
Detailed Quantitative Risk Assessment for Controlled Waters

at
Crown Quay Lane,
Sittingbourne, Kent,
ME10 3JJ

for
Bellway Homes (Kent
Division) Ltd

Report Reference : LP2448

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EXECUTIVE SUMMARY

The site comprises a disused parcel of land which extends to about 2ha in area, situated to the north east of Crown Quay Lane, Sittingbourne, Kent. It is proposed to redevelop the site with 107 No. residential dwellings.

The site has a history of industrial uses and operated most recently as an illegal waste transfer facility, which resulted in stockpiled wastes being deposited across the site. The stockpiled wastes were subsequently processed in 2016/17 for potential reuse to raise site levels for the development and currently remain on site.

The site is bound to the north and east by the tidal Milton Creek. A culverted stream is present in the west of the site, assumed to discharge to the Milton Creek. The exact location of the culvert has not been fully determined.

Intrusive site investigations completed by LEAP between 2013 and 2019 have recorded that the site is underlain by made ground deposits to varying depth of between 2.8m and 7.4m below ground level. The deepest made ground was recorded in the location of the backfilled wharf in the north western part of the site. The made ground is underlain by Alluvium (Secondary Undifferentiated aquifer) to depths of between 6.0m and 7.4m, over the White Chalk Subgroup (Principal aquifer) proven to 25m below ground level.

The site is located within groundwater Source Protection Zones 1 and 2, associated with abstractions from the chalk aquifer. The nearest abstraction borehole is located some 466m north east of the site.

The monitoring works completed have recorded groundwater within two distinct aquifer units, being within the alluvium (shallow groundwater) between 1.35m and 2.25m below ground level and also within the chalk aquifer (deep groundwater) which exhibited sub-artesian conditions. The shallow groundwater was shown to be partially influenced by tidal conditions and therefore in hydraulic continuity with the adjacent surface water feature.

Chemical analysis of soils and groundwater beneath the site (including a recent groundwater monitoring visit in November 2020) has recorded elevated concentrations of metals, PAHs, petroleum hydrocarbons and asbestos containing materials.

The completed risk assessment has identified a risk to the adjacent Milton Creek surface water from the elevated levels of petroleum hydrocarbons, PAHs and to a lesser degree from lead, copper and nickel in shallow groundwater on site. In addition, PAHs recorded in the chalk groundwater (BH3) are above the respective Drinking Water Standards.

A preliminary RTM assessment has predicted no measurable impact within the chalk aquifer beyond 120m from the borehole.

Outline recommendations for remediation of the made ground/soils and shallow groundwater in respect PAHs, petroleum hydrocarbons and metals to protect the adjacent Milton Creek have been provided.

A detailed remediation strategy and implementation plan is to be prepared. This will need to consider all development aspects including final development scheme and layout, development phasing, proposed foundation methodology and the proposed reuse of processed material on site – currently subject to a waste recovery application.

Signed :	 Marc Perry BEng CGeol FGS
Countersigned :	 Darren Beesley BSc MSc C.WEM
Date :	29 January 2021
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A INTRODUCTION

1 Authority

Leap Environmental Ltd (hereafter referred to as **LEAP**) has been appointed by Bellway Homes (Kent Division) to prepare a Detailed Qualitative Risk Assessment in support of the redevelopment for residential housing at a site referred to as Crown Quay. The instruction was given in an email dated 5th January 2021 from Paul Richie of Bellway Homes.

2 Objective

LEAP understands that the site is currently owned by Bellway Homes and it is proposed to redevelop the site with 107 No. residential dwellings as per the attached layout in Figure 2, Appendix B.

The objective of this report is to provide a risk assessment in respect to controlled waters from the recorded contamination present beneath the site within the soils and groundwater.

The findings of the report will be used to inform a remediation method statement and implementation plan for the redevelopment and identify appropriate remedial targets where necessary.

3 Previous Studies

The site has been the subject of previous investigations by **LEAP**.

The reader is referred to these earlier reports which should be read in conjunction with this report.

- Preliminary Contamination Risk Assessment (LP00584), dated 30th September 2013
- Investigation Report and Asbestos Risk Assessment (LP00716), dated 6th June 2014
- Phase II Geotechnical Report (LP01205), dated 3rd March 2017
- Material Processing Closure Summary (LP01205), dated 27th April 2017
- Phase II Contamination Report (LP01205), dated 25th July 2017
- Phase III Site Investigation Report (LP1802), dated 28th February 2019
- Stockpile Reuse Assessment (LP2248) Dated 25th January 2021

4 Scope of Works

To develop a numerical assessment and identify the risks posed to the environment from the recorded contamination, together with remediation criteria and inform the development of a remediation method statement/implementation plan.

5 Limitations

This report has been prepared by Leap Environmental Ltd on the basis of information received from a variety of sources which Leap Environmental Ltd believes to be accurate. Nevertheless, Leap Environmental Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

Leap Environmental Ltd has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed.

The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk.

Full details of the limitations are provided in Appendix A.

B SITE SETTING

6 Environmental Setting

6.1 Site Location and Description

The site is located to the north east of Crown Quay Lane, Sittingbourne in Kent at the approximate National Grid Reference TQ 9108 6423. The site extends to an area of some 2Ha. A site location plan and current site layout are included as Figures 1 and 2 respectively, presented in Appendix B.

The site is bound to the north and east by the tidal Milton Creek and an associated tributary, to the south by a timber yard and to the west by Crown Quay Lane, with further commercial/ industrial units beyond.

The site has historically been used as a soil treatment/ transfer facility, which was determined to have operated without an Environmental Permit. The activity resulted in the stockpiled materials on site being deemed as illegal wastes. Assessment and remediation of the materials has been completed (March 2016 & January 2021) and is summarised separately within previous reports (LEAP LP1205/contam & LP2248/stockpile reuse). The treated materials resulting from remedial works form a series of stockpiles currently located in the central region of the site.

With the exception of a small electricity sub-station, no above ground structures were present at the time of the investigation. The western half of the site is predominantly formed of concrete hardstanding, with the eastern part being vegetated soils and stockpiles.

6.2 Ground Conditions

The geology of the site has been ascertained by reference to the 1:50,000 British Geological Survey sheet, the BGS website (www.bgs.ac.uk) and from intrusive investigation works completed by LEAP. The site is mapped as being underlain by Alluvium overlying the Thanet Formation (north eastern corner) and White Chalk Subgroup (Seaford Chalk Formation) over the remainder of the site.

The previous intrusive investigations have recorded made ground to be present across the site extending to depths of between 2.80m and 7.4m below ground level. The recorded deepest made ground was located within the footprint of the backfilled wharf. The made ground composed of clay and sand containing a variable thickness of flint, brick, chalk, ash, concrete and clinker. Alluvial and organic odours were recorded within the made ground soils. Alluvium was recorded underlying the made ground soils to depths of between 6.00m and 7.4m, with deposits of the White Chalk Subgroup being encountered to the full depth of investigation of 25m.

No deposits of the Thanet Formation were recorded as part of this investigation, although the published BGS Mapping indicated that they should be present.

6.3 Hydrogeology

The underlying alluvium are classified as a Secondary (undifferentiated) aquifer, with White Chalk Subgroup is classified as a Principal aquifer.

The site is largely situated within a groundwater Source Protection Zone 1 (SPZ1), with a groundwater Source Protection Zone 2 (SPZ2) located over the north eastern part of the site. The nearest recorded abstractions are located some 466m north east (paper and printing process), 897m west (food and drink process water) and 1363m east (drinking water). The groundwater Source Protection Zones are associated with abstractions from the underlying Chalk aquifer.

Based on the findings of previous intrusive investigations, two groundwater bodies are present beneath the site, being a shallow aquifer (associated with the made ground and alluvium) and deep aquifer (within the chalk).

The shallow groundwater has been determined as flowing generally to the north, towards the Milton Creek, and in hydraulic continuity. The Milton Creek is tidal and has been identified to have a limited tidal influence on the shallow groundwater beneath the site.

The deep chalk groundwater flow direction has been recorded as flowing approximately to the west/north west, towards the groundwater abstractions. Some variability in flow direction has been recorded, considered to relate to the influences from the individual pumping regimes and the regional groundwater flow.

6.4 Hydrology

The northern and north eastern extents of the site are bounded by the Milton Creek. Additionally, a culverted stream (flowing from south to approximately north) is shown to present on the western side of the site, which discharges to the Milton Creek. The exact position and route across the site of the culvert has not been fully determined, with no definitive discharge point from the site into the Milton Creek being identified.

7 Summary of Previous Reports

7.1 LEAP Reports 2013-2021

LEAP completed a number of reports for the site, predominantly relating to the assessment of waste materials that had been deposited at the site, together with verification of the material following treatment works.

Assessment of Waste Stockpiles

An initial assessment of the on-site waste stockpiles was completed by LEAP (LP584), with the material described as comprising sandy clay to clay based soils with variable quantities of materials present including metal, plastic glass, wood, ash, clinker and general construction wastes (concrete, brick and asphalt). In some stockpiles, evidence of occasional suspected asbestos containing materials was noted.

Chemical analysis results of samples of the stockpiled materials indicated low levels of total petroleum hydrocarbons present (TPH maximum concentration of 52µg/l), with low concentrations of metals (lead and copper). The risk assessment concluded that leachates generated from the stockpiled materials posed a very low risk to surface water (Milton Creek).

The stockpiled wastes processed by Keltbray Remediation during 2016/2017. This included the segregation and removal of visible asbestos containing materials and the screening and crushing of oversize materials. The materials were subject to extensive validation testing to confirm the suitability of the material for future reuse. The material was considered chemically and geotechnically suitable for reuse to raise levels for the proposed residential development.

Stockpile Reuse Risk Assessment

An assessment of chemical suitability of the stockpiles was completed in support of a Waste Recovery Plan submission. The assessment included the review of additional leachate analysis of samples collected from the stockpiles, together with the development of a detailed conceptual model.

The leachate analysis identified low concentrations of a small number of non-hazardous contaminants and also for lead. These relative concentrations were considered to be marginal/slight exceedances of the assessment criteria. The report conclude that the reuse of the material as general fill is suitable and would not result in any measurable deterioration in the quality of controlled waters, specifically the adjacent Milton Creek.

Recommendations were included on the reuse the materials to reduce potential leachate generation and limit any potential impacts to controlled waters from occurring.

Ground Investigation

Further intrusive investigation works of the site were completed (LPI205/contam) which considered the contamination risks present at the site relating to the previous/historic site activities posed to the proposed redevelopment of the site. In addition, the report provided recommendations for further investigation and monitoring works.

Intrusive investigations included the sampling of shallow soils/made ground by trial pits and windowless sampler methods. Cable percussion boreholes were also drilled into the Chalk, with combined gas and groundwater monitoring wells being installed.

Made ground was recorded to be present across the site extending to depths of between 2.80m and 7.4m below ground level. The deepest recorded made ground was located within the footprint of the backfilled wharf. The made ground composed of clay and sand containing a variable thickness of flint, brick, chalk, ash, concrete and clinker. Alluvial and organic odours were recorded within the made ground soils.

Alluvium was recorded underlying the made ground soils to depths of between 6.00m and 7.4m, with deposits of the White Chalk Subgroup being encountered to the full depth of investigation of 25m.

Assessment of chemical analysis of soils recorded elevated concentrations of metals and benzo(a)pyrene within the made ground, with levels of petroleum hydrocarbons indicative of potential free phase product to be present.

The petroleum hydrocarbon contamination was also considered to represent a vapour risk to future end-users.

Samples of groundwater were collected from both the shallow and deep groundwater, with chemical analysis reporting elevated concentrations of metals, PAHs and petroleum hydrocarbons in the shallow groundwater. The identified groundwater contamination is consistent with the recorded soil contamination. Some evidence of tidal influence on shallow groundwater levels was indicated but based on limited monitoring data. It was concluded that the shallow groundwater contamination posed a potential risk to surface water receptors (Milton Creek).

Within the deep Chalk groundwater, very low concentrations of PAHs and petroleum hydrocarbons were recorded, together with groundwater levels exhibiting sub-artesian groundwater conditions.

The investigation works included monitoring of ground gases which recorded elevated concentrations of methane and carbon dioxide. Following the completion of a detailed gas risk assessment, recommendations for gas protection measures for the proposed development were provided.

Outline remediation recommendations included the allowance for a clean cover system in proposed gardens should be made, together with an additional allowance for further excavation of localised areas of deeper contaminated soils.

7.2 Phase III Site Investigation Report (LP1802, dated 28th February 2019)

The Phase III investigation works were to provide an updated controlled waters risk assessment, with the installation of an additional five shallow monitoring wells. Groundwater monitoring and sampling was also completed to confirm any tidal influence on the shallow groundwater and any changes in contaminant levels. Additionally, further gas monitoring was completed to allow further refinement of the zonation for gas protection measures across the site.

Variability and potential influence of tidal conditions was assessed with the installation of groundwater data loggers within six boreholes (WS101, WS103, WS105, WS201, WS202 and WS203). Groundwater levels were monitored for a period of 4 weeks between 10th January and 8th February 2019, recording groundwater levels at 5-minute intervals. The boreholes were selected to provide coverage across the site, accounting for the proximity of the tidal Milton Creek and where groundwater was present.

The recorded groundwater levels ranged between 2.03mAOD (WS015) and 3.88mAOD (WS202). No groundwater was recorded in boreholes WS204 and WS205 throughout the duration of the monitoring.

Groundwater levels within the deep boreholes installed in the chalk aquifer ranged between 1.40mAOD (BH2) and 1.77mAOD (BH4), indicating sub-artesian groundwater conditions to be present.

The following table presents a summary of the recorded groundwater levels determined through the groundwater level loggers. The ground level (as mAOD) at the location of the monitoring well is also included in the table.

Table 1: Summary of Groundwater Level Variability

Monitoring Well	Minimum Groundwater Level (mAOD)	Maximum Groundwater Level (mAOD)	Monitoring Well Ground Level (mAOD)	Minimum Unsaturated Zone Thickness (m)	Evidence of Tidal Influence?
WS101	2.98	3.46	4.81	1.35	None
WS103	2.28	3.22	5.17	1.95	Some
WS105	2.05	2.63	4.88	2.25	None
WS201	2.32	2.63	4.85	2.22	Some
WS202	2.90	4.30a	4.26	1.36 ^b	Yes
WS203	2.48	3.16	5.17	2.01	None

Notes to table:

- a. Maximum groundwater level exceeds the ground level at the monitoring position, indicating that the area had flooded.
- b. Maximum unsaturated zone thickness calculated using minimum recorded groundwater level.

Due to the monitoring technique used (pressure transducer), results from WS202 were skewed due to the borehole being submerged by standing water, rather than actual groundwater level being recorded. The borehole location is within an area of concrete hardstanding and was noted to be covered by standing water from heavy rainfall during the period of monitoring.

Based on the recorded groundwater levels within the made ground and alluvium, an unsaturated thickness was determined of between 2.25m and 1.35m to be present across the site.

The report concluded that groundwater monitoring showed some tidal effects on the northern and eastern extents of the site. A potential risk of contaminant migration into the Milton Creek, particularly in the west of the site in the area of the former works/wharf, was also identified.

No tidal influences were noted in the southern or western parts of the site where groundwater data loggers were also deployed.

The report made recommendations for the remediation of the shallow soils/made ground and groundwater to protect controlled waters and future end-user human health receptors from the identified contamination.

Plans showing the location of intrusive investigation positions and groundwater monitoring points are presented as Figures 4 and 5 respectively and included within Appendix B.

Copies of the trial hole and borehole logs are presented within Appendix C.

8 Site Usage

8.1 Current Land Use

The current site layout is shown in Figure 3, Appendix A.

The site is currently a disused parcel of land on which a number of stockpiles of previously screened/processed materials are located.

8.2 Site History

The site has been the subject of various industrial activities with recorded uses including as an oilcake works, cement works, printing works, bulk liquid storage (tanks of unknown usage), unspecified works and a wharf. A review of available historic mapping indicates that backfilling of the wharf (beneath a former warehouse structure) and tidal mud flats (in the north eastern part of the site) has also occurred.

Recent historical activities on site include the operation of a grab hire lorry business (Brickmaker Utilities) which received waste materials from 2007 until 2013, other similar companies also operated from the site, all owned by the same individual. This activity was undertaken initially under a Waste Exemption issued by the Environment Agency until 2010. However, the operator was unable to obtain an Environmental Permit to continue the waste activity. It is understood the waste operation continued until July 2013 when Bellway Homes took back possession of the site.

Upon surrender back to the client, some 30,000m³ of waste material was stockpiled on site. Investigation and assessments were undertaken by LEAP to ascertain the chemical nature of material within stockpiles on site (summarised in Section 7 above).

The assessment considered potential reuse options for the stockpiled wastes including within commercial development and possible reuse on-site as fill material for flood protection that would be required for raising levels.

8.3 Illegal Waste Incident

During sometime between 10th and 13th April (Easter weekend) 2020, the site was subject to further deposit of illegal wastes, where some 161 stockpiles of waste of unknown origin were illegally dumped onsite by an unknown organisation. The material was estimated to total approximately 4000m³ in volume and covered approximately 0.84Ha of the site. The incident was reported to the Environment Agency and is currently under investigation by the London and South East Waste Crime Team.

Inspection and chemical analysis of the wastes by LEAP recorded elevated concentrations of metals, petroleum hydrocarbons and some positive detections of asbestos. Results of WAC testing indicates that the material not suitable for inert landfill disposal.

The illegal wastes were subsequently removed from site at the clients cost for disposal at a suitable waste facility.

9 Groundwater Monitoring

9.1 Groundwater Sampling

To aid this updated risk assessment, an additional round of groundwater monitoring was undertaken on 23rd November 2020. Groundwater monitoring wells were inspected for the presence of water and separate phase liquids using an electronic interface probe.

Samples of deep chalk groundwater were recovered from boreholes BH2, BH3 and BH4 using a low flow sampling apparatus until consistent physio-chemical parameters were measured on site.

It was noted that the headworks of BH3 had been damaged, assumed to have occurred as a result of the illegal waste activity during 2020. As such, the integrity of monitoring well seal is unknown and may have been damaged.

Samples of the shallow (alluvium/made ground) groundwater were recovered from boreholes WSI01, WSI02, WSI03, WSI04 and WSI06 using a combination of hand pumping and bailer sampling methods.

Samples were recovered in glass amber bottles and/or clear glass vials and placed in cooled insulated boxes for transport to The Environmental Laboratory Ltd for laboratory analysis.

9.1.1 Chemical Water Analysis

Selected samples of groundwater have been subjected to laboratory testing. Sampling techniques and storage have been undertaken as per BS 10175:2011+A1:2013 Code of Practice for Investigation of Potentially Contaminated Sites. The laboratory testing has been carried out by Environmental Laboratory Ltd at its laboratories in East Sussex. Where available, the tests procedures are UKAS and MCERTS accredited.

The following analyses were completed on selected samples:-

- Extended LEAP suite (metals, speciated PAHs and speciated petroleum hydrocarbons)
- LEAP Basic Water Quality Risk Assessment Suite (including REDOX, DO, pH, BOD/COD EC)

The full laboratory test results are presented in Appendix D.

9.2 Groundwater Monitoring Results

The groundwater level results from the recent (November 2020) monitoring visit are summarised below.

Table 2: Summary of Groundwater Levels November 2020

Monitoring Well	Depth to Groundwater Level (mbgl)	Relative Groundwater Level (mAOD)
WSI01	1.98	2.83
WSI02	2.28	2.70
WSI03	2.72	2.45
WSI04	2.46	2.20
WSI06	2.45	2.20
BH2	3.21	1.35
BH3	3.28	1.64
BH4	2.41	2.24

Based on groundwater levels recorded during the monitoring works, the groundwater within the chalk demonstrates a west/north west flow direction, although some slight variability is noted as would be expected due to the competing abstraction rates. A hydraulic gradient of 0.0065 has been calculated using the recent groundwater levels.

Sampling of boreholes WSI02, WSI03 and WSI04 reported very poor/no groundwater recharge rates. As such, it was only possible to collect 'grab' samples of groundwater. Groundwater within borehole WSI01 was recorded as being dark grey/black, with a possible hydrocarbon odour but with no hydrocarbon sheen or floating product present.

C CONCEPTUAL SITE MODEL (CSM)

A risk based approach is used to assess contaminated or potentially contaminated land within the UK. For a potential risk to exist, there must be a contaminant linkage in place, i.e. there must be a source of contamination, a potential receptor, and a pathway linking the two.

In order to quantify the magnitude of the risk, it is necessary to first calculate the potential exposure of the receptor as a result of all the individual active contaminant linkages affecting that receptor. Secondly it is necessary to ascertain “what is an acceptable exposure level for each of the identified receptors and contaminants?”

The purpose of the Conceptual Site Model, in this instance, is to identify all of the potential contaminant linkages by considering, in turn, the potential sources, receptors and pathways.

In relation to this assessment, the conceptual site model is concerned with the potential of contamination within the soils and groundwater beneath the site impacting controlled waters receptors.

10 Conceptual Model Development

An initial phase in developing the CSM requires an understanding of site setting and how the materials are intended to be reused within the development scheme. Together, these inform the Source-Pathway-Receptor relationship for assessing the potential risks to controlled waters receptors.

10.1 Hydrogeological Regime

The previous investigation works have determined that the site is underlain by made ground materials of varying thickness, but between 0.6m and 3.5m where proven. Made ground within BH3 was recorded to a depth of 7.4m and is understood to be in the location of the former wharf. The made ground is underlain by alluvium, encountered as a firm to stiff, grey and light grey mottled silty CLAY. The alluvium overlies the chalk deposits, which were encountered between depths of 6.0m to 7.4m below ground level.

In general terms, the thickness of the made ground is found to be shallower in the west and southwest of the site. Areas of deeper made ground are associated with infilled mudflats in the east and the former wharf.

Two groundwater bodies are present beneath the site, as a shallow groundwater (within alluvium/made ground) and a deep (chalk) groundwater. Groundwater level monitoring has determined:

- Shallow groundwater is typically between 2.63m and 3.46m AOD, resulting in an unsaturated zone thickness of between 1.35m and 2.25m

- Deep groundwater is recorded as being between 1.4m and 1.7m AOD and under sub-artesian pressure conditions.

The site is located within groundwater Source Protection Zones 1 and 2, associated with abstractions from the underlying chalk.

Groundwater quality within the chalk compared to the contaminated shallow groundwater demonstrates that vertical migration is **not** active, with any (potential) contaminant flux being limited by the potentiometric pressures within the chalk aquifer. However, noting the depth of the made ground recorded within BH3 (location of the former wharf), made ground in that part of the site is in contact with the underlying chalk.

Shallow groundwater beneath the site is shown to be impacted by a range of contaminants associated with the former site activities. Groundwater levels are shown in parts of the site to be influenced by tidal variability within the adjacent Milton Creek. The degree of influence on groundwater levels varies across the site, however, is generally found to be greater in the east and northern/north eastern extents of the site. This is considered to be associated with areas of infilled mudflats.

The overriding flow direction of the shallow groundwater is towards the Milton Creek, and has been shown to be (in part) tidally influenced.

A culverted stream flowing from the south, entering at the southwestern corner of the site, is present. In late 2020 Keltbray undertook an investigation to try and locate and determine the route that the culvert follows across the site before discharging to the Milton Creek (as shown on historic mapping). This yielded limited results. It is assumed that the stream discharges from the northwestern boundary of site. It is thought that the discharge point has been obscured by sediments from the creek and poor maintenance of the river banks. Due to the poor condition of the culvert (collapses and debris) it was not possible to determine the invert levels.

10.2 Development and Material Reuse

The proposed redevelopment of the site is for residential housing, including private gardens, areas of public open space, access roads and associated car parking.

Due to the made ground and alluvial soils present, a piled foundation solution is likely to be adopted for the development. The piling technique is still to be confirmed, but given the sensitivity of the location (SPZ1/SPZ2, principal aquifer, adjacent surface water), underlying chalk, identified contamination and reference to the Environment Agency's guidance on piling works, a continuous flight auger (CFA) solution is likely to be adopted. Any proposals for piling works will be supported by a Foundation Works Risk Assessment for approval by the Environment Agency.

Due to the site location immediately adjacent to the Milton Creek, the site levels are to be raised to mitigate the flood risk to the site. A remediation strategy is to be developed to

remediate the recorded soil contamination, with the placement of a clean cover system of subsoil and topsoil in private gardens and public open space to protect future end users.

The redevelopment of the site will therefore create areas where infiltration will be prevented (housing, roads, pavements and car parking) or where infiltration will be reduced/limited (private gardens and public open space).

The stockpiled materials are intended to be used to raise the current site levels (following removal of the existing site surfacing where required). As such the proposed placement would have a minimal change on the current unsaturated zone thickness between the placed soils and the groundwater. Removal of the made ground is not envisaged, but may occur in limited parts for construction enabling works (e.g. piling obstruction clearance), with compaction/ground improvements being required (e.g. beneath roads, car parks, for pile mats, etc.). As such, no net change in groundwater flow (permeability or direction) is considered likely.

10.3 Sources

Chemical analysis of soils and groundwater samples collected during previous intrusive investigations completed by LEAP, together with the recent (November 2020 included in Section II below) have highlighted elevated concentrations of a range of contaminants including metals (lead, copper and nickel), PAHs and petroleum hydrocarbons. The contamination is limited to the shallow soils and groundwater associated with the recorded made ground and alluvial deposits across the site.

Low concentrations of PAHs are present within the deep chalk groundwater, with petroleum hydrocarbons historically (recorded during 2017 only). The concentrations remain lower than encountered in the shallow groundwater.

10.4 Pathways

Based on the understanding of the site and the development proposals, the following pathways have been identified:

- Shallow groundwater discharging into the adjacent surface water (Milton Creek)
 - Shown to be tidally influenced
- Areas of made ground
 - Variable in thickness, extent and composition
 - Anticipated to have variable permeability
- Below ground structures
 - Preferential pathways may be present associated with the previous development on site including the former wharf, service/drainage conduits and the culverted stream

Piling works and construction works *may* create vertical pathways but will be supported/directed by appropriate risk assessment to prevent or minimise this from occurring. Notwithstanding the sub-artesian groundwater conditions, it is considered that the deep groundwater can be discounted as a potential pathway from the recorded shallow soil and groundwater contamination.

10.5 Receptors

Identified receptors considered within the assessment include:

- Groundwater
 - Alluvium (Shallow) Secondary (Undifferentiated) aquifer
 - White Chalk Subgroup (Deep) Principal aquifer
- Groundwater Source Protection Zones 1 and 2 – Abstractions located:
 - 466m north east (paper and printing process)
 - 897m west (food and drink process water)
 - 1363m east (drinking water)
- Surface Water – (tidal) Milton Creek (directly adjacent)

11 Groundwater and Surface Water Assessment Criteria

The generic controlled waters risk assessment was conducted in accordance with the principles of EA 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination' 2006 (EA 2006) and the 'prevent and limit' approach of the Water Framework Directive (2000/60.EC). Generic controlled waters risk assessments compare directly measured concentrations with standard assessment criteria.

Appropriate Water Quality Standards (WQS) are selected based on both a hierarchy of relevance to England and Wales and the receptor. In this case, the controlled water receptor identified in the CSM relate to groundwater, being the underlying shallow Secondary Undifferentiated aquifer (Alluvium) and deep Principal aquifer (Chalk) and additionally, surface water with the adjacent tidal Milton Creek surface water feature. As such, the following hierarchy of WQS are considered to be appropriate:

Groundwater

- UK Drinking Water Quality Standards (DWS) from *The Water Supply (Water Quality) Regulations 2016* (England).
- World Health Organisation *Guidelines for Drinking Water Quality*, Fourth Edition, Volume 1, (2011).

Surface Water

- Environmental Quality Standards (EQS) from The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

In the case of petroleum hydrocarbons, no current UK standard is available, so an initial assessment criterion of 10µg/l, based on the former target concentration for dissolved or emulsified hydrocarbons, is considered to represent a conservative tier 1 screening value for total petroleum hydrocarbons. The CL:AIRE guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies¹, itself based on WHO guidelines, may then also be used where applicable for considering petroleum hydrocarbon fractions and derivatives in more detail.

12 Groundwater Monitoring Results

The following sections summarise the chemical analysis results of groundwater monitoring collected between 2017 and 2020. The laboratory results are included in Appendix D.

12.1 Shallow Groundwater (Made Ground / Alluvium)

Table 3: Summary of Groundwater Quality Test Results (38 samples)

Determinant (Total, unless otherwise specified)	Measured Range (mg/l)	Assessment Criteria (mg/l)		Samples that exceed assessment criterion
		Annual Average Environmental Quality Standard	UK Drinking Water Standard	
Arsenic	<0.005 – 0.028	0.025	0.01	WS102 = 0.028mg/l (23/11/17)
Cadmium	<0.001 – 0.01	0.0002	0.005	WS103 = 0.01mg/l (23/11/20) WS103 = 0.002mg/l (27/4/17)
(total) Chromium	<0.0005	0.0006	0.05	None
Copper	<0.005 - 0.024	0.00376	0.002	9 Exceedances
Mercury	<0.0001	-	0.001	None

¹ Petroleum Hydrocarbons in Groundwater - Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies – CL:AIRE, March 2017

Nickel	<0.005 – 0.032	0.0086	0.02	14 Exceedances
Lead	0.001 – 0.042	0.0013	0.01	WSI05 = 0.002mg/l WSI02 = 0.002mg/l WSI05 = 0.002mg/l WSI03 = 0.003mg/l WSI03 = 0.013mg/l WSI03 = 0.02mg/l WSI03 = 0.037mg/l WSI03 = 0.042mg/l
Selenium	<0.005 – 0.057	-	0.01	22 Exceedances
Fluoride	<0.5 – 1.3	5	0.0015	
Sulphate	22.4 – 1610	-	250	18 Exceedances

The results of groundwater chemical analysis shows that the shallow groundwater is impacted by a range of metals, including lead, copper and nickel. A limited number of exceedances for arsenic (single occasion) and cadmium (two occasions) have also been reported.

The lead exceedances are considered to represent only slight exceedance of the EQS (saline) screening criteria, with no results being reported greater than an order of magnitude above the EQS value.

Elevated levels of selenium and sulphate have also been recorded, both exceeding the Drinking Water Standard screening criteria. Noting the tidal conditions of the adjacent Milton Creek, these are not considered to represent a risk to surface water receptors.

Table 4: Summary of Shallow Groundwater Test Results – TPH & PAHs

Borehole	Total Petroleum Hydrocarbons (TPHs) ^a			Total Polyaromatic Hydrocarbons (PAHs) ^b		
	Measured Concentration Range 2017 (µg/l)	Measured Concentration 2019 (µg/l)	Measured Concentration 2020 (µg/l)	Measured Concentration Range 2017 (µg/l)	Measured Concentration 2019 (µg/l)	Measured Concentration 2020 (µg/l)
WS101	105 – 184	21.5	216	8.51 – 40.2	4.31	26.5
WS102	3060 – 6500	-	1220	134 – 266	-	365
WS103	1200 – 3030	216	516	114 – 159	82.9	57.1
WS104	345 – 1350	-	5.5	3.79 – 9.93	-	4.2
WS105	15800 – 98200	835	-	150 – 243	25.4	-
WS106	808 – 2160	-	<5.0	69.8 – 85.1	-	4.12
WS201	-	17.0	-	-	3.45	-
WS202	-	27.8	-	-	20.4	-

Notes to table:

- a. Adopted Tier I Screening Criteria of 10µg/l
- b. Adopted Tier I Screening Criteria of 0.1mg/l

The results of petroleum hydrocarbons (as Total Petroleum Hydrocarbons) within the shallow groundwater are generally shown to have not deteriorated since the initial monitoring works completed during 2017. A slight increase is reported for TPH in borehole WS101 with a concentration of 216µg/l for November 2020, compared to previous results of 21.5µg/l in 2019 and a maximum of 184µg/l during 2017.

The detections of petroleum hydrocarbons relate to heavy range Aromatic / Aliphatic fractions >C₁₆, with the majority being >C₂₁ fractions, with the greatest concentration being reported in borehole WS102.

Elevated concentrations of PAHs remain present in all samples collected, and in the main the November 2020 results are generally consistent with previous monitoring results. A notable decrease in concentrations is recorded for WS106 and increase is reported within borehole WS102. It is unclear as to cause of the variations in concentrations.

The reported concentrations of both TPH and PAHs do not suggest any overall change (improvement/deterioration) in groundwater quality beneath the site. The initial (gross) petroleum hydrocarbon contamination is considered to be potentially related to disturbance of contamination within the soils and groundwater, resulting from the installation of the monitoring wells. The concentrations relate to relative low mobility hydrocarbon ranges and PAHs.

12.2 Deep Groundwater (Chalk)

Table 5: Summary of Deep Chalk Groundwater Test Results (6 Rounds)

Determinant (Total, unless otherwise specified)	Measured Range (mg/l)	Assessment Criteria (mg/l)		Samples that exceed assessment criterion
		Annual Average Environmental Quality Standard	UK Drinking Water Standard	
Arsenic	<0.005	0.025	0.01	None
Cadmium	<0.001	0.0002	0.005	None
(total) Chromium	<0.005	0.0006	0.05	None
Copper	<0.005 - 0.013	0.00376	0.002	None
Mercury	<0.001	-	0.001	None
Nickel	<0.005 – 0.038	0.0086	0.02	BH2 = 0.011mg/l BH3 = 0.038mg/l
Lead	0.001	0.0013	0.01	None
Selenium	<0.005 – 0.013	-	0.01	BH2 = 0.013mg/l
Fluoride	<0.5	5	0.0015	None
Sulphate	22.4 – 200	-	250	None

The monitoring results show only very minor exceedances of the screening criteria on a very limited number of occasions, relating to nickel (two occasions) and selenium (single occasion).

Table 6: Summary of Deep Chalk Groundwater Test Results (6 Rounds) – TPH & PAHs

Borehole	Total Petroleum Hydrocarbons (TPH)			Total Polyaromatic Hydrocarbons (PAHs)		
	Measured Concentration Range 2017 (µg/l)	Measured Concentration 2019 (µg/l)	Measured Concentration 2020 (µg/l)	Measured Concentration Range 2017 (µg/l)	Measured Concentration 2019 (µg/l)	Measured Concentration 2020 (µg/l)
BH2	<5.0 – 76.5	<5.0	<5.0	1.08 – 1.4	0.27	0.15
BH3	<5.0 – 24.6	<5.0	<5.0	0.75 – 1.46	0.11	1.05
BH4	<5.0 – 14.3	<5.0	<5.0	0.45 – 0.28	0.13	0.15

Notes to table:

- a. Adopted Tier 1 Screening Criteria of 10µg/l
- b. Adopted Tier 1 Screening Criteria of 0.1mg/l

The analysis results of deep groundwater do not show any current impacts from petroleum hydrocarbons. Low concentrations of petroleum hydrocarbons were detected during the 2017 monitoring but have not been subsequently recorded.

Generally low concentrations of PAHs have been recorded but at concentrations that marginally exceed the adopted screening criteria. Concentrations recorded during both 2019 and (recent) 2020 monitoring visits are lower than levels recorded during 2017. Previous assessments have indicated that the PAHs relate to off-site source, with an inferred contamination plume based on the relative concentrations of TPH and PAHs in the deep groundwater across the site.

However, further assessment of the recorded concentration is required to confirm the potential risk to off-receptors noting that the site lies within groundwater Source Protection Zone 1. This assessment is shown in Section 12.3 below.

D RISK ASSESSMENT

12.1 Soil Contamination

The site is underlain by made ground of varying thicknesses and composition across the entire site. Typically, the deepest made ground is found to be associated with the infilling of the mudflats (land reclamation) on the site boundaries and the former wharf (where the made ground is deepest).

Soil contamination has been considered during previous risk assessments undertaken by LEAP. This work included the combination of trial pits, windowless sampler and cable percussion boreholes across the site. Chemical analysis results of the soils/made ground encountered recorded generally low concentrations of petroleum hydrocarbons, typically relating to aliphatic fractions $>C_{16}$, together with a limited number of elevated lead and benzo(a)pyrene results (4 and 3 exceedances from 25 samples against human health criteria respectively).

The highest petroleum hydrocarbon concentration was recorded in the eastern part of the site within TPI06 (Aliphatic $C_{13}-C_{35}$ = 2980mg/kg at 4.4mbgl), with the next highest result being located roughly centrally within WS105 (Aliphatic $C_{13}-C_{35}$ = 684.9mg/kg at 1.3mbgl).

The chemical analysis results of soils indicate that the petroleum hydrocarbons impacts relate to low concentrations of mid to heavy range fractions, and to a lesser extent by lead and benzo(a)pyrene.

The previous investigations did acknowledge that intrusive works were limited in the west of the site in the location former works due to the thickness of the concrete hardstanding and in-ground obstructions.

The previous investigation works also identified that a shallow groundwater is present within the made ground across much of the site, which also in hydraulic continuity with the adjacent surface water. As such, the recorded soil contamination beneath the site is likely to be impacting controlled water receptors.

12.2 Shallow (Made Ground / Alluvium) Groundwater

12.2.1 Metals/Non-Metals

Results of shallow groundwater monitoring has identified exceedances of the screening criteria in respect of lead, copper and nickel. Additionally, a limited number of exceedances for arsenic (single occasion) and cadmium (two occasions) have been reported.

In respect of copper, marginal exceedances of EQS have reported on 9 occasions, with the remainder of the results being below the laboratory limit of detection. The detections are limited to five monitoring wells (WS102, WS103, WS105, WS106 and WS203) which are located across the entire site.

For nickel, the greatest concentrations relate to boreholes WS103, WS104 and WS203, although no exceedances of the EQS screening criteria. As such the results are not considered to represent an unacceptable risk to surface water receptors.

The lead exceedances are considered to represent only slight exceedance of the EQS (saline) screening criteria, with no results being reported greater than an order of magnitude above the EQS value. The exceedances are limited to three monitoring well locations (WSI03, WSI05 and WSI02).

Elevated levels of selenium and sulphate have also been recorded, both exceeding the Drinking Water Standard screening criteria. Noting the tidal conditions of the adjacent Milton Creek, these are not considered to represent a risk to surface water receptors.

12.2.2 Petroleum Hydrocarbons and PAHs

The recent (November 2020) groundwater monitoring recorded petroleum hydrocarbons concentrations above the screening criteria of 10µg/l within three of the monitoring locations (WSI01, WSI02 and WSI03) with the highest concentration recorded in WSI02 (1220µg/l). The recorded petroleum hydrocarbon bandings predominantly relate to aliphatic/aromatic fractions >C₂₁. No BTEX compounds were recorded during any of the monitoring visits, including the recent November 2020 visit.

As highlighted within Table 5.1 of the CLAIRE² petroleum hydrocarbon risk assessment guidance, the recorded hydrocarbon ranges (>C₂₁) are indicative of heavy fuel oils, lubricating oils and greases, and have an overall relative mobility in groundwater of Very Low to Low. It is considered that they represent a low (relative) risk to controlled waters receptors, specifically the adjacent Milton Creek.

Noting the absence of a published EQS value for TPH or individual hydrocarbon fractions, some comparison can be made against the WHO guide values for TPHCWG fractions (where available) in drinking water as included within Table 5.4 of the CLAIRE guidance. This comparison highlights that exceedances are limited to aromatic and aliphatic fractions C₂₁-C₃₅ within boreholes WSI02 and WSI03. The highest concentration relates to WSI02 aromatic C₂₁-C₃₅ = 472µg/l.

The monitoring results also report elevated concentrations of a range of polyaromatic hydrocarbons (PAHs) to be present within the shallow groundwater across the site. It is considered that detections are likely to be linked to the petroleum hydrocarbon contamination noting the respective hydrocarbon fractions identified. As such the PAH contamination is likely to relate to oils/greases. The elevated concentrations are also likely to be reflective of the associated very low mobility and slow degradation rates in groundwater. PAHs are therefore considered to represent an on-going source term and risk to surface waters.

² Petroleum Hydrocarbons in Groundwater - Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies – CL:AIRE, March 2017

12.3 Deep (Chalk) Groundwater

Monitoring of the deep groundwater within the underlying chalk aquifer has only recorded minor levels of contamination to be present. Low levels of PAHs remain above the adopted screening criteria of 0.1 µg/l (total PAHs).

A review of the drinking water standards for benzo(a)pyrene (0.01 µg/l) and sum of benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and benzo(ghi)perylene (0.1 µg/l) shows marginal exceedances for borehole BH3 above the drinking water standards only. It is considered that the detections within borehole BH3 may relate to the deep made ground associated with the former wharf feature at this location. Concentrations within BH2 and BH4 are below the respective DWS and therefore demonstrate that they do not pose a risk to off-site groundwater receptors.

Noting the marginal exceedances and distance to the nearest groundwater abstraction (some 466m north east), it is considered the concentrations of PAHs in BH3 to represent an overall very low risk at the abstraction point.

However, noting the sensitivity of the location with respect groundwater receptors (SPZ1, principal aquifer), a quantitative risk assessment using the Environment Agency's Remedial Targets Methodology 'P20 worksheet' has been completed for the recorded PAHs that exceed the DWS. The assessment is preliminary in nature but uses conservative assumptions (professional judgement) and site specific values.

A summary of the P20 input parameters and RTM Worksheets are included in Appendix E.

The results show that within 120m of the borehole (BH3) where the exceedances were reported, the PAH concentrations are predicted to be below the DWS. It is also noted that borehole BH3 is approximately 25m from the site boundary. As such, the reported concentrations of PAHs in groundwater are not considered to represent a risk to off-receptors (groundwater abstractions). However, this does highlight that development activities *may* result in mobilisation of contamination within the made ground deposits that could lead to increased contamination of the chalk groundwater.

Any remediation strategy and foundation works risk assessment prepared for the development must therefore consider the potential risks to the chalk groundwater.

13 Remediation Criteria

The soil and groundwater beneath the site have been recorded as being contaminated (from previous site uses). Due the sensitivity of the location in respect of controlled waters receptors, being within groundwater Source Protection Zone I and bound by a tidal surface water, it is considered remediation of the soil and/or shallow groundwater beneath the site is required.

Remediation of the deep chalk groundwater is not considered to be required, with only very low concentrations of PAHs being reported. Additionally, a preliminary numerical assessment has been completed, which predicts concentrations to reduce to below the DWS within 70m of the impacted borehole, within 50m of the site boundary.

It is understood from discussions with remediation contractors that an outline remediation strategy is likely to include in-situ treatment of soils/shallow groundwater. Some localised excavations may also be required, predominantly relating to clearance of in-ground obstructions ahead of construction works, including piling activities. With this remedial approach a soil remedial target is not appropriate.

No monitoring of surface water quality has been completed during any previous phase of the investigation works undertaken by LEAP. Due to the location of the site with respect surrounding commercial/industrial activities and tidal conditions, monitoring of surface water quality (i.e. at the receptor) it is not considered appropriate or necessarily representative of any contamination resulting from the site.

However, in order to demonstrate an improvement in shallow groundwater quality, and by extension reduction in risk to the surface water receptor, it is suggested that monitoring groundwater quality on the site boundaries is undertaken. The monitoring wells would provide representative water quality results between the contamination source and the surface water receptor. The monitoring should demonstrate a 'betterment' in the shallow groundwater quality following completion of the remediation works, with comparison against published surface water quality standards.

Where bulk excavation works are required, the soils/made ground will need to be subject to verification testing to confirm suitability for reuse, treatment or off-site disposal to be completed where analysis results indicate. A reuse criteria will need to be developed as part of a remediation strategy.

APPENDIX A – Limitations

Limitations

LIMITATIONS

This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk. Unless explicitly agreed otherwise in writing, this report has been prepared under LEAP's standard terms and conditions, as included in the quotation for this works.

This report has been prepared by Leap Environmental Ltd on the basis of information received from a variety of sources which Leap Environmental Ltd believes to be accurate. Nevertheless, Leap Environmental Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

Leap Environmental Ltd has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed. LEAP cannot be held responsible for any disclosures or changes in regulation that are provided post production of this report, and will not automatically update the report.

The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted, and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

The extent of the exploratory holes, laboratory testing and monitoring undertaken may have been restricted due to a number of factors including accessibility, the presence of buried or overhead services, current development and site usage, timescales or clients specification. The exploratory holes only assess a small proportion of the site area with respect to the site as a whole, and as such may only provide an overall assessment of ground conditions on site. The presence of hotspots of undisclosed contamination or exceptional and unforeseen ground conditions cannot be discounted.

Eurocode 7 gives guidance on the type of sampling, sample quality, number and spacing of intrusive investigations, and number of laboratory tests required. It is intended that the Geotechnical Information section of this report will fulfil the general requirements of the Ground Investigation Report as set out in section 6 of Eurocode⁷³, although this is subject to the restrictions imposed on the investigation as listed above. For geotechnical design, Eurocode 7 requires the Geotechnical Design Report to address both the geotechnical and

³ BS EN 1997 Eurocode 7- Geotechnical Design - Part 1: General Rules (2004) and Part 2: Ground Investigation and Testing (2007)

structural aspects of the geotechnical design for both the limit and serviceability states. The Geotechnical Appraisal section of this report will not meet the requirements of a Geotechnical Design Report (GDR), and should therefore be used for preliminary guidance only.

The presence of asbestos may be noted during the site walkover survey, intrusive investigations and/or from the results of contamination testing. However, this report does not constitute an asbestos survey. On this basis, the presence of asbestos on site cannot be discounted and a full asbestos survey should be undertaken.

APPENDIX B – Figures

Figures



Client:	Bellway Homes (Kent Division)	Date:	25/1/2021	Project ID:	LP2448
Project:	Crown Quay, Sittingbourne	Title:	Site Location Plan	Fig. No.	1



LEGEND - UNIT TYPE


- 4 Bed 5 Person House
- 3 Bed 4 Person House
- 2 Bed 3 Person House
- 2 Bed 4 Person Apartment
- 2 Bed 3 Person Apartment
- 1 Bed 2 Person Apartment



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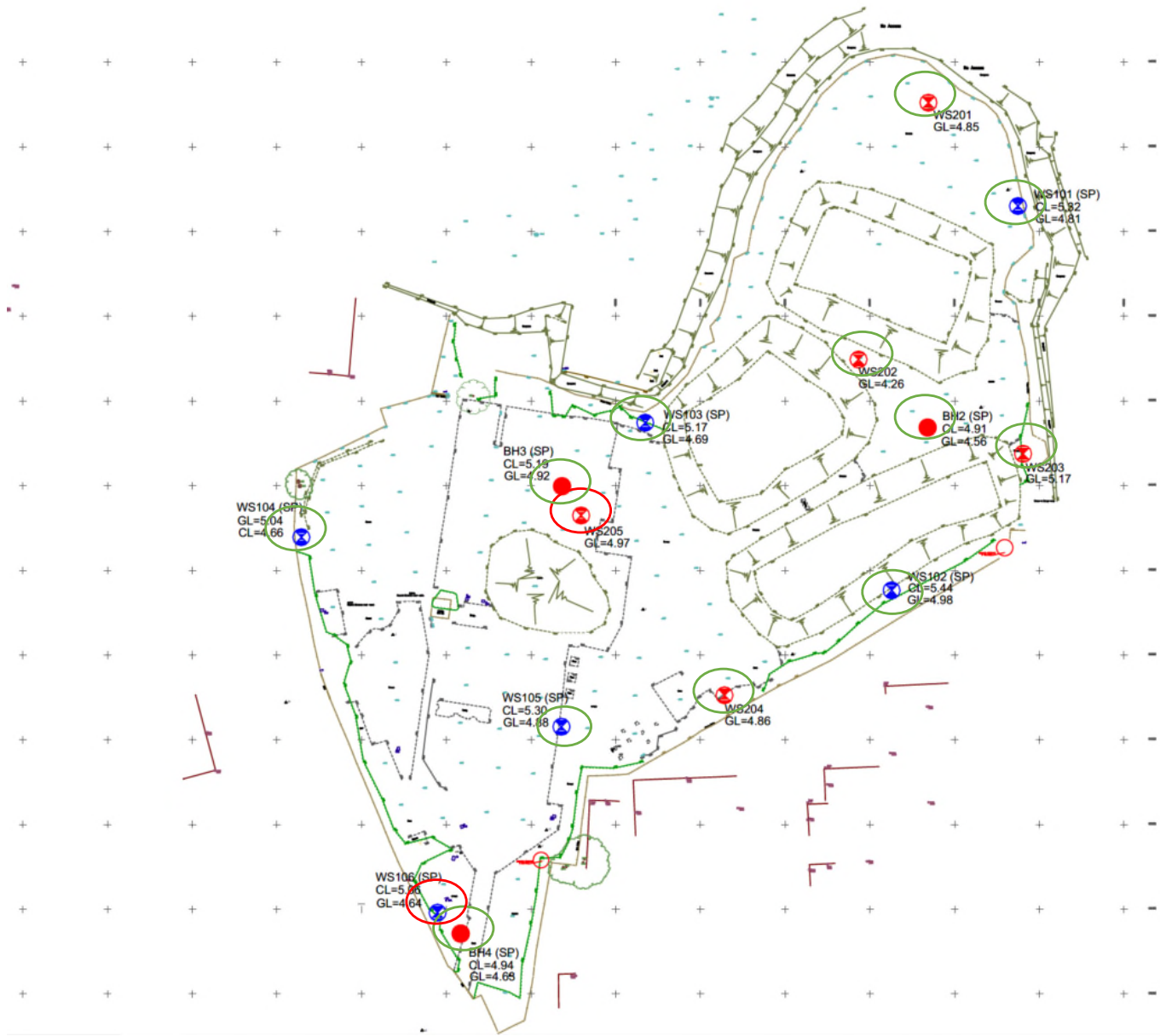
crown quay lane, sittingbourne

Unit Type Layout
 10/07/2020 revised
 1:1000 @ A3 scaling
 051904-BEL-K-05

	Client:	Bellway Homes (Kent Division)	Date:	25/1/2021	Project ID:	LP2448
	Site:	Crown Quay Lane, Sittingbourne	Title:	Proposed Development Plan	Figure No.:	2







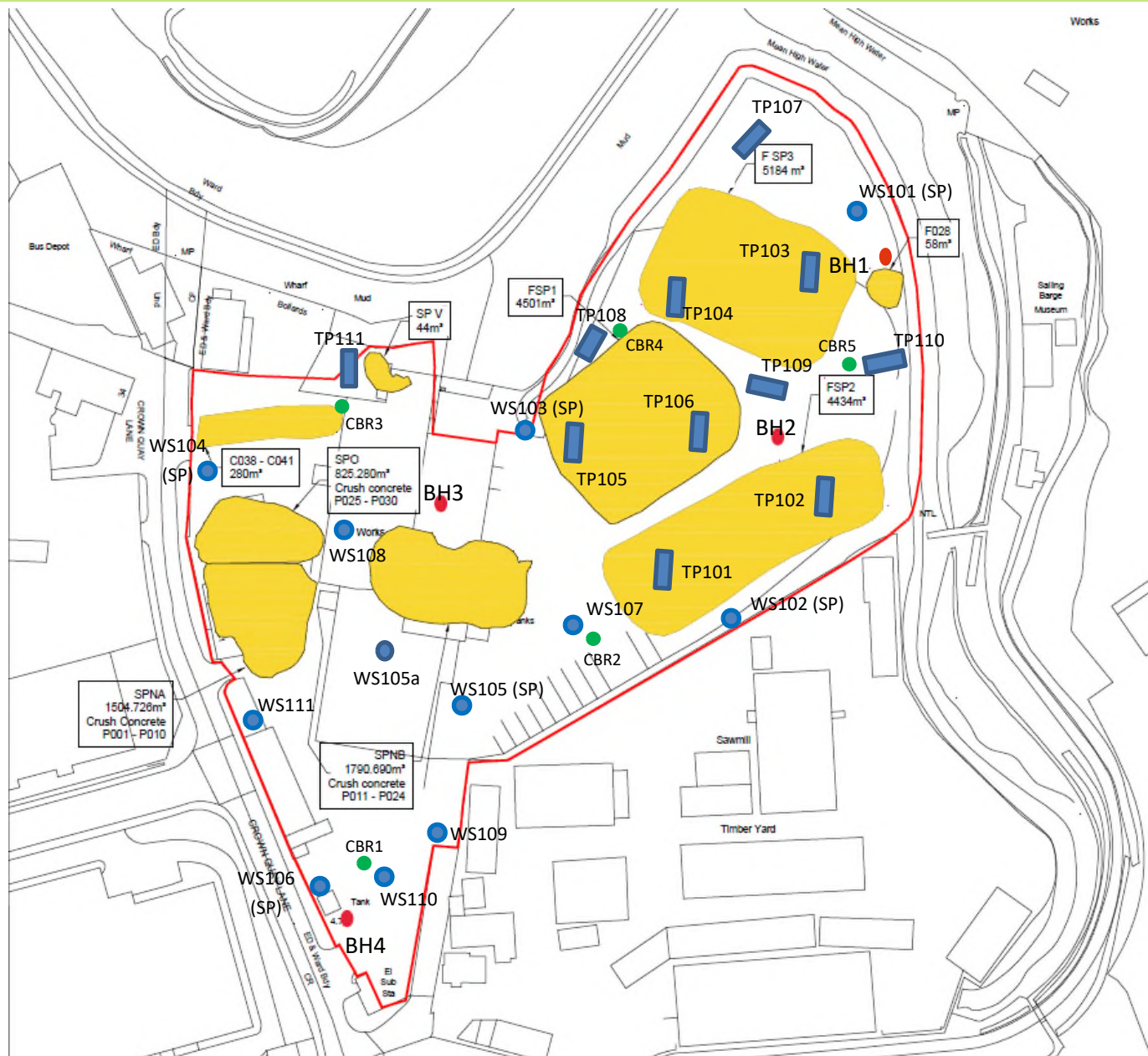
Client:	Keltbray Remediation	Date:	18/01/2021	Project ID:	LP2448
Site:	Crown Quay Lane, Sittingbourne	Title:	Current Site Layout	Figure No.:	3




Client: Bellway Homes (Kent Division)	Date: 25/01/2021	Project ID: LP2448
	Site: Crown Quay Lane, Sittingbourne	Title: Monitoring Well Plan

Key

-  Trial Pits
-  Windowless Sampler Positions
-  Cable Percussion Boreholes
-  CBR Test Positions



	Client : Bellway Homes (Kent Division)	Date : 25/01/2021	Project ID: LP2448
	Project : Crown Quay Lane, Sittingbourne	Title : Trial Hole Location Plan (2017 investigation)	Fig. No. 5

APPENDIX C – Trial Hole Logs

Trial Hole Logs



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Borehole Log

Borehole No.

BH1

Sheet 1 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 10/01/2017 - 11/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.15	D		0.15			Topsoil.		
		0.15	ES					MADE GROUND: Brown gravelly sandy clay. Gravel is fine to coarse flint, brick, chalk and occasional ash.		
		0.50	D							
		0.50 - 1.00	ES							
				1.00	D					1
				1.50	D		1.50		MADE GROUND: Soft dark grey brown sandy gravelly clay with a slight alluvial odour. Gravel is fine to coarse flint and brick.	
				1.50						
				1.50 - 2.00	B	N=8 (1,2/3,2,2,1)				
				2.50	D					
				3.00					Soft to firm grey and dark grey mottled silty slightly sandy CLAY with an alluvial/organic odour. <i>Hand Pen at 4.4m = 80kPa (UCS)</i>	
				3.00 - 3.50	B	N=4 (1,2/1,0,1,2)				
				4.00	D					
				4.40	D		4.40		with occasional shell and chalk fragments below 5.8m	
				4.40 - 4.95	U	Ublow=10				
				5.00	D					
		5.80	D				Off white and grey structureless CHALK recovered as gravelly silt (80% silt, 20% gravel of chalk.)			
		6.00								
		6.00 - 6.45	D	N=6 (1,0/1,2,1,2)						
		7.00	D		7.00			7		
		7.50								
		7.50 - 7.95	D	N=7 (1,1/2,2,1,2)						
		8.50	D							
		9.00								
		9.00 - 9.50	B	N=5 (1,2/1,1,1,2)						
		10.00	D							

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 8.2m - SWL on completion: 5.7m.





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Borehole Log

Borehole No.

BH1

Sheet 2 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 10/01/2017 - 11/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50 10.50 - 11.00	B	N=12 (1,2/3,6,2,1)	16.50				11
		11.50	D						12
		12.00 12.00 - 12.50	B	N=7 (1,2/2,1,2,2)					13
		13.00	D						14
		13.50 13.50 - 14.00	B	N=5 (1,0/0,1,2,2)					15
		14.50	D						16
		15.00 15.00 - 15.45	D	N=6 (1,0/1,1,2,2)					17
		16.00	D						18
		16.50 16.50 - 16.95	D	N=14 (2,3/2,3,5,4)					19
		17.50	D						20
		18.00 18.00 - 18.45	D	N=20 (3,5/4,5,6,5)					
		19.00	D						
	19.50 19.50 - 19.95	D	N=27 (4,5/5,6,9,7)						

Off white and grey structured CHALK recovered as gravelly silt. (60% silt, 40% gravel of weak, low density chalk and flints).

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 8.2m - SWL on completion: 5.7m.





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Borehole Log

Borehole No.

BH1

Sheet 3 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 10/01/2017 - 11/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
Well casing		20.50	D					
		21.00 21.00 - 21.45	D	N=26 (3,7/5,7,7,7)				21
		22.00	D					22
		22.50 22.50 - 22.95	D	N=28 (5,5/5,7,7,9)				23
		23.50	D					24
		24.00 24.00 - 24.45	D	N=39 (5,10/13,9,8,9)				24
	25.00 25.00 - 25.45	D	N=31 (6,5/6,7,9,9)	25.00			25 End of borehole at 25.00 m	
							26	
							27	
							28	
							29	
							30	

Remarks
Borehole cased to 25m. Water strike at 8.2m - SWL on completion: 5.7m.





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Borehole Log

Borehole No.

BH2

Sheet 1 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 09/01/2017 - 10/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.15		Asphalt.		
		0.50	D				MADE GROUND: Dark orange brown gravelly sandy clay. Gravel is fine to coarse flint, brick, occasional chalk and ash.		
		0.50	ES						
		1.00	D					1	
		1.50			N=7 (2,1/2,1,2,2)				
		1.50 - 2.00	B					with an alluvial odour below 2.0m	2
		2.50	D						
		2.50	ES						
		3.00			N=5 (1,0/1,1,1,2)				
		3.00 - 3.30	B			3.30			3
		3.30	D					Soft grey green brown sandy silty CLAY with an alluvial/organic odour. Hand Pen at 3.3m = 80kPa (UCS)	
		4.00	D						4
		4.50 - 4.95	U		Ublow=12				
		5.00	D						5
		5.90	D					becoming brown below 5.9m	
	6.00	D		N=7 (1,2/1,2,2,2)			with organic matter between 5.9m and 6.0m	6	
	6.00 - 6.45	D					becoming lighter brown with much fine to coarse gravel of flint and chalk below 6.2m		
	7.00			N=5 (1,0/1,1,2,1)				7	
	7.20	D			7.20				
	7.50 - 7.95	D					Off white structureless CHALK recovered as gravelly silt (80% silt, 20% gravel of chalk.)	8	
	8.50	D							
	9.00			N=7 (1,2/3,1,2,1)				9	
	9.00 - 9.45	D							
	10.00	D						10	

Continued on next sheet

Remarks

Borehole cased to 25m. Water strike at 7.5m - SWL on completion: 7.8m. Borehole chiselled between 13.5m and 13.9m. Backfilled with gravel to 15m, standpipe installed to 15m: Top 3.5m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH2

Sheet 2 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 09/01/2017 - 10/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50 10.50 - 10.95	D	N=9 (1,2/2,3,2,2)	12.00		Off white structured CHALK recovered as gravelly silt. (60% silt, 40% gravel of weak, low density chalk and flints).	11	
		11.50	D						
		12.00 12.00 - 12.50	B	N=11 (1,2/3,2,3,3)					
		13.00	D						
		13.50 13.50 - 14.00	B	N=50 (25 for 100mm/50 for 20mm)					
		14.50	D						
		15.00 15.00 - 15.45	D	N=10 (2,2/2,2,3,3)					
		16.00	D						
		16.50 16.50 - 16.95	D	N=15 (2,3/2,3,4,6)					
		17.50	D						
		18.00 18.00 - 18.45	D	N=45 (5,6/6,10,16,13)					
		19.00	D						
	19.50 19.50 - 19.95	D	N=25 (4,5/5,7,6,7)						
								20	

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 7.5m - SWL on completion: 7.8m. Borehole chiselled between 13.5m and 13.9m. Backfilled with gravel to 15m, standpipe installed to 15m: Top 3.5m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH2

Sheet 3 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 09/01/2017 - 10/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
Well casing		20.50	D		25.00			21 22 23 24 25 26 27 28 29 30
		21.00 21.00 - 21.45	D	N=28 (4,5/5,9,6,8)				
		22.00	D					
		22.50 22.50 - 22.95	D	N=27 (5,5/5,6,7,9)				
		23.50	D					
		24.00 24.00 - 24.45	D	N=28 (5,9/7,7,7,7)				
	25.00 25.00 - 25.45	D	N=37 (5,8/11,9,9,8)			End of borehole at 25.00 m		

Remarks
 Borehole cased to 25m. Water strike at 7.5m - SWL on completion: 7.8m. Borehole chiselled between 13.5m and 13.9m. Backfilled with gravel to 15m, standpipe installed to 15m: Top 3.5m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH3

Sheet 1 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 12/01/2017 - 13/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		1.20	D	N=28 (1,2/6,5,10,7)	3.00		MADE GROUND: Brown gravelly clayey sand. Gravel is fine to coarse flint, brick, concrete and occasional chalk and ash.			
		1.50 1.50 - 2.00	B							
		2.50 2.50	D ES	N=4 (1,0/0,1,2,1)				<i>becoming sandy clay below 2.5m</i>		
		3.00 3.00 - 3.50	B							
		4.00	D	N=6 (1,1/1,2,1,2)						
		4.50 4.50 - 5.00	B							
		5.50 5.50	D ES	N=10 (1,2/2,2,3,3)					<i>with much gravel of chalk below 5.5m</i>	
		6.00 6.00 - 6.30 6.30	B D							
		7.40 7.50 7.50 - 7.95	D D	N=6 (1,1/2,1,1,2)						MADE GROUND: Orange brown sandy silty clay with occasional fine to coarse gravel of flint and brick (reworked).
		8.50	D							
	9.00 9.00 - 9.45	D	N=5 (2,1/2,1,1,1)	Off white structureless CHALK recovered as gravelly silt (80% silt, 20% gravel of chalk.)						
	10.00	D								

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 7.4m - SWL on completion: 5.7m. Backfilled with gravel to 15m, standpipe installed to 15m: Top 6.5m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH3

Sheet 2 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 12/01/2017 - 13/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50 10.50 - 10.95	D	N=9 (2,1/2,3,2,2)	10.50		Off white structured CHALK recovered as gravelly silt (60% silt, 40% gravel of weak, low density chalk and flints).	
		11.50	D					
		12.00 12.00 - 12.45	D	N=12 (2,1/2,3,4,3)				
		13.00	D					
		13.50 13.50 - 13.95	D	N=14 (3,2/6,2,3,3)				
		14.50	D					
		15.00 15.00 - 15.45	D	N=19 (5,5/6,3,5,5)				
		16.00	D					
		16.50 16.50 - 16.95	D	N=36 (5,5/8,8,9,11)				
		17.50	D					
	18.00 18.00 - 18.45	D	N=33 (5,7/7,9,7,10)					
	19.00	D						
	19.50 19.50 - 19.95	D	N=40 (6,7/7,10,10,13)					

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 7.4m - SWL on completion: 5.7m. Backfilled with gravel to 15m, standpipe installed to 15m: Top 6.5m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH3

Sheet 3 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 12/01/2017 - 13/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.50	D		25.00			
		21.00 21.00 - 21.45	D	N=31 (8,7/8,8,7,8)				21
		22.00	D					22
		22.50 22.50 - 22.95	D	N=32 (9,10/7,8,8,9)				23
		23.50	D					24
		24.00 24.00 - 24.95	D	N=39 (5,9/10,9,9,11)				24
	25.00 25.00 - 25.45	D	N=41 (6,10/10,9,11,11)	25	25	End of borehole at 25.00 m		
							26	
							27	
							28	
							29	
							30	

Remarks
 Borehole cased to 25m. Water strike at 7.4m - SWL on completion: 5.7m. Backfilled with gravel to 15m, standpipe installed to 15m: Top 6.5m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH4

Sheet 1 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 12/01/2017 - 13/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		1.50		N=18 (4,3/2,2,4,10)	2.80		MADE GROUND: Brown gravelly clayey sand. Gravel is fine to coarse flint, brick, clinker, concrete and occasional shell.	1			
		1.50 - 2.00	B								2
			2.50	D				Orange brown sandy gravelly CLAY. Gravel is fine to coarse flint.	3		
			2.50	ES							
			2.80	D							
			3.00		N=7 (1,/2,1,2,2)			becoming very sandy between 4.0m and 5.0m	4		
			3.00 - 3.45	D							
			3.50	D							
			4.50	D	N=5 (1,/1,,2,2)				5		
			4.50	D							
			5.00	D							
			5.50	D					6		
			6.00	D	N=4 (1,/1,,1,2)	6.00					
			6.00 - 6.45	D						Off white structureless CHALK recovered as gravelly silt (80% silt, 20% gravel of chalk.)	7
			6.50	D					8		
		7.50	D	N=9 (3,2/2,2,2,3)	7.50				Off white structured CHALK recovered as gravelly silt (60% silt, 40% gravel of weak, low density chalk and flints).	9	
		7.50	D								
		8.50	D					10			
		9.00	D	N=15 (3,3/4,3,4,4)							
		9.00 - 9.45	D								
		9.50	D								

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 6.0m - SWL on completion: 4.0m. Borehole chiselled 11.2m-11.4m, 13.6m-13.8m and 24.3m-24.5m. Backfilled with arisings to 15m, standpipe installed to 15m: Top 2.0m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH4

Sheet 2 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 12/01/2017 - 13/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50 10.50	D	N=20 (4,5/5,4,6,5)				11
		11.50	D					12
		12.00 12.00 - 12.95	D	N=40 (7,8/9,9,10,12)				13
		12.50	D					14
		13.50 13.50	D	N=50 (20,5/50 for 80mm)				15
		14.50	D					16
		15.00 15.00 - 15.45 15.50	D	N=50 (8,11/50 for 245mm)				17
		16.50 16.50	D	N=37 (9,9/7,8,10,12)				18
		17.50	D					19
		18.00 18.00 - 18.45 18.50	D	N=40 (7,12/7,10,9,14)				20
		19.50 19.50 19.50 - 19.95	D	N=42 (8,9/8,10,11,13)				

Continued on next sheet

Remarks
Borehole cased to 25m. Water strike at 6.0m - SWL on completion: 4.0m. Borehole chiselled 11.2m-11.4m, 13.6m-13.8m and 24.3m-24.5m. Backfilled with arisings to 15m, standpipe installed to 15m: Top 2.0m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Borehole Log

Borehole No.

BH4

Sheet 3 of 3

Project Name: Crown Quay	Project No. LP01205	Co-ords: -	Hole Type CP
Location: Crown Quay Lane, Sittingbourne	Level:		Scale 1:50
Client: Bellway Homes	Dates: 12/01/2017 - 13/01/2017		Logged By ML

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		20.50	D					
		21.00		N=50 (10,11/50 for 220mm)				21
		21.00 - 21.45	D					
		21.50	D					22
		22.50	D	N=41 (8,8/9,9,10,13)				
		22.50	D					23
		22.50 - 22.95	D					
		23.50	D					
		24.00		N=50 (7,12/50 for 120mm)				24
		24.00 - 24.45	D					
		24.50	D					
		25.00		N=50 (9,9/50 for 250mm)	25.00			25
		25.00 - 25.45	D					
								26
							27	
							28	
							29	
							30	

End of borehole at 25.00 m

Remarks
 Borehole cased to 25m. Water strike at 6.0m - SWL on completion: 4.0m. Borehole chiselled 11.2m-11.4m, 13.6m-13.8m and 24.3m-24.5m. Backfilled with arisings to 15m, standpipe installed to 15m: Top 2.0m plain pipe with bentonite surround, remainder slotted with gravel surround. Fitted with end caps and upstanding security cover.





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Trial Pit Log

Trialpit No
TP101
Sheet 1 of 1

Project Name: Crown Quay	Project No. LP01205	Co-ords: - Level:	Date 06/10/2016
Location: Crown Quay Lane, Sittingbourne		Dimensions (m): Depth 3.70	Scale 1:25
Client: Bellway Homes			Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.10			Blacktop.	
				0.30			MADE GROUND: Gravel of medium to coarse brick and rubble.	
	1.00	ES					MADE GROUND: Dark brown and black silty slightly clayey sandy gravel. Gravel is fine to coarse flint, slate, glass, brick, concrete and rare metal. Occasional pockets of light brown silty clay with gravel of brick.	
							PID @ 1.0m = 0.4ppm	1
				1.90			Grey brown, orange green and orange brown silty CLAY with a gravel of flint with an organic odour.	
	2.70	ES					PID @ 2.4m = 1.7ppm	2
				3.40			Dark grey and black fine sandy SILT with fine sandy partings and an organic odour.	
	3.50	ES					PID @ 3.5m = 0.3ppm	3
				3.70			End of pit at 3.70 m	4
								5

Remarks: Remained dry.

Stability: Stable.





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Trial Pit Log

Trialpit No
TP102
Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: -
Level: Date 06/10/2016

Location: Crown Quay Lane, Sittingbourne Dimensions (m): Scale 1:25

Client: Bellway Homes Depth 2.80 Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.08			Blacktop. MADE GROUND: Compacted clinker, brick and flint with a hardcore subbase.
				0.40			MADE GROUND: Dark red brown silty very sandy gravel of fine to coarse chalk, brick and concrete.
				1.00			MADE GROUND: Dark brown and black silty very sandy gravel. Gravel is fine to coarse chalk, brick, flint, metal and boulders of concrete and part brick wall.
	1.80	ES					PID @ 1.7m = 0.1ppm
				2.50			Black and dark grey silty fine sandy CLAY with fine fibrous organic matter and rare fine gravel of flint.
	2.70	ES					PID @ 2.7m = 0.2ppm
				2.80			End of pit at 2.80 m

Remarks: Seepage from 1.9m.

Stability: Overbreak in made ground to 0.9m.





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Trial Pit Log

Trialpit No
TP103
Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: - Date 06/10/2016
Level:

Location: Crown Quay Lane, Sittingbourne Dimensions (m): Scale 1:25

Client: Bellway Homes Depth 3.70 Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	1.50	ES				[Cross-hatched pattern]	MADE GROUND: Dark brown silty sandy gravelly clay. Gravel is fine to coarse and cobbles of brick, tile, concrete, metal and chalk fragments. Also plastic, food wrappers, cloth and fabric. <i>PID @ 1.5m = 0.7ppm</i>
				2.40			MADE GROUND: Dark brown and grey silty gravelly clay. Gravel of fine to coarse flint, brick and rare chalk.
	3.60	ES		3.50		[Cross-hatched pattern]	Green grey and grey silty fine sandy CLAY with occasional coarse gravel of flint. <i>PID @ 3.6m = 0.6ppm</i>
				3.70			End of pit at 3.70 m

Remarks: Moderate seepage at 2.4m.

Stability: Slight overbreak to 1.2m.





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Trial Pit Log

Trialpit No
TP104
Sheet 1 of 1

Project Name: Crown Quay	Project No. LP01205	Co-ords: - Level:	Date 06/10/2016
Location: Crown Quay Lane, Sittingbourne		Dimensions (m): Depth 3.70	Scale 1:25
Client: Bellway Homes			Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.08			Blacktop. Roadstone.
				0.38			Compacted chalk.
	1.20	ES		0.50			MADE GROUND: Red brown and light brown silty slightly gravelly clay. Gravel is fine to coarse and rare boulders of brick and flint. <u>PID @ 1.2m = 0.3ppm</u>
				2.70			MADE GROUND: Dark brown and black sandy gravelly silty clay. Gravel is fine to coarse and cobbles of brick, metal and cable.
				3.10			Dark grey silty fine sandy CLAY with slight organic odour. Occasional fibrous organic material. <u>Becoming black from 3.4m.</u>
	3.60	ES		3.70			<u>PID @ 3.6m = 0.4ppm</u> End of pit at 3.70 m

Remarks: Moderate water inflow at 2.7m.

Stability: Slight overbreak to 1.0m.





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Trial Pit Log

Trialpit No
TP105
Sheet 1 of 1

Project Name: Crown Quay	Project No. LP01205	Co-ords: - Level:	Date 06/10/2016
Location: Crown Quay Lane, Sittingbourne		Dimensions (m): Depth 3.70	Scale 1:25 Logged MP
Client: Bellway Homes			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.15			Blacktop.
				0.70			MADE GROUND: Black and white with organic brown silty clayey gravel. Gravel is fine to coarse brick, concrete, flint and chalk.
				1.20			MADE GROUND: Dark brown silty sandy gravelly clay. Gravel is fine to coarse brick concrete, glass, metal and clinker.
	1.40	ES		1.60			MADE GROUND: Dark grey brown silty sand. Sand is fine to coarse ash, brick and clinker.
				2.90			MADE GROUND: Black and dark grey silty sandy clay with occasional gravel of brick, flint and rare metal.
	3.20	ES		3.70			Dark grey and light grey silty slightly sandy CLAY with fine sandy partings.
							End of pit at 3.70 m

Remarks: Rapid inflow of water at 2.4m with a slight sheen.

Stability: Stable.





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Trial Pit Log

Trialpit No
TP106
 Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: -
 Level: Date 06/10/2016

Location: Crown Quay Lane, Sittingbourne Dimensions (m):
 Depth 4.60

Client: Bellway Homes Scale 1:25
 Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.08			Blacktop. MADE GROUND: Brown silty sand. Sand is fine to coarse with brick and concrete fragments.
	1.20	ES		1.00			MADE GROUND: Dark brown and black slightly gravelly clay. Gravel of fine to coarse flint, brick, chalk and concrete with metal wire and plastic.
				1.60			MADE GROUND: Brown silty clay with occasional gravel of brick and flint.
	2.80	ES		2.90			MADE GROUND: Dark brown silty slightly gravelly clay with timber and rare glass bottles. Also slight chemical solvent odour.
	3.30	ES					
	4.40	ES					
				4.60			End of pit at 4.60 m

Remarks: Standing water at 4.45m with a slight sheen.

Stability: Stable.





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Trial Pit Log

Trialpit No
TP107
Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: -
Level: Date 14/02/2017

Location: Crown Quay Lane, Sittingbourne Dimensions (m): Scale 1:25

Client: Bellway Homes Depth 3.00 Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50	ES					MADE GROUND: Dark brown and brown sandy very gravelly clay. Gravel is fine to coarse flint, brick, concrete, ceramic tile and rare cobble of brick and concrete and rare wood and plastic pipe.
	1.00	ES					
	2.10	ES		1.50			MADE GROUND: Dark brown gravelly clay with occasional pockets of fine sand and fibrous organic material. Gravel is fine to coarse brick, flint and concrete.
				3.00			
End of pit at 3.00 m							

Remarks: Seepage from 1.8m.

Stability: Stable.





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Trial Pit Log

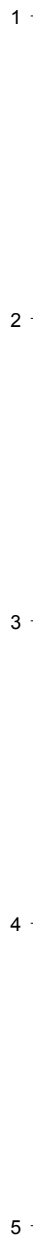
Trialpit No
TP108
Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: -
Level: Date 14/02/2017

Location: Crown Quay Lane, Sittingbourne Dimensions (m):
Depth 1.70

Client: Bellway Homes Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20			MADE GROUND: Brown silty gravelly clay. Gravel is fine to coarse brick and concrete.
				0.40			MADE GROUND: Black coarse gravel of limestone.
	0.50	ES					MADE GROUND: Brown sandy gravelly clay. Gravel is fine to coarse brick, mortar, glass and ceramic.
	0.90	ES					
				1.70			End of pit at 1.70 m



Remarks: Trial pit remained dry. No further progress- brick obstruction.

Stability: Stable.





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Trial Pit Log

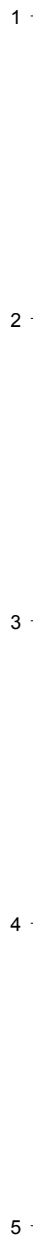
Trialpit No
TP109
Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: -
Level: Date 14/02/2017

Location: Crown Quay Lane, Sittingbourne Dimensions (m): Scale 1:25

Client: Bellway Homes Depth 2.50 Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.08 0.12			Blacktop. MADE GROUND: Black ashy gravel of limestone.
	0.50	ES					MADE GROUND: Brown sandy very gravelly clay. Gravel is fine to coarse flint, concrete and brick with occasional coarse gravel and cobbles of chalk.
							Chalk becoming abundant below 1.1m.
	1.40	ES		1.30			MADE GROUND: Grey brown very silty gravelly clay. Gravel is fine to coarse chalk with occasional brick and flint.
							End of pit at 2.50 m
	2.40	D		2.50			



Remarks: Slight ingress of water from 2.5m.

Stability: Stable.





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Trial Pit Log

Trialpit No
TP110
Sheet 1 of 1

Project Name: Crown Quay	Project No. LP01205	Co-ords: - Level:	Date 14/02/2017
Location: Crown Quay Lane, Sittingbourne		Dimensions (m): Depth 2.90	Scale 1:25 Logged MP
Client: Bellway Homes			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.12			Blacktop.
	0.40	ES					MADE GROUND: Dark brown silty gravel of fine to coarse limestone, clinker and brick with cobbles of whole brick.
				0.70			MADE GROUND: Brown and dark brown silty clayey sandy gravel. Gravel is fine to coarse clinker and brick.
				1.00			MADE GROUND: Brown and orange brown fine sandy gravelly clay. Gravel is fine to coarse flint and brick with plastic sheeting and rare boulders of concrete.
	1.50	ES					
				1.80			MADE GROUND: Light grey brown, grey brown and occasionally yellow brown silty very sandy gravelly clay. Gravel is fine to coarse brick, flint and rare rubber, metal and timber.
	2.40	ES					Black silty sandy CLAY with fibrous organic matter and a strong organic odour.
	2.50	ES					
				2.90			End of pit at 2.90 m

Remarks: Moderate water ingress at 2.2m. Standing water level after 5 minutes = 1.4m.

Stability: Overbreak below 1.4m.





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Trial Pit Log

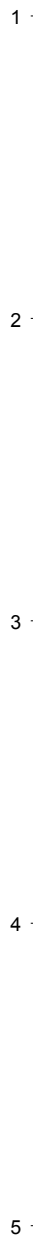
Trialpit No
TP111
Sheet 1 of 1

Project Name: Crown Quay Project No. LP01205 Co-ords: -
Level: Date 14/02/2017

Location: Crown Quay Lane, Sittingbourne Dimensions (m): Scale 1:25

Client: Bellway Homes Depth 1.50 Logged MP

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.40	ES				[Cross-hatch pattern]	MADE GROUND: Dark brown and brown sandy gravelly clay. Gravel is fine to coarse brick, concrete and flint.
							<i>With much wood, roots, plastic and occasional timber at 0.7m.</i>
	1.30	ES		1.20		[Cross-hatch pattern]	MADE GROUND: Dark brown and dark grey very sandy gravel. Gravel is fine to coarse with cobbles and rare boulders of concrete.
				1.50			----- End of pit at 1.50 m



Remarks: Trial pit remained dry. No further progress- brick obstruction.

Stability: Stable.





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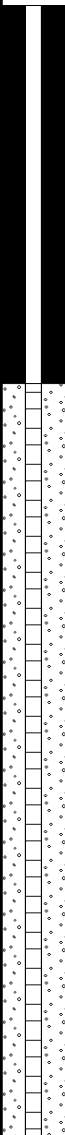
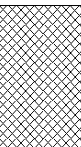
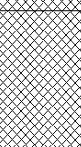
Borehole Log

Borehole No.

WS201

Sheet 1 of 1

Project Name: Crown Quay Planning	Project No. LP1802	Co-ords: 591154 - 164330	Hole Type WLS
Location: Sittingbourne		Level: 4.85	Scale 1:20
Client: Bellway Homes Ltd		Dates: 04/12/2018 - 04/12/2018	Logged By TK

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.40	4.45		MADE GROUND: Brown/dark brown gravelly sandy silty clay. Gravel is fine to coarse brick, flint and sandstone. Sand is fine to coarse.
								MADE GROUND: Dark brown and grey gravelly sandy silty clay. Gravel is fine to coarse brick, flint and organic matter.
								<i>Becoming dark grey with an organic odour below 1.1m.</i>
					3.00	1.85		End of borehole at 3.00 m

Remarks
Borehole remained stable. Water ingress at 2.0m. Standpipe installed to 3.0m, top 1.0m plain with bentonite seal and remaining 2.0m slotted with gravel surround. Completed with gas tap and safety cover.





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Borehole Log

Borehole No.

WS202

Sheet 1 of 1

Project Name: Crown Quay Planning	Project No. LP1802	Co-ords: 591137 - 164270	Hole Type WLS
Location: Sittingbourne		Level: 4.26	Scale 1:20
Client: Bellway Homes Ltd		Dates: 04/12/2018 - 04/12/2018	Logged By TK

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.25	4.01		MADE GROUND: Grey brown sandy clayey fine to coarse gravel of flint, brick and tiling.
								MADE GROUND: Brown grey gravelly sandy silty clay. Gravel is fine to coarse flint, brick and charcoal.
					1.00	3.26		MADE GROUND: Grey gravelly sandy silty clay with organic odour. Gravel is fine to coarse brick, chalk, coal and flint.
					3.00	1.26		End of borehole at 3.00 m

Remarks
Borehole remained stable. Water ingress at 2.0m. Standpipe installed to 3.0m, top 1.0m plain with bentonite seal and remaining 2.0m slotted with gravel surround. Completed with gas tap and safety cover.





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Borehole Log

Borehole No.

WS203

Sheet 1 of 1

Project Name: Crown Quay Planning

Project No.
LP1802

Co-ords: 591176 - 164248

Hole Type
WLS

Location: Sittingbourne

Level: 5.17

Scale
1:20

Client: Bellway Homes Ltd

Dates: 04/12/2018 - 04/12/2018

Logged By
TK

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
							MADE GROUND: Dark brown gravelly sandy silty clay. Gravel is fine to coarse brick, clinker, flint and tile. Sand is fine to coarse.	
				1.60	3.57		MADE GROUND: Yellow brown gravelly sandy silty clay. Gravel is fine to coarse brick, coal, flint and organic matter. Sand is fine to coarse.	
				2.00	3.17		Firm to stiff grey and light grey mottled silty CLAY with occasional orange iron staining.	
							<i>Hand Penetrometer UCS at 2.5m = 180kPa.</i>	
				3.00	2.17		End of borehole at 3.00 m	

Remarks
 Borehole remained dry and stable. Standpipe installed to 3.0m, top 1.0m plain with bentonite seal and remaining 2.0m slotted with gravel surround. Completed with gas tap and safety cover.





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Borehole Log

Borehole No.

WS204

Sheet 1 of 1

Project Name: Crown Quay Planning	Project No. LP1802	Co-ords: 591106 - 164191	Hole Type WLS
Location: Sittingbourne		Level: 4.86	Scale 1:20
Client: Bellway Homes Ltd		Dates: 04/12/2018 - 04/12/2018	Logged By TK

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
							MADE GROUND: Brown very clayey gravelly sand. Gravel is fine to coarse brick, flint, mortar, sandstone and clinker.	
		1.80	ES		1.30	3.56	MADE GROUND: Black sandy fine to coarse gravel of clinker and blacktop.	
							<i>Becoming grey and clayey below 2.5m.</i>	
					3.00	1.86	End of borehole at 3.00 m	

Remarks
 Borehole collapsed to 2.0m. Water ponding in base of borehole. Standpipe installed to 2.0m, top 1.0m plain with bentonite seal and remaining 1.0m slotted with gravel surround. Completed with gas tap and safety cover.





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Borehole Log

Borehole No.

WS205

Sheet 1 of 1

Project Name: Crown Quay Planning	Project No. LP1802	Co-ords: 591072 - 164233	Hole Type WLS
Location: Sittingbourne		Level: 4.97	Scale 1:20
Client: Bellway Homes Ltd		Dates: 04/12/2018 - 04/12/2018	Logged By TK

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		2.10	ES		0.17	4.80	CONCRETE	
					0.60	4.37	MADE GROUND: Brown gravelly fine to coarse sand. Gravel is fine to coarse brick, flint and mortar.	
					0.95	4.02	MADE GROUND: Yellow brown sandy fine to coarse gravel of yellow brick.	
					1.70	3.27	MADE GROUND: Dark grey gravelly sandy silty clay. Gravel is fine to coarse brick, charcoal, clinker and flint. Sand is fine to coarse.	
					2.20	2.77	MADE GROUND: Black sandy fine to coarse gravel of clinker and blacktop. Sand is fine to coarse.	
					2.50	2.47	MADE GROUND: Black gravelly sandy silty clay with organic odour. Gravel is fine to coarse brick, flint and charcoal.	
End of borehole at 2.50 m								

Remarks
 Borehole remained dry and stable. No further progress below 2.5m as too dense. Standpipe installed to 2.5m, top 1.0m plain with bentonite seal and remaining 1.5m slotted with gravel surround. Completed with gas tap and safety cover.



APPENDIX D – Laboratory Test Results

Laboratory Test Results



THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 20-31002

Issue: 1

Date of Issue: 01/12/2020

Contact: Hayley Bowers

Customer Details: Leap Environmental Ltd
The Atrium
Curtis Road
Dorking
SurrevRH4 1X4

Quotation No: Q14-00063


Order No: LPO-2895

Customer Reference: LP2370

Date Received: 24/11/2020

Date Approved: 01/12/2020

Details: Crown Quay

Approved by: 

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

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Sample Summary

Report No.: 20-31002, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
220997	BH2	23/11/2020	24/11/2020		
220998	BH3	23/11/2020	24/11/2020		
220999	BH4	23/11/2020	24/11/2020		
221000	WS101	23/11/2020	24/11/2020		
221001	WS102	23/11/2020	24/11/2020		
221002	WS103	23/11/2020	24/11/2020		
221003	WS104	23/11/2020	24/11/2020		
221004	WS106	23/11/2020	24/11/2020		

Results Summary

Report No.: 20-31002, issue number 1

ELAB Reference	220997	220998	220999	221000	221001	221002
Customer Reference						
Sample ID						
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
Sample Location	BH2	BH3	BH4	WS101	WS102	WS103
Sample Depth (m)						
Sampling Date	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020

Determinand	Codes	Units	LOD	220997	220998	220999	221000	221001	221002
Dissolved Metals									
Arsenic	U	ug/l	5	< 5	< 5	< 5	6	15	14
Calcium	U	ug/l	100	139000	322000	141000	527000	249000	591000
Cadmium	U	ug/l	1	< 1	< 1	< 1	< 1	< 1	10
Chromium	U	ug/l	5	< 5	< 5	< 5	< 5	< 5	< 5
Copper	U	ug/l	5	< 5	13	< 5	< 5	< 5	24
Mercury	U	ug/l	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Potassium	U	ug/l	100	8920	39400	14400	53600	19200	203000
Magnesium	U	ug/l	100	21100	50400	9190	130000	76800	761000
Manganese	U	ug/l	5	< 5	1340	< 5	2590	1340	696
Sodium	U	ug/l	100	194000	491000	31500	830000	34400	6380000
Nickel	U	ug/l	5	< 5	38	< 5	6	7	26
Lead	U	ug/l	1	< 1	< 1	< 1	< 1	5	42
Selenium	U	ug/l	5	< 5	< 5	9	< 5	< 5	< 5
Zinc	U	ug/l	5	< 5	79	25	< 5	11	1100
Anions									
Chloride	U	mg/l	0.5	343	892	34.7	1850	26.5	12100
Fluoride	U	mg/l	0.5	< 0.5	< 0.5	< 0.5	0.6	1.3	0.6
Nitrate	U	mg/l	0.5	37.2	2.3	37.5	< 0.5	< 0.5	5.6
Sulphate	U	mg/l	0.5	78.3	216	137	147	253	1610
Inorganics									
Complex cyanide	N	ug/l	5	< 5	< 5	< 5	< 5	< 5	< 5
Free Cyanide	N	ug/l	5	< 5	< 5	< 5	< 5	< 5	< 5
Ammoniacal Nitrogen as N	N	mg/l	0.1	< 0.1	8.2	< 0.1	41	< 0.1	< 0.1
Free ammonia (NH3)	N	mg/l	0.1	0.1	12	0.1	61	0.1	0.1
Total Cyanide	U	ug/l	5	< 5	< 5	< 5	< 5	< 5	< 5
Miscellaneous									
Total Alkalinity (CaCO3)	N	mg/l	5	380	830	300	1150	820	390
Electrical Conductivity	U	uS/cm	50	1810	4390	929	7770	1750	3450
Dissolved Oxygen	N	mg/l	0.1	7.6	7.4	8.6	1.6	5.4	7.7
pH	N	pH units	0.1	7.1	7.0	7.1	7.0	7.2	7.2
Redox Potential	N	mV	-1000	228	220	192	-97.8	-40.5	230
Polyaromatic hydrocarbons									
Naphthalene GCMS	N	ug/l	0.01	0.02	0.03	0.03	0.16	1.66	0.29
Acenaphthylene GCMS	N	ug/l	0.01	0.02	0.03	0.02	0.31	4.51	0.80
Acenaphthene GCMS	N	ug/l	0.01	< 0.01	0.08	< 0.01	0.43	1.56	0.13
Fluorene GCMS	N	ug/l	0.01	< 0.01	0.04	< 0.01	0.19	2.06	0.17
Phenanthrene GCMS	N	ug/l	0.01	0.02	0.06	0.01	1.07	18.3	2.14
Anthracene GCMS	N	ug/l	0.01	< 0.01	0.03	< 0.01	0.45	8.07	1.10
Fluoranthene GCMS	N	ug/l	0.01	0.01	0.12	0.01	3.67	47.1	6.25
Pyrene GCMS	N	ug/l	0.01	0.01	0.12	0.01	3.35	38.7	5.61
Benzo (a) anthracene GCMS	N	ug/l	0.01	< 0.01	0.07	< 0.01	1.96	32.2	4.39
Chrysene GCMS	N	ug/l	0.01	< 0.01	0.08	< 0.01	2.15	28.1	4.38
Benzo (b) fluoranthene GCMS	N	ug/l	0.01	< 0.01	0.09	0.01	2.43	34.5	5.93
Benzo (k) fluoranthene GCMS	N	ug/l	0.01	< 0.01	0.09	< 0.01	2.19	29.3	5.14
Benzo (a) pyrene GCMS	N	ug/l	0.01	< 0.01	0.07	< 0.01	2.61	39.7	6.52
Indeno (1,2,3-cd) pyrene GCMS	N	ug/l	0.01	< 0.01	0.05	< 0.01	2.27	31.7	5.51
Dibenzo(a,h)anthracene GCMS	N	ug/l	0.01	< 0.01	0.02	< 0.01	0.67	11.6	1.88
Benzo(ghi)perylene GCMS	N	ug/l	0.01	< 0.01	0.07	< 0.01	2.55	35.8	6.80
Total PAH(16) GCMS	N	ug/l	0.01	0.15	1.05	0.15	26.5	365	57.1

Results Summary

Report No.: 20-31002, issue number 1

ELAB Reference	220997	220998	220999	221000	221001	221002
Customer Reference						
Sample ID						
Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
Sample Location	BH2	BH3	BH4	WS101	WS102	WS103
Sample Depth (m)						
Sampling Date	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020

Determinand	Codes	Units	LOD						
BTEX									
Benzene	N	ug/l	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Toluene	N	ug/l	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Ethylbenzene	N	ug/l	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Xylenes	N	ug/l	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
MTBE	N	ug/l	1	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
TPH CWG									
>C5-C6 Aliphatic	N	ug/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C6-C8 Aliphatic	N	ug/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C8-C10 Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
>C10-C12 Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
>C12-C16 Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
>C16-C21 Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	21.6	6.0
>C21-C35 Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	69.9	277	109
>C35-C40 Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	36.7	160	75.1
Total (>C5-C40) Aliphatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	107	458	190
>C5-C7 Aromatic	N	ug/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C7-C8 Aromatic	N	ug/l	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
>C8-C10 Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
>C10-C12 Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
>C12-C16 Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
>C16-C21 Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	< 5.0	23.9	5.9
>C21-C35 Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	72.0	472	193
>C35-C40 Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	37.0	269	127
Total (>C5-C40) Aromatic	N	ug/l	5	< 5.0	< 5.0	< 5.0	109	765	326
Total (>C5-C40) Ali/Aro	N	ug/l	5	< 5.0	< 5.0	< 5.0	216	1220	516

Results Summary

Report No.: 20-31002, issue number 1

ELAB Reference	221003	221004
Customer Reference		
Sample ID		
Sample Type	WATER	WATER
Sample Location	WS104	WS106
Sample Depth (m)		
Sampling Date	23/11/2020	23/11/2020

Determinand	Codes	Units	LOD		
Dissolved Metals					
Arsenic	U	ug/l	5	< 5	< 5
Calcium	U	ug/l	100	283000	150000
Cadmium	U	ug/l	1	< 1	< 1
Chromium	U	ug/l	5	< 5	< 5
Copper	U	ug/l	5	< 5	< 5
Mercury	U	ug/l	0.1	< 0.1	< 0.1
Potassium	U	ug/l	100	58400	21400
Magnesium	U	ug/l	100	52000	10400
Manganese	U	ug/l	5	509	6
Sodium	U	ug/l	100	185000	58300
Nickel	U	ug/l	5	10	< 5
Lead	U	ug/l	1	< 1	< 1
Selenium	U	ug/l	5	10	24
Zinc	U	ug/l	5	< 5	< 5
Anions					
Chloride	U	mg/l	0.5	280	55.9
Fluoride	U	mg/l	0.5	< 0.5	< 0.5
Nitrate	U	mg/l	0.5	1.3	42.0
Sulphate	U	mg/l	0.5	573	206
Inorganics					
Complex cyanide	N	ug/l	5	< 5	< 5
Free Cyanide	N	ug/l	5	< 5	< 5
Ammoniacal Nitrogen as N	N	mg/l	0.1	< 0.1	< 0.1
Free ammonia (NH3)	N	mg/l	0.1	0.1	0.1
Total Cyanide	U	ug/l	5	< 5	< 5
Miscellaneous					
Total Alkalinity (CaCO3)	N	mg/l	5	540	310
Electrical Conductivity	U	uS/cm	50	2600	1110
Dissolved Oxygen	N	mg/l	0.1	8.0	8.8
pH	N	pH units	0.1	7.3	7.3
Redox Potential	N	mV	-1000	172	150
Polyaromatic hydrocarbons					
Naphthalene GCMS	N	ug/l	0.01	0.04	0.04
Acenaphthylene GCMS	N	ug/l	0.01	0.07	0.06
Acenaphthene GCMS	N	ug/l	0.01	0.02	0.02
Fluorene GCMS	N	ug/l	0.01	0.05	0.02
Phenanthrene GCMS	N	ug/l	0.01	0.22	0.19
Anthracene GCMS	N	ug/l	0.01	0.07	0.07
Fluoranthene GCMS	N	ug/l	0.01	0.64	0.58
Pyrene GCMS	N	ug/l	0.01	0.58	0.55
Benzo (a) anthracene GCMS	N	ug/l	0.01	0.33	0.31
Chrysene GCMS	N	ug/l	0.01	0.35	0.35
Benzo (b) fluoranthene GCMS	N	ug/l	0.01	0.37	0.37
Benzo (k) fluoranthene GCMS	N	ug/l	0.01	0.35	0.38
Benzo (a) pyrene GCMS	N	ug/l	0.01	0.41	0.42
Indeno (1,2,3-cd) pyrene GCMS	N	ug/l	0.01	0.27	0.30
Dibenzo(a,h)anthracene GCMS	N	ug/l	0.01	0.09	0.12
Benzo(ghi)perylene GCMS	N	ug/l	0.01	0.32	0.37
Total PAH(16) GCMS	N	ug/l	0.01	4.20	4.12

Results Summary

Report No.: 20-31002, issue number 1

ELAB Reference	221003	221004
Customer Reference		
Sample ID		
Sample Type	WATER	WATER
Sample Location	WS104	WS106
Sample Depth (m)		
Sampling Date	23/11/2020	23/11/2020

Determinand	Codes	Units	LOD		
BTEX					
Benzene	N	ug/l	1	< 1.00	< 1.00
Toluene	N	ug/l	1	< 1.00	< 1.00
Ethylbenzene	N	ug/l	1	< 1.00	< 1.00
Xylenes	N	ug/l	1	< 1.00	< 1.00
MTBE	N	ug/l	1	< 1.00	< 1.00
TPH CWG					
>C5-C6 Aliphatic	N	ug/l	1	< 1.0	< 1.0
>C6-C8 Aliphatic	N	ug/l	1	< 1.0	< 1.0
>C8-C10 Aliphatic	N	ug/l	5	< 5.0	< 5.0
>C10-C12 Aliphatic	N	ug/l	5	< 5.0	< 5.0
>C12-C16 Aliphatic	N	ug/l	5	5.5	< 5.0
>C16-C21 Aliphatic	N	ug/l	5	< 5.0	< 5.0
>C21-C35 Aliphatic	N	ug/l	5	< 5.0	< 5.0
>C35-C40 Aliphatic	N	ug/l	5	< 5.0	< 5.0
Total (>C5-C40) Aliphatic	N	ug/l	5	5.5	< 5.0
>C5-C7 Aromatic	N	ug/l	1	< 1.0	< 1.0
>C7-C8 Aromatic	N	ug/l	1	< 1.0	< 1.0
>C8-C10 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C10-C12 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C12-C16 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C16-C21 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C21-C35 Aromatic	N	ug/l	5	< 5.0	< 5.0
>C35-C40 Aromatic	N	ug/l	5	< 5.0	< 5.0
Total (>C5-C40) Aromatic	N	ug/l	5	< 5.0	< 5.0
Total (>C5-C40) Ali/Aro	N	ug/l	5	5.5	< 5.0

Method Summary

Report No.: 20-31002, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Water					
Aliphatic/Aromatic hydrocarbons in water	N		01/12/2020		GC-FID
Aromatic hydrocarbons in water	N		01/12/2020		GC-FID
Alkalinity in waters	N		26/11/2020	100	Titrimetry
pH of waters	N		26/11/2020	113	Electromeric
Cyanide in waters	U		26/11/2020	130	Colorimetry
PAHs and/or PCBs in waters	N		26/11/2020	135	GC-MS
Electrical conductivity of water	U		26/11/2020	136	Electromeric
Ammonia in waters	N		26/11/2020	151	Colorimetry
BTEX in waters	N		01/12/2020	200	GC-MS
Low range Aliphatic hydrocarbons water	N		01/12/2020	200	GC-MS
Low range Aromatic hydrocarbons water	N		01/12/2020	200	GC-MS
Redox potential in waters	N		01/12/2020	201	Electromeric
Cyanide in waters	U		26/11/2020	205	Colorimetry
DO (Dissolved Oxygen) in waters	N		27/11/2020	211	Electromeric
Aliphatic hydrocarbons in water	N		26/11/2020	215	GC-FID
Aromatic hydrocarbons in water	N		26/11/2020	215	GC-FID
Anions	U		26/11/2020	270	Ion Chromatography
Dissolved metals by ICP in waters	U		26/11/2020	301	ICPMS

Tests marked N are not UKAS accredited

Report Information

Report No.: 20-31002, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

LOD LOD refers to limit of detection, except in the case of pH soils and pH waters where it means limit of discrimination.
Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.
ELAB are unable to provide an interpretation or opinion on the content of this report.
The results relate only to the sample received.
PCB congener results may include any coeluting PCBs
Uncertainty of measurement for the determinands tested are available upon request
Unless otherwise stated, sample information has been provided by the client. This may affect the validity of the results.

Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

APPENDIX E – RTM Worksheets

RTM Worksheets

Site Name
 Address
 Completed by
 Date

Crown Quay
 Sittingbourne
 MP
 25/01/2021

Parameter	Symbol	Inputs	Units	Comment/Justification
Bulk density of soil zone material	r	1.8	g/cm3	Typical Value for Chalk
Fraction of organic carbon	foc	0.01	fraction	Typical values for Chalk.
Area of contaminant source	A	750	m2	Approximate area of former wharf
Length of contaminant source in direction of groundwater flow	L	50	m	Approximate length of former wharf
Saturated aquifer thickness	da	15	m	Max proven thickness of saturated zone from investigations to date
Hydraulic Conductivity of aquifer in which dilution occurs	K	0.4	m/d	Approximation based on nearby sites
Hydraulic gradient of water table	i	0.0065	fraction	Calculated from on site groundwater level measurements and site survey
Width of contaminant source perpendicular to groundwater flow	w	15	m	Width of site
Background concentration	Cu	0	mg/l	Conservatively Assumed as zero
Bulk density of aquifer materials	r	1.8	g/cm3	Wiedemeier, 1990
Effective porosity of aquifer	n	0.01	fraction	Typical value for chalk (dual porosity aquifer)
Distance to compliance point	x	150	m	Used to determine extent of impacts
Width of plume in aquifer at source (perpendicular to flow)	Sz	15	m	Approximate width of former wharf
Plume thickness at source	Sy	15	m	Assumed thickness based on 90% of proven aquifer thickness

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Benzo(a)Pyrene		from Level 1
Target Concentration	1.00E-05	mg/l	from Level 1

Select Method for deriving Partition Co-efficient (using pull down menu)
 User specified value for partition coefficient

Soil water partition coefficient	Kd	1.00E-03	l/kg
Entry if specify partition coefficient (option)			
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,rel}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.00E-03	l/kg

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	7.00E-05	mg/l	Max recorded concentration in BH3
Half life for degradation of contaminant in water	4.50E+03	days	The Effects of Contaminant Concentration
Calculated decay rate	1.54E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	1.50E+01	m	Assumed width of the former wharf area
Plume thickness at source	1.50E+01	m	Assumed thickness based on 90% of proven aquifer thickness
Saturated aquifer thickness	2.50E+01	m	Max proven thickness of saturated zone
Bulk density of aquifer materials	1.80E+00	g/cm ³	Wiedemeier, 1990
Effective porosity of aquifer	1.00E-01	fraction	Conservative effective porosity value for Chalk
Hydraulic gradient	6.50E-03	fraction	Calculated from on site groundwater level measurements and site survey
Hydraulic conductivity of aquifer	4.00E-01	m/d	Assumed value for high permeability chalk
Distance to compliance point	1.50E+02	m	Initial theoretical compliance point
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	1.00E-03	l/kg	see options
Longitudinal dispersivity	1.50E+01	m	see options
Transverse dispersivity	1.50E+00	m	see options
Vertical dispersivity	1.50E-01	m	see options

Calculated Parameters

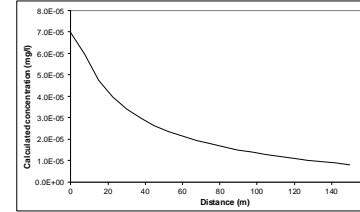
Groundwater flow velocity	v	2.60E-02	m/d
Retardation factor	Rf	1.02E+00	fraction
Decay rate used	λ	1.51E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	2.55E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	8.29E-06	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	8.44E+00	

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Variable	Value	Unit	Source
Longitudinal dispersivity	ax	1.50E+01	m
Transverse dispersivity	az	1.50E+00	m
Vertical dispersivity	ay	1.50E-01	m

Note values of dispersivity must be > 0
 For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
 Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.414}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.
 By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.
 Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc then an alternative solution should be used

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	7.5E-05
7.5	5.95E-05
15.0	4.75E-05
22.5	3.89E-05
30.0	3.39E-05
37.5	2.97E-05
45.0	2.63E-05
52.5	2.36E-05
60.0	2.14E-05
67.5	1.94E-05
75.0	1.78E-05
82.5	1.63E-05
90.0	1.50E-05
97.5	1.38E-05
105.0	1.28E-05
112.5	1.19E-05
120.0	1.10E-05
127.5	1.02E-05
135.0	9.54E-06
142.5	8.99E-06
150.0	8.29E-06

Site being assessed:	Crown Quay
Completed by:	MP
Date:	00/01/1900
Version:	3.2

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	8.44E-05	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	150	m	
Concentration of contaminant at compliance point after	8.29E-06	mg/l	Ogata Banks
	1.0E+100	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
 The recommended value for time when calculating the remedial target is 9.9E+99.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note



Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Sum of 4 PAH		from Level 1
Target Concentration	1.00E-04	mg/l	from Level 1

Select Method for deriving Partition Co-efficient (using pull down menu)
 User specified value for partition coefficient

Soil water partition coefficient	Kd	1.00E-03	l/kg
Entry if specify partition coefficient (option)			
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,2}$		l/kg
Sorption coefficient for ionised species	$K_{oc,1}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.00E-03	l/kg

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	3.00E-04	mg/l	Max recorded concentration in BH3
Half life for degradation of contaminant in water	4.27E+03	days	The Effects of Contaminant Concentration
Calculated decay rate	1.62E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	1.93E+01	m	Assumed width of former shaft area
Plume thickness at source	1.93E+01	m	Assumed thickness based on 90% of proven aquifer thickness
Saturated aquifer thickness	2.50E+01	m	Max proven thickness of saturated zone
Bulk density of aquifer materials	1.80E+00	g/cm ³	Wiedemeier, 1990
Effective porosity of aquifer	1.00E-01	fraction	Conservative effective porosity value for Chalk
Hydraulic gradient	6.50E-03	fraction	Calculated from on site groundwater level measurements and site survey
Hydraulic conductivity of aquifer	4.00E-01	m/d	Assumed value for high permeability chalk
Distance to compliance point	1.00E+02	m	Initial theoretical compliance point
Distance (lateral) to compliance point perpendicular to flow direction	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	0.00E+00	m	
Time since pollutant entered groundwater	1.00E+100	days	time variant options only
Partition coefficient	Kd	1.00E-03	l/kg see options
Longitudinal dispersivity	ax	1.00E+01	m see options
Transverse dispersivity	az	1.00E+00	m see options
Vertical dispersivity	ay	1.00E-01	m see options

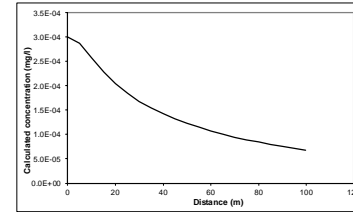
Calculated Parameters Variable

Groundwater flow velocity	v	2.60E-02	m/d
Retardation factor	Rf	1.02E+00	fraction
Decay rate used	λ	1.59E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	2.55E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	6.72E-05	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	4.47E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Ogata Banks	4.47E-04	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	100	m	
Concentration of contaminant at compliance point after	6.72E-05	mg/l	Ogata Banks
	1.0E+100	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Crown Quay
Completed by:	MP
Date:	00/01/1900
Version:	3.2

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
0	3.0E-04
5.0	2.8E-04
10.0	2.5E-04
15.0	2.2E-04
20.0	2.0E-04
25.0	1.8E-04
30.0	1.6E-04
35.0	1.5E-04
40.0	1.4E-04
45.0	1.3E-04
50.0	1.2E-04
55.0	1.1E-04
60.0	1.0E-04
65.0	1.0E-04
70.0	9.4E-05
75.0	8.8E-05
80.0	8.3E-05
85.0	7.9E-05
90.0	7.4E-05
95.0	7.0E-05
100.0	6.7E-05