recommendations.

3.2.3.7 Methods of Achieving Gas Protection Scores

The appropriate level of precautions, to be designed in accordance with the point scoring system of BS 8485:2015, should, therefore, be determined for the specific type of developments based on the GSV and CS of the site. These may include a combination of two or more of the following three types of protection measures, which could be used to achieve the required score:

- The structural barrier of the floor slab, or of the basement slab and walls if a basement is present;
- Ventilation measures; and
- Gas resistant membrane which should include verification and potentially integrity testing.

Verification and integrity testing should be undertaken in accordance with CIRIA report C735 *'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases'* (2014) and would typically be detailed in a Verification Plan report in advance of construction which should be agreed with the Local Planning Authority. A copy of CIRIA C735 gas protection measures inspection proforma is included in Appendix V.

The points achieved for each element of the ground gas precautions are summarised in Tables 5, 6 and 7 of the British Standard. These tables are reproduced below.

Table 5 — *Gas protection scores for the structural barrier*

Floor and substructure design (see Annex A)	Score [A]
Precast suspended segmental subfloor (i.e. beam and block)	0
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5
Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations	1 or 1.5 [B]
Basement floor and walls conforming to BS 8102:2009, Grade 2 waterproofing [C] [D]	2
Basement floor and walls conforming to BS 8102:2009, Grade 3 waterproofing [C] [D]	2.5

[A] The scores are conditional on breaches of floor slabs, etc., being effectively sealed.

[B] To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in (see **A.2.2.2**).

[C] The score is conditional on the waterproofing being provided by a suitable structural barrier with the design and detailing of the walls and floor meeting the requirements for Type B protection. The score cannot be assigned for Type A (waterproof membrane) or Type C (drained cavity wall).

[D] If a membrane is installed beneath and around the basement to provide Type A waterproofing (BS 8102:2009), it can be assigned a gas protection score in accordance with Table 7, if it meets all the criteria for a gas resistant membrane in that table.

When practical, utilities should enter the building above floor level with any conduit or meter housing being properly vented outside of the building.

Table 6 — *Gas protection scores for ventilation protection measures*

Protection element/system	Score	Comments
(a) Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building)	0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems. If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is zero.

Table 6 *(continued)*

Protection element/system	Score	Comments
(b) Passive sub floor dispersal layer:	2.5	Performance criteria for methane and carbon dioxide are shown in Figure B.6 and Figure B.7, respectively.
Very good performance:	1.5	
Good performance:		
Media used to provide the dispersal layer are: • Clear void • Polystyrene void former blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer		The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B. Passive ventilation should be designed to meet at least "good performance", see Annex B.
(c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least "good performance", as described in Annex B.
(d) Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient "coverage" of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least "good performance".
(e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)	4	Assumes that the car park is vented to deal with car exhaust fumes, designed to *Buildings Regulations 2000, Approved Document F* [9].

Table 7 — *Gas protection score for the gas resistant membrane*

Protection element/system	Score	Comments
Gas resistant membrane meeting all of the following criteria: • sufficiently impervious ⟨A1⟩ , both in the sheet material [A)] and in the sealing of sheets and sealing around sheet penetrations, to prevent any significant passage of methane and/or carbon dioxide through the membrane; ⟨A1⟩ • sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • ⟨A1⟩ *Text deleted* ⟨A1⟩ • sufficiently strong ⟨A1⟩ [B)] ⟨A1⟩ to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); ⟨A1⟩ and to withstand in-service stresses (e.g. settlement if placed below a floor slab); ⟨A1⟩ • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735 [N1].	2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. ⟨A1⟩ *Text deleted* ⟨A1⟩ If a membrane is installed that does not meet all the criteria in column 1 then the score is zero.

[A)] ⟨A1⟩ A membrane with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheets and joints (tested in accordance with BS ISO 15105-1:2007 manometric method) is regarded as sufficiently impervious.

[B)] For example, reinforced LDPE (virgin polymer) membranes having a minimum mass per unit area of 370 g/m² and not significantly less than 0.4 mm thickness between the reinforcement scrim (tested in accordance with Procedure D (2 mm diameter tip) of BS EN ISO 9863-1:2016) installed above floor slabs are considered sufficiently strong to meet the performance criteria (see also **C.3**). Thicker and more robust membranes or an additional membrane protection layer should be installed directly beneath cast-in-situ floor slabs. ⟨A1⟩

3.2.3.8 Borehole Hazardous Gas Flow Rates

For the purposes of assessing the ground gas risk from each borehole, we have derived the borehole hazardous gas flow rate (Q_{hg}) for each individual well installation (in general accordance with BS 8485), utilising the following equation:

Equation 1: $Q_{hg} = q(C_{hg}/100)$

Where Q_{hg} is the borehole hazardous gas flow rate, q is the measured borehole flow rate (in l/hr) and C_{hg} is the measured hazardous gas concentration (in % v/v).

The borehole hazardous gas flow rate can be derived for each monitoring visit, however for the purposes of this assessment, we have utilised the highest measured gas concentrations and the highest measured flow rate for each well installation across the combined dataset, which is summarised in Table 4 below. This is considered suitably precautionary.

TABLE 4 – ASSESSMENT SUMMARY OF GAS MONITORING DATA							
BH ID	No. Monitoring Visits	Maximum % Methane (v/v)	Maximum % Carbon Dioxide (v/v)	Maximum Positive Flow Rate (l/hr)	Methane GSV	Carbon Dioxide GSV	Worst Case BS8485 Classification
Deep Boreholes (Installed within Buried Topsoil)							
BH1	6	0.1	1.4	8.3	0.0083	0.1162	CS2
BH2B	6	0.1	1.1	1.5	0.0015	0.0165	CS1
BH3	6	0.1	1.3	12.3	0.0123	0.1599	CS2
WS1	6	0.2	9.7	0.0	0.0002	0.0097	CS1
WS2	6	1.2	4.7	0.0	0.0012	0.0047	CS1
WS10	6	0.1	3.9	0.1	0.0001	0.0039	CS1
WS15	6	0.0	0.2	0.1	0.0000	0.0002	CS1
WS017	6	0.1	17.5	0.0	0.0001	0.0175	CS1
Notes 1. Where no flow is revealed, use Limit of Detection (LOD) of 0.1l/hr in calculation							

The foregoing assessment of ground gas monitoring results in individual boreholes reveals that the maximum Characteristic Situation (CS) classification is CS2 (BH1 and BH3). The highest Gas Screening Value was 0.1599 which fits comfortably within CS2 and is significantly below the threshold to CS3 of 0.7l/hr.

3.2.3.9 Worst Case Check

A worst case check should be carried out to derive a worst case GSV adopting the maximum recorded flow in any standpipe with the maximum gas concentration in any other standpipe in accordance with BS8485:2015 +A1 2019 section 6.3.7.4.

Methane

The programme of ground gas monitoring detected Methane up to a maximum concentration of 1.2% v/v (expressed as 0.012 as a fraction) with a maximum measurable positive flow rate of 12.3 l/h detected.

The maximum GSV for methane is calculated as follows:

- 12.3 x (1.2/100) = 0.1476l/h

Carbon Dioxide

The programme of ground gas monitoring detected Carbon Dioxide up to a maximum concentration of 17.5% v/v (expressed as 0.175 as a fraction) with a maximum positive measurable flow rate of 12.3 l/h detected.

The maximum GSV for Carbon Dioxide is calculated as follows:

- 12.3 x (17.5/100) = 2.1525l/h

Discussion

A maximum Methane concentration of 1.2% v/v and a maximum Carbon Dioxide concentration of 17.5% v/v together with a maximum GSV for Carbon Dioxide of 2.15l/h would potentially cause the site to be classified as CS3 in accordance with BS8485 by virtue of the Carbon Dioxide GSV.

However, we would note that the GSV for Methane sits within the lower end of CS2. We would note that the maximum flow rate was revealed in BH3 where very low levels of Methane and Carbon Dioxide were present throughout the monitoring programme, whilst the maximum concentration of Carbon Dioxide was revealed in WS17, where only a very low flow rate was revealed.

Taking account of the foregoing and the fact that borehole specific GSV calculation reveals GSVs at the lower end of the CS2 category, we consider that a CS2 classification may be applied to the site.

We consider that the proposed residential use of the site at ground floor would constitute a building Type B (where there is central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building).

We consider that the proposed ground floor commercial use of the site at ground floor would constitutes a building Type C (a commercial building with central building management control of any alterations to the building it its uses and central building management control of the maintenance of the building).

Gas protection measures design options are detail in Table 5 below.

TABLE 5 – GAS PROTECTION MEASURES OPTIONS

CS2 Site					
Construction Type and Use	Score Required	Structural Barrier (Score)	Gas Membrane (Score)	Ventilation/Dilution (Score)	Total Achieved Score
Type B Residential Building (pre-cast suspended floor)	3.5	Suspended Ground Floor i.e. beam and block or planks (0)	Gas resistant membrane designed, installed and verified in accordance with BS8485 (2)	Ventilated sub-floor void and external air bricks and ventilation of internal sleeper walls providing good or very good ventilation (1.5 to 2.5)	3.5 to 4.5
Type B Residential Building (reinforced cast in-situ suspended (piled) floor slab with minimal penetrations)	3.5	Reinforced cast in-situ suspended floor slab with minimal penetrations (1 to 1.5)	Gas resistant membrane designed, installed and verified in accordance with BS8485 (2)	Pressure relief pathway (usually formed of low fines gravel of with a thin geocomposite blanket or strips termination in a gravel trench external to the building (0.5)	3.5 to 4.0
Type B Residential Building (with basement carpark)	3.5	Basement floor and walls conforming to BS 8102:2009 Grade 3 Waterproofing (2.5)	NA	Ventilated car park (floor slab of occupied part of the building under construction is underlain by a basement or undercroft car park.	6.5

				Assumes that the car park is vented to deal with exhaust fumes designed to Building Regulations 2000, Approved Doc F (4)	
Type C Building (pre-cast suspended floor)	2.5	Suspended Ground Floor i.e. beam and block or planks (0)	Gas resistant membrane designed, installed and verified in accordance with BS8485 (2)	Ventilated sub-floor void and external air bricks and ventilation of internal sleeper walls providing good or very good ventilation (1.5 to 2.5)	3.5 to 4.5
Type C Building (reinforced cast in-situ suspended (piled) floor slab with minimal penetrations)	2.5	Reinforced cast in-situ suspended floor slab with minimal penetrations (1 to 1.5)	Gas resistant membrane designed, installed and verified in accordance with BS8485 (2)	Pressure relief pathway (usually formed of low fines gravel of with a thin geocomposite blanket or strips termination in a gravel trench external to the building (0.5)	3.5 to 4.0
Type C Building (with basement carpark)	2.5	Basement floor and walls conforming to BS 8102:2009 Grade 3 Waterproofing (2.5)	NA	Ventilated car park (floor slab of occupied part of the building under construction is underlain by a basement or undercroft car park. Assumes that the car park is vented to deal with exhaust fumes designed to Building Regulations 2000, Approved Doc F (4)	6.5

The foregoing assessment has been provided for guidance purposes only and is not intended to comprise a design, as we do not wish to prejudice the ability of the Consultant involved in the development phase of the site to undertake their own assessment. Once the development team for Phase 2 development works has been confirmed, a detailed design for the ground gas protection measures should be prepared in full accordance with BS8485:2015 + A1:2019 and a Verification Plan produced.

We would further note that should ground conditions after completion of the Phase 1 enabling works differ significantly from those present at the time of our works, it may be necessary to re-monitor and reassess the site or areas of the site.

Similarly should remediation works, following tank removal/validation etc, result in the presence of locally elevated levels of volatile organics/hydrocarbons in the ground (for example where the practical limit of excavation is reached leaving contamination in the ground) it may be necessary to upgrade the ground gas membrane to a ground gas and hydrocarbon/vapour resistant membrane to address residual contamination.

3.2.4 Cross Contamination/Segregation

Visually clean and contaminated materials, together with materials with different properties should be carefully stripped and mounded separately prior to decisions regarding re-use/disposal. Care should be taken to ensure that visually clean materials are segregated from contaminated materials.

Should any visually contaminated materials be encountered, this should be segregated from clean materials and subject to further inspection, analysis and final decisions regarding the re-use or disposal, as appropriate.

Materials management should be designed to ensure that cross contamination does not take place on the site.

3.2.5 Off-site Disposal

Any materials proposed for off site disposal should be taken to a suitably licensed waste disposal facility with appropriate chain of custody documentation. Materials requiring disposal should typically be temporarily stockpiled, tested/classified (to include WAC testing as appropriate) prior to disposal.

3.2.6 Construction Workers

It is recommended that construction personnel involved with direct contact with the soils at the site use appropriate PPE/RPE equipment (as required together with welfare facilities in accordance with general health and safety guidelines). A site Health and Safety file should be prepared and include copies of our reports (together with a CAR risk assessment to be produced by others – as appropriate).

3.2.7 Utilities

We would recommend that this report together with our previous reports are supplied to utility companies (including water supply), and that their recommendations relating to appropriate supply pipes are adhered to.

Consideration should be given to the use of ventilated manhole covers to mitigate against the build up of Carbon Dioxide in manhole chambers. We consider that manhole chambers should be considered as confined spaces, with monitoring prior to entry etc.

3.2.8 Licenses, Permits, Registrations and Approvals

The Contractor/Developer is responsible for, and must ensure that, all necessary licenses, permits, registrations, plans and approvals are in place prior to commencing with the works at the site. These will include any Mobile Treatment Licenses (MTLs), Site Waste Management Plans / Materials Management Plans and/or Environmental Licenses/Exemptions as necessary to enable the completion of the proposed works.

A MMP should be accompanied by a suitable Qualified Persons Declaration (QPD) and will require verification in due course.

We understand that Wates has instructed a suitable consultant to prepare a MMP for the site.

3.2.9 Unexploded Ordnance

We understand that Wates has appointed a suitable UXO consultant with respect to advice regarding the enabling earthworks and piled foundations at the site.

3.2.10 Piling Works

We understand that potentially CFA piles are proposed for the site. The design of piles and production of a foundation works risk assessment (or similar) to the satisfaction of the EA will be the responsibility of others.

3.2.11 Statutory Consultation

In accordance with normal planning requirements, we would recommend that a copy of our report, and our previous reports, are issued by the Client to the Local Planning Authority (and any necessary consultees such as the Environment Agency) for information purposes (as Planning Condition 3 has already been discharged).

The enabling earthworks (Phase 1) element of this report should be utilised by Wates to inform Phase 1 works. The RMS will also inform the subsequent production of a Materials Management Plan (MMP) for the site, which we understand that Wates are in the process of completing.

The guidance provided in respect to development Phase 2 works may be used by Wates (or successor) and the Consultant responsible for Phase 2 works onward, to assist in informing their design as appropriate.

3.2.12 Validation

Validation works will be required at the site for both Phase 1 (enabling) and Phase 2 (development) works, as detailed within this RMS. Phase 2 (development) works will also require a Verification Plan (to be prepared by the Phase 2 design team) to confirm the design and verification required for ground gas protection measures to protect end users taking account of differing build types (Type B or Type C) etc.

4.0 CONCLUSIONS

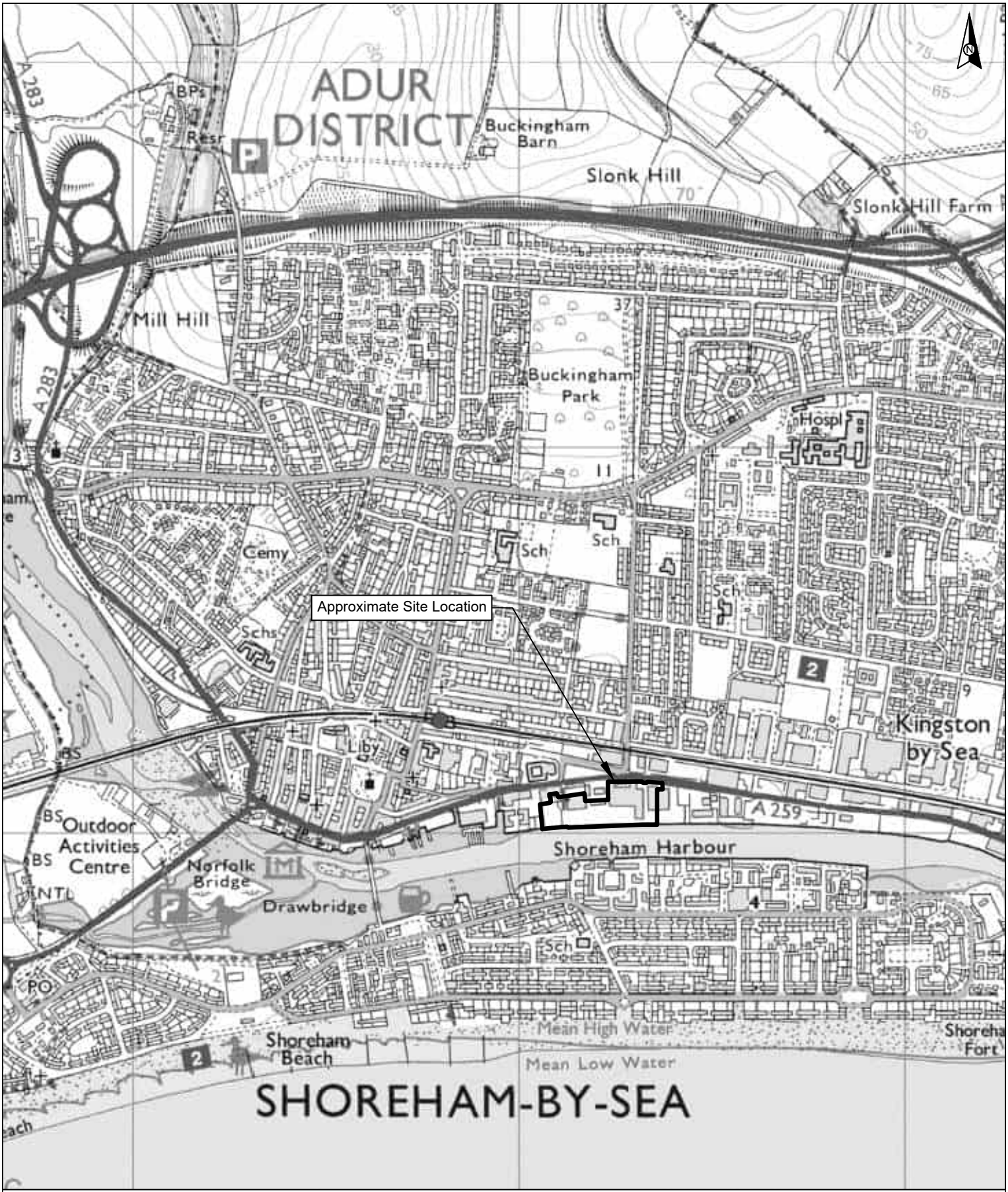
To the best of our knowledge, this RMS has been prepared to be compliant with the requirements of the Local Planning Authority and Environment Agency.

Nevertheless, this RMS represents a 'living document' and may be subject to revision following receipt of comments from regulatory authorities or to take account of findings on site or changes to development proposals.

GeoDyne

APPENDIX I

Site Location Plan



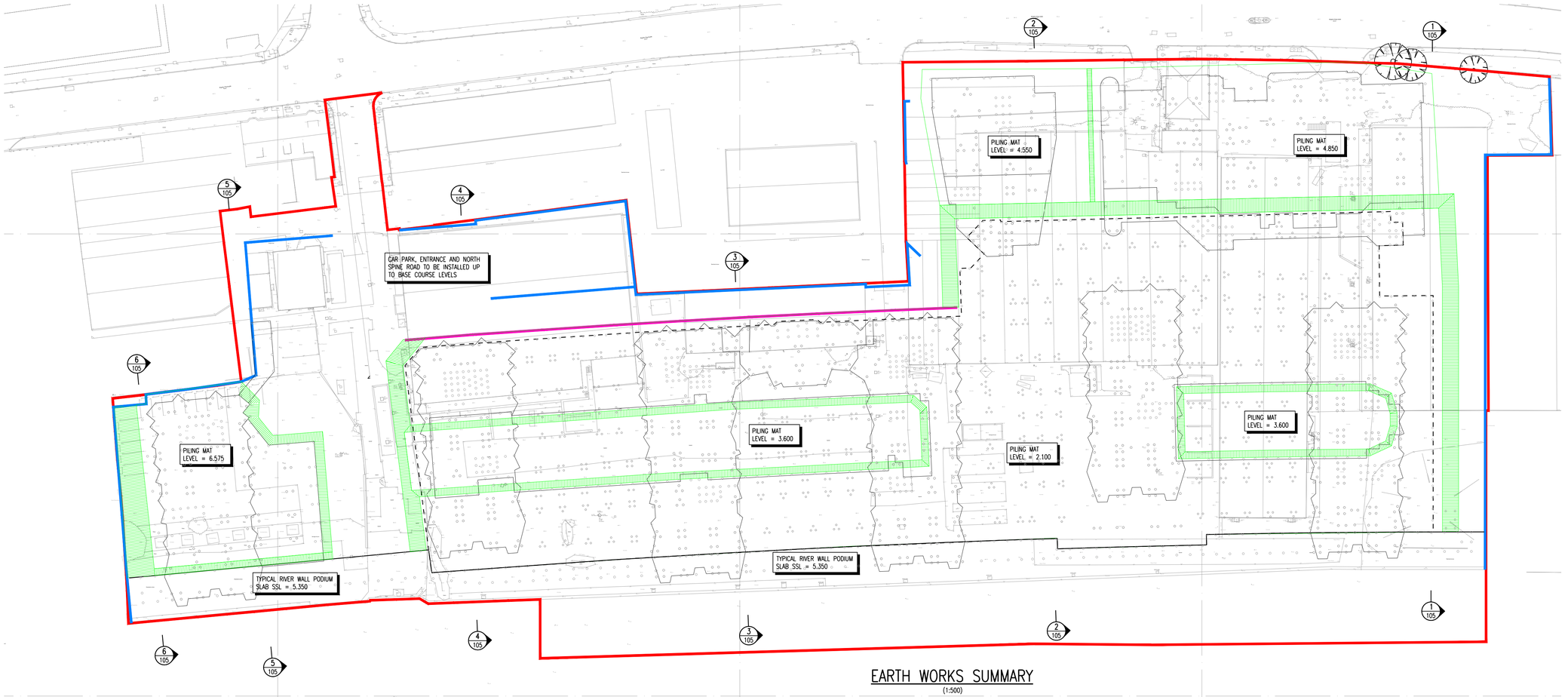
Project No.	31149	Drawn By	ACH
Client	Wates Construction Ltd	Checked By	CJP
		Approved By	JPH
Project	Brighton Road, Shoreham	Scale	NTS
		Date Drawn	23/05/2019
Title	Site Location Plan	Revision	
		Figure No.	31149/RMS/01

GeoDyne
Nottingham 0115 962 0001
Derby 01332 290 798
Warrington 01925 661739
info@geodyne.co.uk
www.geodyne.co.uk

GeoDyne

APPENDIX II

Plans Showing Proposed Wates Phase I Enabling Works and Proposed Site Layout



EARTH WORKS SUMMARY

(1:500)

Project/Task No. 14576 Scale: AS SHOWN ORIGINAL DRAWING SIZE A1

1. GENERAL

(i) This drawing is not to be scaled, work to figured dimensions only, confirmed on site.

(ii) This drawing is to be read in conjunction with all relevant architectural drawings, detailed specifications where applicable and all associated drawings in this series.

(iii) Any discrepancy on this drawing is to be reported immediately to the partnership for clarification.

(iv) The contractor is responsible for all temporary works and for the stability of the works in progress.

(v) See drawing 14576-HOP-EN-XX-DR-S-0105 for sections.

2. REFER TO DRAWING 14576-HOP-EN-XX-DR-S-6003 FOR ADDITIONAL NOTES

LEGEND

- DENOTES SITE BOUNDARY
- DENOTES CHANGE IN PILE MAT LEVEL
- DENOTES EXTENT OF WORKING PLATFORM
- TEMPORARY STEEL SHEET PILED WALL SEE DRAWING 14576-HOP-EN-XX-DR-S-0104
- DENOTES RETAINING WALL SEE DRAWING 14576-HOP-EN-XX-DR-S-0104

SITE INVESTIGATION

REFER TO SITE INVESTIGATION REPORTS LISTED BELOW BY GEODYNE FOR FULL DETAILS.

COMBINED PHASE I DESK STUDY AND INITIAL PHASE II EXPLORATORY INVESTIGATION FOR OPTIMISATION DEVELOPMENTS LTD DATED 28/09/2012

COMBINED GROUND INVESTIGATION AND GEOPHYSICAL SURVEY REPORT FOR BSCP LTD AND WM MORRISONS DATED 09/07/2013

REVIEW OF PREVIOUS REPORTS AND SUPPLEMENTARY PHASE II EXPLORATORY INVESTIGATION FOR THE NEWBRIDGE GROUP / SOUTHERN HOUSING GROUP DATED 30/06/2015

NOTE

ALL BOUNDARY WALL DEMOLITION TO BE SUITABLY PLANNED AND TAKE ACCOUNT OF USERS AND PARTY WALL AGREEMENTS, SUITABLY COORDINATED WITH FENCE/WALL CONSTRUCTION

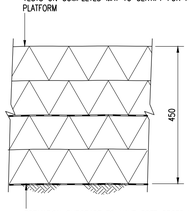
PILING MAT

GOOD QUALITY GRANULAR MATERIAL SHOULD BE USED FOR THE WORKING PLATFORM eg. 6F2/TYPE 1.

- IT SHOULD BE FREE FROM ORGANIC MATTER.
- IT SHOULD NOT CONTAIN MORE THAN 15% FINES (IE NOT MORE THAN 15% BY WEIGHT OF PARTICLES OF SILT AND CLAY SIZE).
- IT SHOULD BE FREE DRAINING.
- IT SHOULD BE DURABLE AND NOT EASILY DEGRADED WITHIN THE DESIGN LIFE OF THE PLATFORM.
- THE MAXIMUM PARTICLE SIZE SHOULD NOT BE GREATER THAN 2/3 OF THE THICKNESS OF THE LAYERS IN WHICH MATERIAL IS COMPACTED OR 150mm WHICHEVER IS THE LESSER

PROVIDE 450mm THICK LAYER OF CRUSHED CONCRETE 6F2 OR TYPE 1 ON SUBGRADE WITH TERRAM 1000 OR SIMILAR NON WOVEN GEOTEXTILE AND CENTRAL LAYER OF TENSAR TRIAX TX20 OR SIMILAR APPROVED – UNDERTAKE PLATE BEARING TESTS ON COMPLETED MAT TO CERTIFY FOR PILING PLATFORM

PRELIMINARY PILING MAT DESIGN SUBJECT TO CONFIRMATION OF PILING RIG LOADS



FORMATION SUBGRADE TO HAVE SOFT SPOTS EXCAVATED, BACKFILLED AND COMPACTED WITH SUITABLE MATERIAL – MIN. CBR OF 14%

ASSUMED PILING RIG LOADING

TYPE	WIDTH	LENGTH	Q_1	Q_2
CFA	0.7m	3.15m	103kN/m²	206kN/m²

IF LOADING OF SELECT RIG IN EXCESS OF ASSUMED LOADING, PILING MAT DESIGN WILL NEED TO BE REVISED

DETAIL OF PILING MAT

(1:10)

NOTE

DEMOLITION CARRIED OUT IN ACCORDANCE WITH BS 6187:2011

ALL SERVICES TO BE DISCONNECTED AND/OR SEALED PRIOR TO DEMOLITION WORKS STARTING ON SITE.

ALL EXISTING SUBSURFACE OBSTRUCTIONS TO BE REMOVED INCLUDING EXISTING FOUNDATIONS AND SLABS, HISTORIC CRANE RAILS AND FEATURES, WEYBRIDGES, HOPPERS ETC.

WASTE TIMBER AND OTHER COMBUSTIBLE MATERIALS TO BE TAKEN OFF-SITE TO AN APPROPRIATE TIP FOR DISPOSAL. BURNING ON SITE IS PROHIBITED

ENSURE THAT ANY ASBESTOS MATERIAL, TO WHICH THE ASBESTOS (LICENSING) REGULATIONS 2012 APPLY, IS CAREFULLY REMOVED, BY A LICENSED CONTRACTOR, WITH FULL CONTAINMENT THROUGHOUT IN ACCORDANCE WITH THOSE REGULATIONS.

SEE ASBESTOS SURVEY CARRIED OUT BY ENV SURVEYS LTD. REFERENCE S0914/51 FOR LOCATIONS OF IDENTIFIED ASBESTOS AND RECOMMENDED ACTIONS THEREIN.

IN THE EVENT THAT A SUSPECT MATERIAL IS DISCOVERED WORKS SHOULD IMMEDIATELY CEASE, THE AREA SEALED OFF, AND THE MATERIAL ANALYSED BY A UKAS ACCREDITED LABORATORY. ANY SUBSEQUENT ACTIONS WILL BE DEPENDENT UPON THE ANALYSIS RESULT.

ENSURE THAT ANY OTHER ASBESTOS MATERIALS ARE HANDLED SAFELY IN THE FOLLOWING MANNER:
- CAREFULLY REMOVE BY HAND, BEFORE DEMOLISHING THE REST OF THE STRUCTURE.
- KEEP THE MATERIAL DAMP TO AVOID ASBESTOS DUST BECOMING AIRBORNE.
- AVOID, SO FAR A PRACTICABLE, BREAKING OR DAMAGING MATERIAL.
- PLACE MATERIAL CAREFULLY INTO A SKIP, WITHOUT THROWING.
- COVER THE SKIP WITH A TARPAULIN OR OTHER EFFECTIVE COVER BEFORE REMOVAL FROM THE SITE.

ALL CONCRETE AND FOUNDATIONS ETC. TO BE CRUSHED TO 6F2 SPECIFICATION AND SUITABLY STOCKPILED ON-SITE FOR RE-USE AS WORKING PLATFORM.

ALL EXCAVATIONS AND SOFT SPOTS TO BE IDENTIFIED, FILLED AND COMPACTED WITH TYPE II SUB-BASE, HARDCORE OR SIMILAR APPROVED PRODUCT, LAID AT OPTIMUM MOISTURE CONTENT. FILL TO BE COMPACTED IN LAYERS IE. 150mm THICK WITH 7T VIBRATING ROLLER AND A MINIMUM OF 7 PASSES. COMPACTION WITHIN 1700mm OF WALLS TO BE WITH A VIBRATING PLATE OR SIMILAR

ALL PROPOSED PILE LOCATIONS WITHIN ENABLING WORKS TO BE PROPOSED TO CONFIRM NO OBSTRUCTION PRIOR TO PILING WORKS COMMENCING

WORKING PLATFORM TO BE INSTALLED TO LEVELS INDICATED WITH GOOD QUALITY SITE CRUSHED 6F2 MATERIAL AS WORKING PLATFORM DETAIL INCLUDING TERRAM OR SIMILAR GEOTEXTILE MEMBRANE AND CENTRAL LAYER OF TENSAR GEOGRID OR SIMILAR

ESTIMATED EXCAVATION VOLUMES, RE-USE AND OFF SITE REMOVAL

EXISTING SITE LEVEL ASSUMED AS 4.1m AOD THROUGHOUT

1. EXCAVATE AND CRUSH EXISTING CONCRETE FOR PILING MAT

	AREA	VOLUME	NOTES
WHARF AND BUILDING SLABS (ASSUMED AS 240mm THROUGHOUT)	26260 m²	5357 m³	ASSUMED 85% OF SITE AREA, 240mm THICK
TIES ANCHOR BLOCKS (ASSUMED 100 No. AT 2m³)		100 m³	
BUILDING PAD FOUNDATIONS (ASSUMED 125 No. AT 1.5m³)		188 m³	
BUILDING STRIP FOUNDATIONS (ASSUMED 150m No. AT 0.2m²/m)		30 m³	
ESTIMATED ADDITIONAL FROM DEMOLISHED CONVEYOR, CRANE RAIL ETC.		500 m³	
	TOTAL	6175 m³	
ASSUMED BULKING FACTOR OF 30% ON CRUSHED MATERIAL		8027 m³	
EXISTING ON SITE STOCK PILE		1000 m³	
	TOTAL	9027 m³	TOTAL CRUSHED MATERIAL FROM EXISTING SITE

2. REDUCE DIG/FILL TO PILING MAT/ROAD FORMATION LAYER

3.86m REDUCED TO 1.65m (2.1m AOD PILING MAT)	10873 m²	24029 m³	
3.86m REDUCED TO 1.65m (RIVER FRONT)	1200 m²	2652 m³	
3.86m REDUCED TO 3.15m (3.6m AOD PILING MAT)	2490 m²	1768 m³	
3.86m FILLED TO 6.1m (6.55m AOD PILING MAT)	1387 m²	-3107 m³	
3.86m FILLED TO 4.4m (4.85m AOD PILING MAT)	2149 m²	-1160 m³	
3.86m FILLED TO 4.1m (4.55m AOD PILING MAT)	1010 m²	-242 m³	
3.86m FILLED TO 5.4m (ACCESS ROADS)	2861 m²	-4406 m³	
	TOTAL	19534 m³	NET EXISTING REMOVED FROM SITE, ESTIMATED BREAKDOWN:
			ESTIMATED INERT MUCK AWAY (90%) 17580m³
			ESTIMATED STABLE NON-REACTIVE (NON-REACTIVE) (7.5%) 1465m³
			ESTIMATED HAZARDOUS (2%) 391m³
			ESTIMATED ASBESTOS CONTAINING MATERIAL (0.5%) 98m³

3. PLACE WORKING PLATFORM

AREA REQUIRED FOR WORKING PLATFORM (450mm THICK)	18493 m²	8322 m³	
	TOTAL	8322 m³	TOTAL PILING MAT VOLUME REQUIRED
POTENTIAL SURPLUS CRUSHED MATERIAL (6F2) NOT REQUIRED		705 m³	FOR DISPOSAL (ADDITIONAL TO NET EXCAVATION SURPLUS)

ISSUED FOR TENDER	P.M	J.S	02.07.18	P1
Description	By	Aprvd.	Date	Rev.

TENDER DRAWING
NOT FOR CONSTRUCTION

Title: EARTH WORKS SUMMARY GENERAL ARRANGEMENT

Project: FREE WHARF – ENABLING WORKS SHOREHAM-BY-SEA

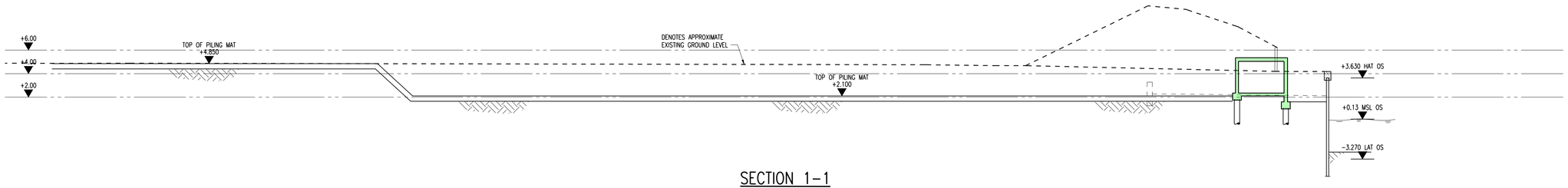
Client: SOUTHERN HOUSING GROUP

HOP
CONSULTING CIVIL AND STRUCTURAL ENGINEERS
HOP House, 41 Church Road
Hove, East Sussex BN3 2BE
www.hop.uk.com
ask@hop.uk.com
+44 (0)1273 223900

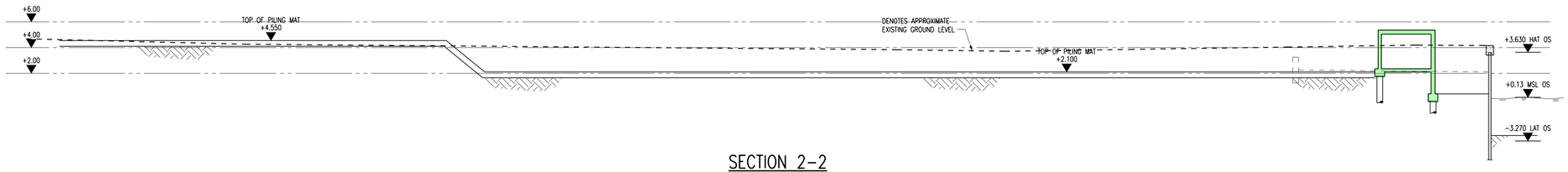
Drawing No. 14576-HOP-EN-XX-DR-S-0104 Status D2 Rev. P1

1:20 0 0.2m 0.4m 0.6m 0.8m 1m
1:50 0 0.5m 1m 1.5m 2m 2.5m
1:100 0 1m 2m 3m 4m 5m

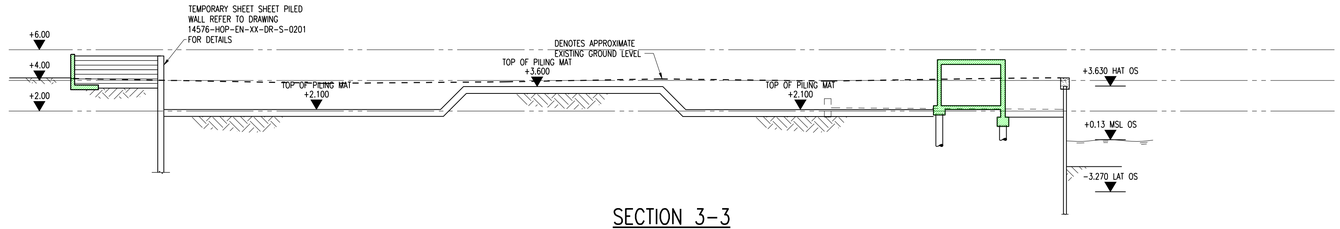
P:\PROJECTS\14576 Free Wharf, Brighton Road, Shoreham\Drawings\HOP\14576-HOP-EN-XX-DR-S-0104 Earth Works Summary GA Peter Mitchell



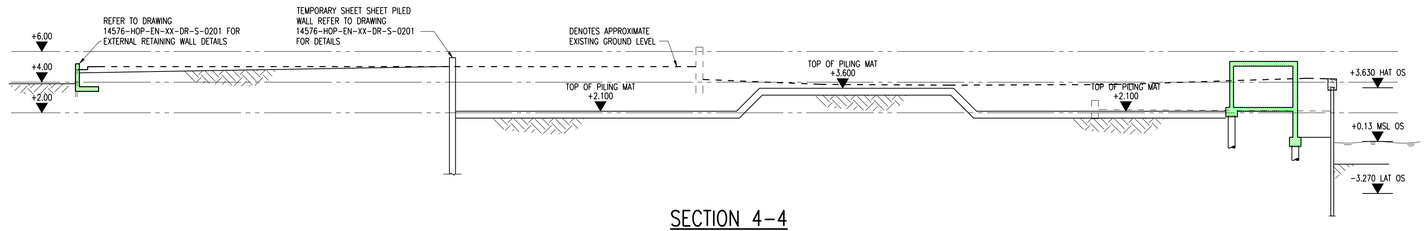
SECTION 1-1
(1:200)



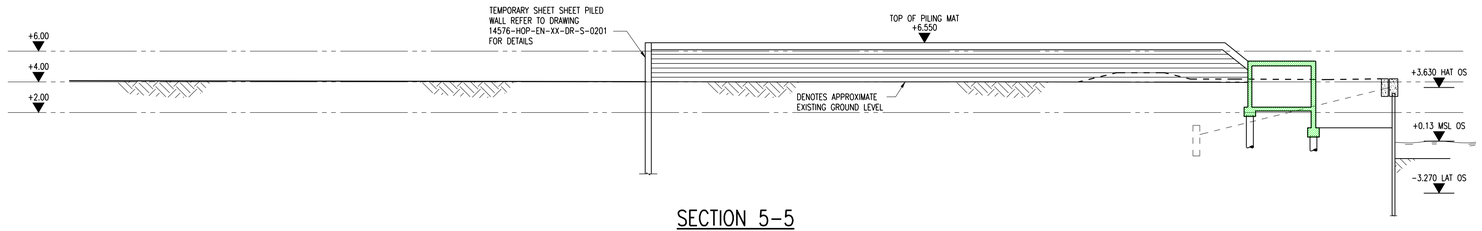
SECTION 2-2
(1:200)



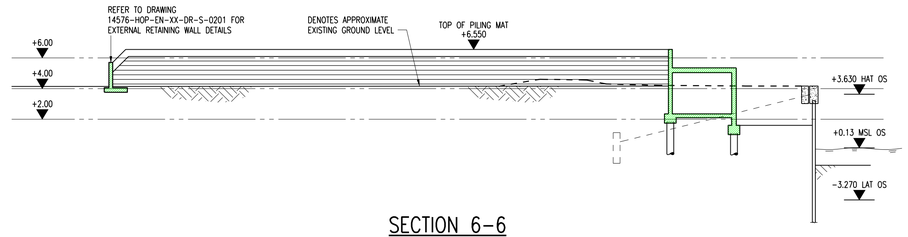
SECTION 3-3
(1:200)



SECTION 4-4
(1:200)



SECTION 5-5
(1:200)



SECTION 6-6
(1:200)

Project/Task No. 14576 Scale: AS SHOWN ORIGINAL DRAWING SIZE A1

1. GENERAL

(i) This drawing is not to be scaled, work to figured dimensions only, confirmed on site.

(ii) This drawing is to be read in conjunction with all relevant architectural drawings, detailed specifications where applicable and all associated drawings in this series.

(iii) Any discrepancy on this drawing is to be reported immediately to the partnership for clarification.

(iv) The contractor is responsible for all temporary works and for the stability of the works in progress.

2. REFER TO DRAWING 14576-HOP-EN-XX-DR-S-6003 FOR ADDITIONAL NOTES

REFER TO DRAWING 14576-HOP-EN-XX-DR-S-0104 FOR DETAILS OF PRELIMINARY PILE MAT

REFER TO DRAWING SERIES 14576-HOP-EN-XX-DR-S-200 FOR DETAILS OF EXTERNAL RETAINING WALLS

REFER TO DRAWING SERIES 14576-HOP-EN-XX-DR-S-300 FOR DETAILS OF NEW RIVER WALL STRUCTURE

Description	By	Aprvd.	Date	Rev.
ISSUED FOR TENDER	P.M	J.S	02.07.18	P1

TENDER DRAWING
NOT FOR CONSTRUCTION

Title
EARTH WORKS SUMMARY
SECTIONS SHEET 1

Project
FREE WHARF - ENABLING WORKS
SHOREHAM-BY-SEA

Client
SOUTHERN HOUSING GROUP

HOP
CONSULTING CIVIL AND STRUCTURAL ENGINEERS
HOP House, 41 Church Road
Hove, East Sussex BN3 2BE
www.hop.uk.com
ask@hop.uk.com
+44 (0)1273 223900

Drawing No. 14576-HOP-EN-XX-DR-S-0105 Status D2 Rev. P1

1:20 0 0.2m 0.4m 0.6m 0.8m 1m
1:50 0 0.5m 1m 1.5m 2m 2.5m
1:100 0 1m 2m 3m 4m 5m