CROWNHILL TOPSOIL PRELIMINARY GROUND AND SURFACE WATER RISK ASSESSMENT REV1 - 2020

Unit 1009, Caerwent Army Training Estate, Caerwent

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Introduction

Ecovigour Ltd were commissioned by Crownhill Topsoil and Aggregates in 2018 to prepare a ground and surface water risk assessment in support of an application for a Bespoke Environmental Permit based on the following Standard Rule Set SR2010_No12 – Treatment of Waste to produce Soil, Soil Substitutes and Aggregates. This document is an update on this report incorporating information from surface and ground water monitoring, undertaken at the site in November 2019.

The permit application is for the operation of an inert waste recycling facility for the production of soils and aggregates from inert wastes.

Site Location

The site is located at Unit 1009 within the Caerwent Army Training Estate. The site occupies an area of around 6ha in the north west of the estate. There are a number of brick and concrete built buildings within the boundary of the site which have previously been used for compost production. This site is a combination of hard covered and permeable areas within the secure confines of the Army Training Estate. The site is secure against unauthorised access with all traffic entering and leaving the site passing through a manned security barrier.

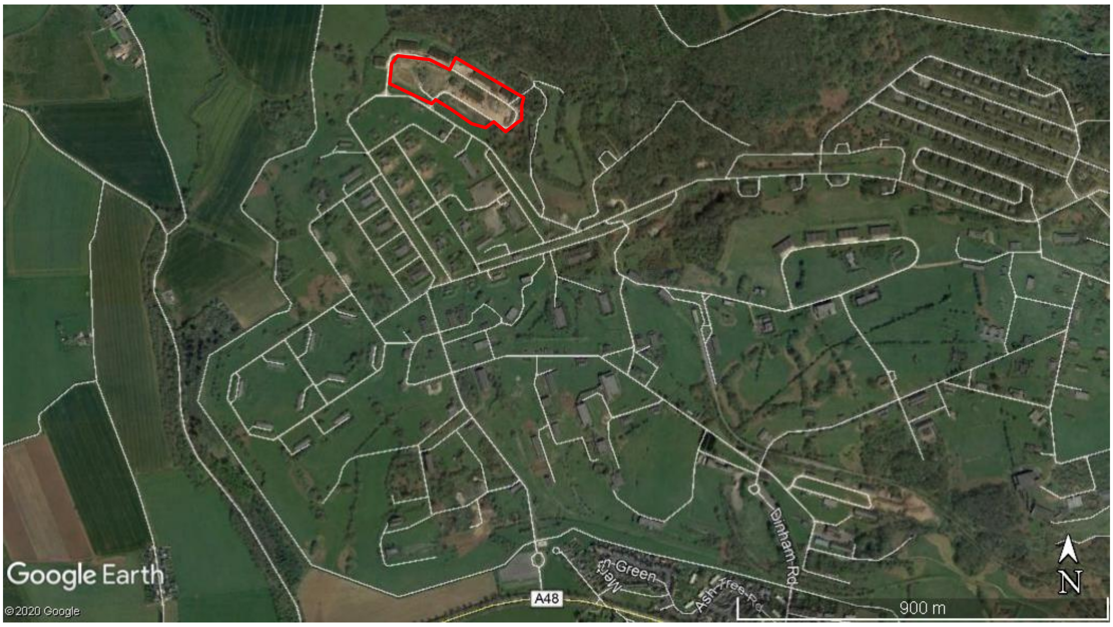


FIGURE 1: SITE LAYOUT

Scope of Work

This report initially details the geology, hydrogeology and hydrology of the site. This information is then utilised to produce a groundwater risk assessment in accordance with the Risk Assessments and Groundwater Risk Assessments Guidance produced by the Environment Agency and The Department for Environment, Food and Rural Affairs (DEFRA) in February 2016. This guidance has replaced the H1 Environmental Risk Assessment tool and guidance which was withdrawn in February 2016. These guidance notes outline the following requirements:

- Source/Pathway/Receptor Approach

- Conceptual Model
- Tiered Risk assessment

Risk Assessment Methodology

As per the Environment Agency guidelines, this risk assessment follows a strict methodology to ensure it is thorough and accurate. This methodology comprises of the following steps:

Desk Study

The desk study utilises all available geological maps, historical maps, hydrological maps and previous site investigation/condition reports to generate a thorough understanding of the environmental setting of the site. The desk study includes a water features survey, which identifies any private and licensed groundwater abstractions within proximity to the site.

One of the primary objectives of the desk study is to identify all possible sources, pathways and receptors for the site. These are listed and described in detail, which allows risks to be easily identified and subsequently mitigated.

Conceptual Model

A conceptual model can be created once the above have been identified. Groundwater Protection: Principles and Practice (GP3) states that a conceptual model is "a simplified representation or working description of what we believe to be the physical, chemical and biological processes operating at a site or study area.". This usually takes the form of an annotated diagram outlining the processes taking place at the site.

Risk Assessment

The guidance recommends the use of a tiered approach, which ensures that time and effort is correctly utilised where required. The guidance identifies 3 tiers:

Tier 1 – qualitative risk screening – investigate what the risks are, whether more detailed assessment is needed and what that would need to focus on (risk prioritisation). This involves carrying out basic calculations to predict dilution factor within the mixing zone beneath the site, as well as the attenuation factor for each substance.

Tier 2 – generic quantitative risk assessment – to collect more information an informed decision can be made regarding the risk posed by the site. This includes the use of hydrogeological calculations to predict the level of attenuation present for the discharge to ground under worst-case scenario.

Tier 3 – detailed quantitative risk assessment – to collect more information and formulate a plan if there are clear source-pathway-receptor relationships. This involves a detailed assessment of groundwater, the attenuation processes present, as well as using probabilistic calculations to assess what outcomes of certain scenarios may be.

Compliance points must also be identified. These are important in ensuring that the contaminant concentrations do not reach unacceptable levels. Compliance points are monitoring locations, such as boreholes, which must be located in a position which will accurately assess the nature of the site's impact on the groundwater. Limits of concentration must be set based on environmental standards, if these are exceeded action must be taken.

Principle Source

This study is based on information gained during the following studies undertake at the site:

Tier one groundwater and surface water risk assessment undertaken by SKM Enviros as part of a Land Quality Assessment in 2014;

DTE Caerwent – Former Wormtech Area LQA2 Addendum – Jacobs – July 2016;

DTE Caerwent – Former Wormtech Area LQA2 Addendum – Jacobs – November 2019.

Desk Study

Much of the desk study is based on reports generated by data searches undertaken by Groundsure in November 2016. These provide data on geology, hydrogeology, hydrology and site history. More detailed information regarding groundwater location, flow and composition has been obtained from the Land Quality Assessments of the site undertaken of by SKM Enviros and Jacobs. These reports include risk assessments for the impact to groundwater and surface water the results of which are outlined in this report.

Site History

The site is located on an Army training facility, which has been utilised by the military since 1939, initially as a propellant factory, then from 1968 until 1993 a US Army Reserve Storage Depot, and finally utilised as a training facility, which continues to this day.

The exact nature of the use of the site during the time when it was used by the MoD is not known, but from the nature of the buildings and the position of Unit 1009 on the periphery of the site it is likely that the site was constructed during the latter stages of the development of the army base and was used for storage.

Between 2006 and 2012, the site was occupied by Wormtech, company specialising in the composting of green waste, and later food waste. Systems were initially put in place by Wormtech to prevent contamination. The operations were carried out on hardstanding, and runoff from waste stockpiles was piped to a lagoon, from which the water was pumped into tankers and removed from site. In the later stages of Wormtech’s operations, more waste was accepted than was processed and removed. This resulted in large stockpiles being left on site. The hardstandings, particularly the roads, deteriorated due to wear. Similarly, the piping systems showed evidence of leakage and failure. As a result, runoff from the stockpiles caused a significant impact on surface and groundwater. The environmental consequences of the site prompted the shutting down of the business. No remedial action was undertaken by Wormtech, who left the stockpiles of green waste on site. All food waste and a large amount of green waste was removed from the site by the Welsh Assembly Government in 2013.

Historical mapping of the area is severely limited due to the site’s past military use. The oldest map in which the site is shown to have roads and structures present is 2002. Prior to this, all mapping shows the site being located across two agricultural fields. The military base has been present at this site in some form since 1939.

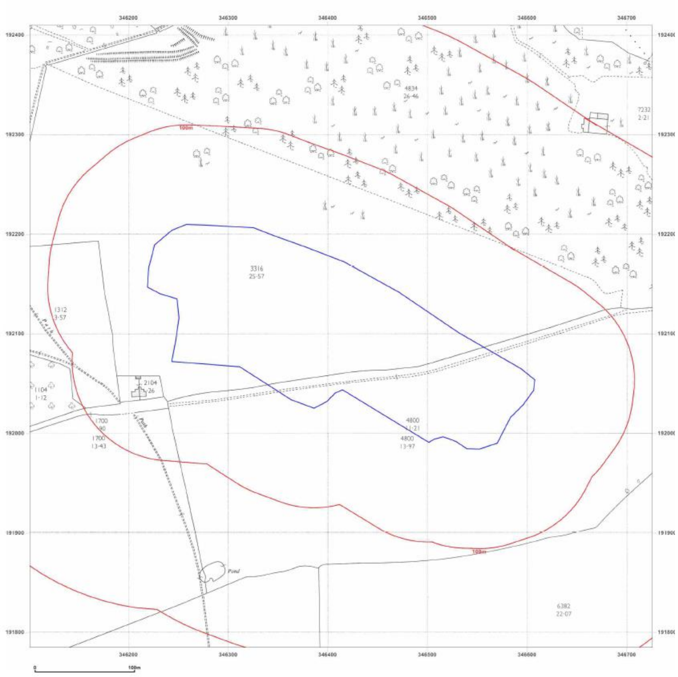


FIGURE 2: OS MAP OF SITE 1964

Although historical maps of the area remain predominantly unchanged until recently, the Groundsure data search returned data regarding potentially contaminative historical land features and historical ground works information.

The search did not identify any potentially contaminative land within the site boundary. It did however identify a number of areas of "Potentially Infilled Land", including cuttings and unspecified heaps within 500m of the site boundary. There was also an unspecified mill 193m south west of the site, and a number of quarries and kilns located over 350m from the boundary. These are predominantly clustered in the south/south east, although two disused mills were identified 452m to the north of the site.

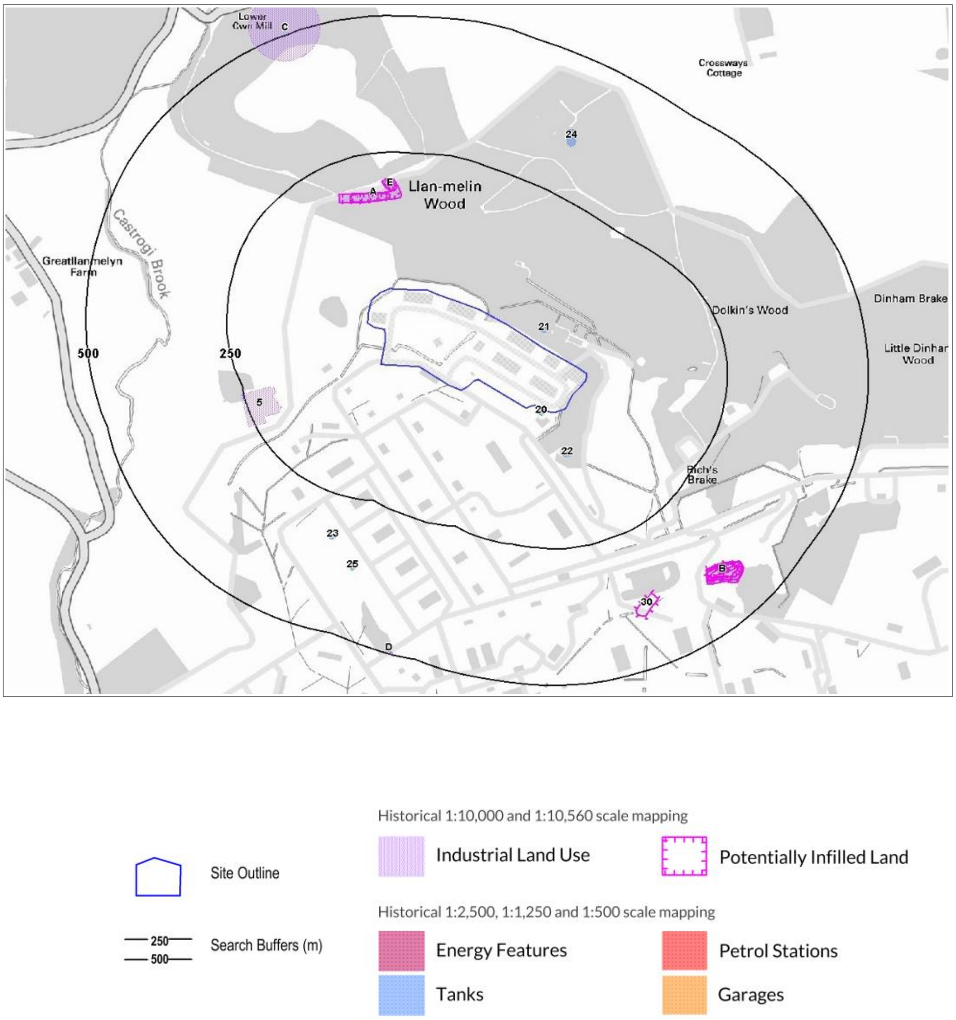


FIGURE 3: HISTORICAL INDUSTRIAL SITES

The data search also returned 5 records of pollution incidents within 500m of the site. 4 of these were located on site, and occurred in October 2012, all of which are identified as occurring within the site boundary. These were listed as having a significant impact on the land, with a minor impact to water. There was also a pollution incident in November 2010 which had significant impact on both land and water, with minor impact to air. This was located 325m south west of the site. These incidents coincided with the presence of the Wormtech composting facility on site, which was run between 2006 and 2012.

FIGURE 4: POLLUTION INCIDENTS AT SITE

The data search returned 4 waste treatment licenses for the Wormtech composting facility on site. No other waste treatment, transfer or disposal sites were identified within 500m of the site.

FIGURE 5: WASTE SITES

The Groundsure report identified two historic mining areas within 1000m of the site. The first was located 193m south west of the site. The second was 612m to the west of the site. Both records were from 1902 and do not specify mining type.

FIGURE 6: HISTORICAL MINING

Geological Setting

The geology of the site has been identified through both the data search undertaken by Groundsure and reviews of the Land Quality Assessment report carried out by SKM environmental and the 2016 and 2019 addendums completed by Jacobs. These identify river terrace deposits to the south west of the site. These deposits consist of clay, silt, sand and gravel, and cover most of the south west of the army training facility. Clays and gravels are present to a depth of 4 - 6m, as identified by trial pits and boreholes utilised for the SKM report. The superficial deposits across the site have been identified as having low to moderate permeability.

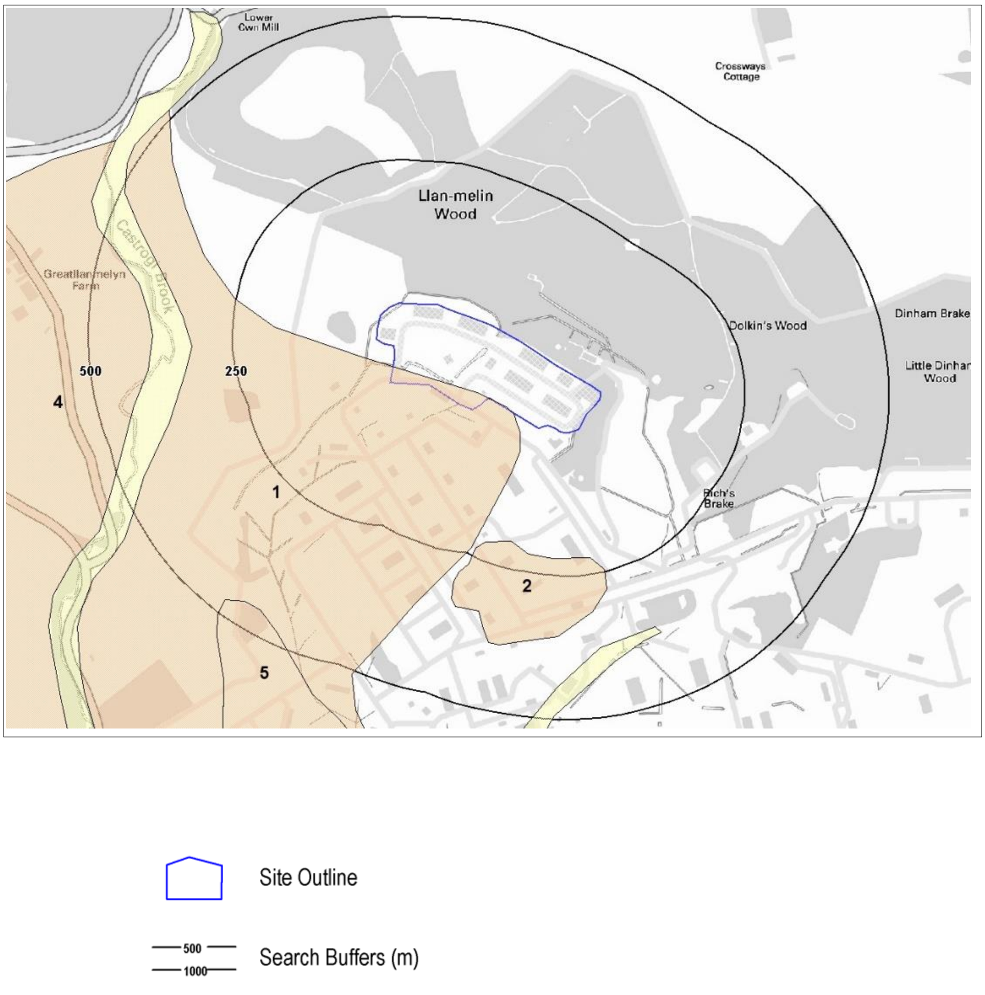


FIGURE 7: SUPERFICIAL DEPOSITS

The bedrock geology of the area is composed of Carboniferous Limestone, specifically the Black Rock Limestone Subgroup (Dolostone) and the Gully Oolite Formation. There is a fault which runs through the site from north to south in the east of the site. There is also a fault to the north, which runs perpendicular with the fault which bisects the site, intersecting north of the boundary.

The data search identified that the permeability of the bedrock underlying the site is between high and very high. This is due to the presence of the faults and fractures present within the rock formation.

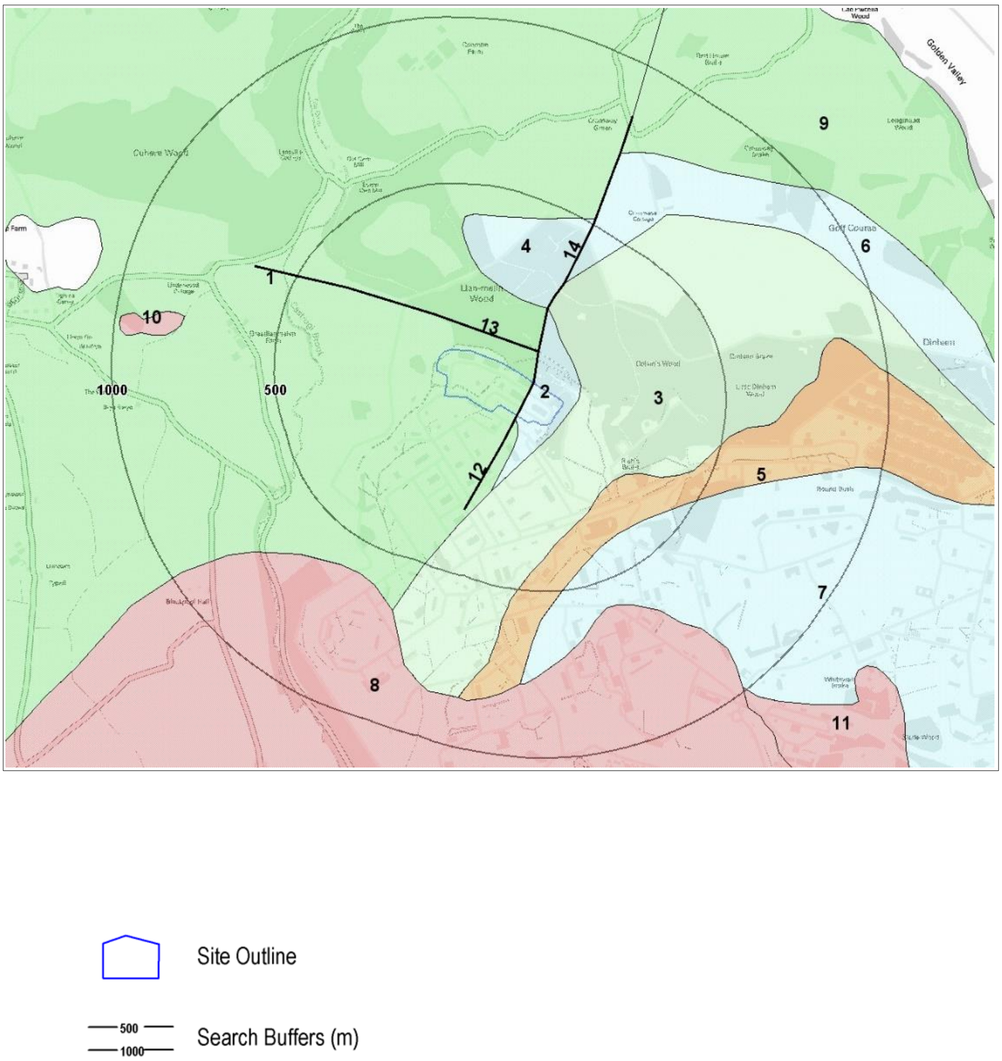


FIGURE 8: BEDROCK GEOLOGY

Hydrogeological Setting

The superficial deposits present on site have been designated as “unproductive”. It has been identified that these deposits have low permeability, and as such have negligible significance for water supply or river base flow.

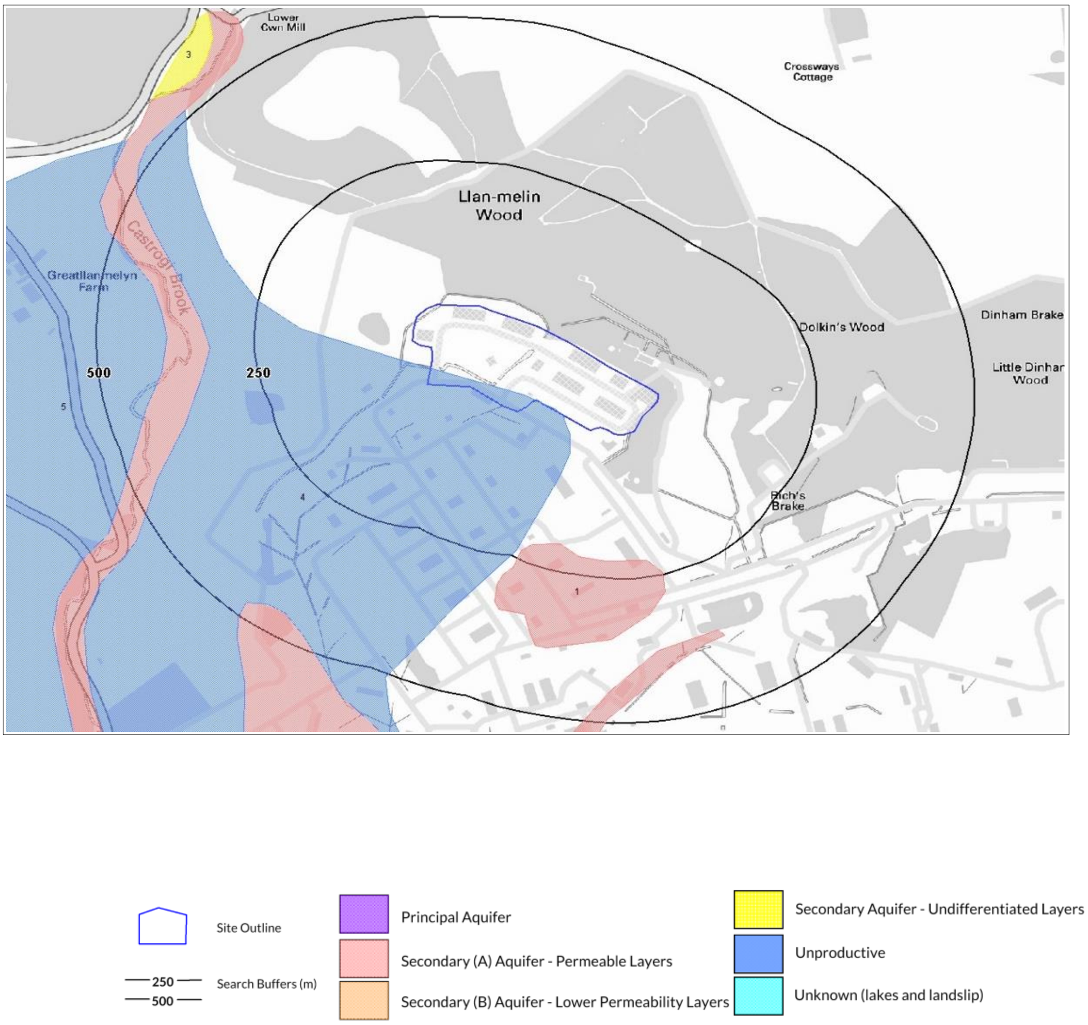


FIGURE 9: AQUIFERS WITHIN SUPERFICIAL GEOLOGY

The bedrock has a high level of permeability. It has been designated as a “Principle Aquifer” by the data search, which is defined as “Geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale. Generally principal aquifers were previously major aquifers”. This principle aquifer forms part of the source protection zone (SPZ1) for the Severn Tunnel Great Spring Abstraction at Sudbury.

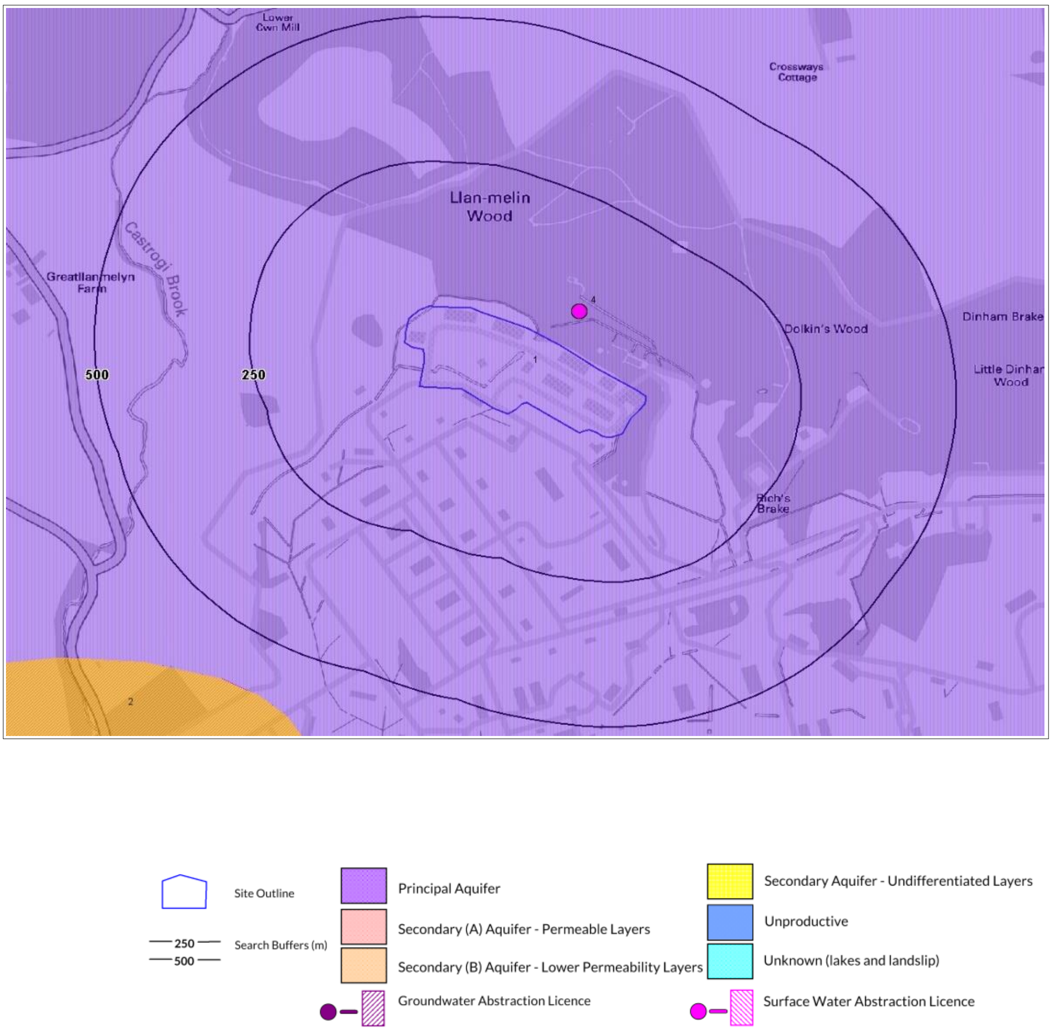


FIGURE 10: AQUIFERS PRESENT IN UNDERLYING GEOLOGY

The 2014 Land Quality Assessment established 11 groundwater monitoring locations to establish and then enable monitoring of groundwater conditions at the site. These boreholes were ten monitored in July 2014 and November 2019 (some of the boreholes had been removed or damaged by this point meaning that samples could not be taken) The following information is provided by reporting from these studies:

- The general direction of groundwater movement is southerly at the site;
- Water levels tend to be higher on the northern side of the site;
- During periods of low rainfall, there are substantial variations in groundwater level, often over short distances, suggesting the aquifer is not laterally consistent with the water table;
- During periods of high rainfall, this is not the case, with levels being fairly uniform, as shown in figures 11 and 12 (rainfall was consistently high between 25th November and 10th December 2014);

- Two of the boreholes within close proximity to each other (122m) differed by up to 5.9m, which suggests the fault near the lower-level borehole is increasing the flow rate of the groundwater.

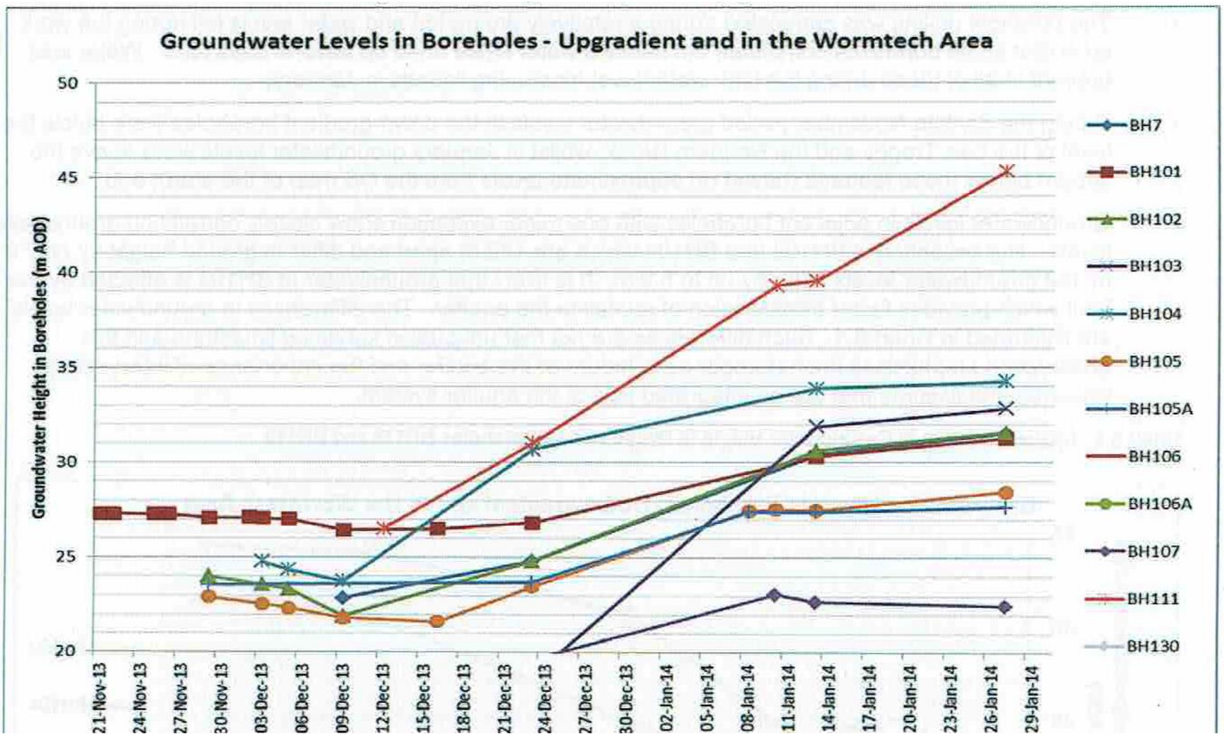


FIGURE 11: GROUNDWATER LEVELS IN BOREHOLES UPGRADIENT OF SITE

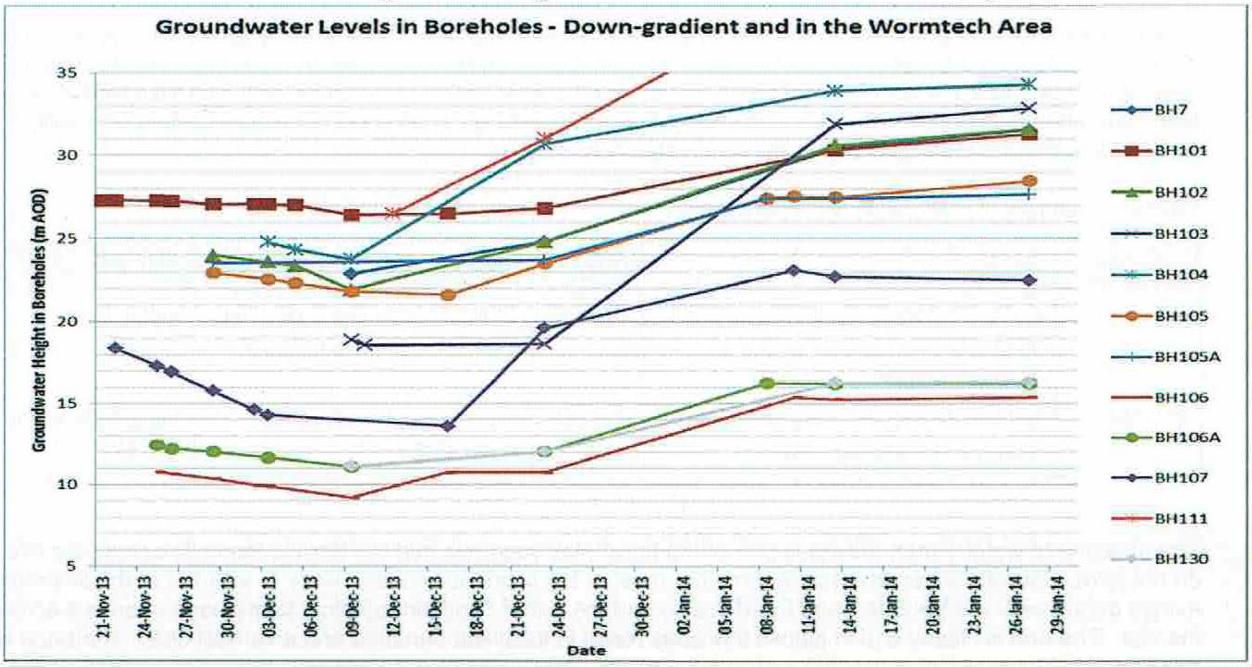
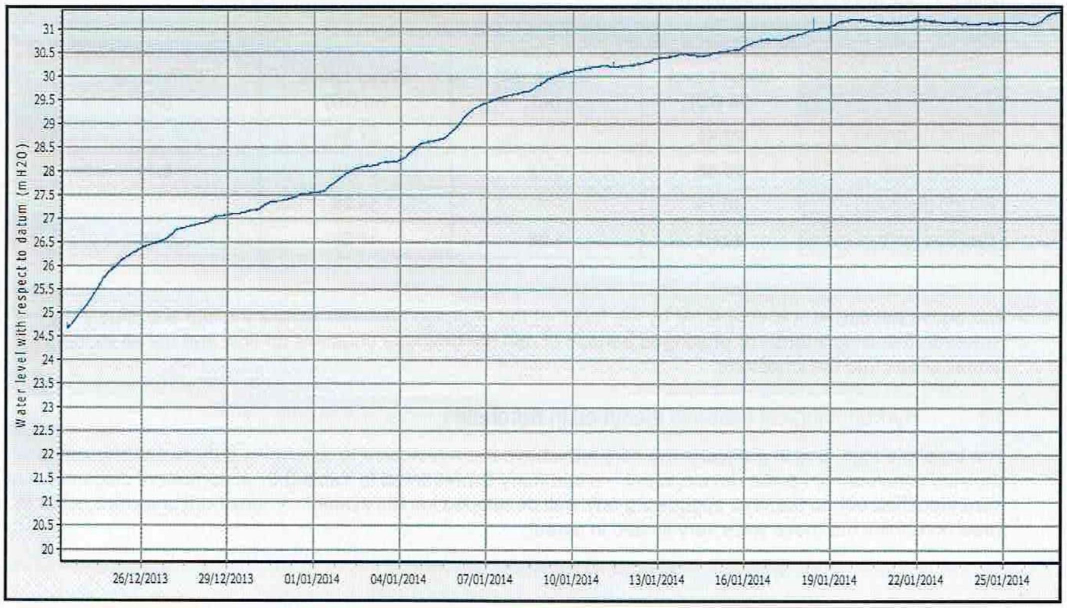


FIGURE 12: GROUNDWATER GRADIENT IN BOREHOLES DOWNGRADIENT OF SITE

The SKM report found that the recharge at the site is dominated by dispersed recharge from incident rainfall across the site, rather than fast recharge and discharge associated with fast moving, highly permeable geology. This can be seen in Figure 12 where there are no significant peaks or troughs.



Borehole logs also identify that there appears to be a number of small perched watertables within the site boundary where the material above the limestone becomes very clay-heavy. These are predominantly located in the south west and south east of the site, and do not carry a great deal of water.

No groundwater discharges have been identified on site.

There are no groundwater abstractions present in the vicinity of the site. There are 4 abstraction locations which have been identified down gradient of the site. These are:

- Phillips Abstraction;
- Broome & Co Ltd Abstraction;
- Marriott St Pierre Hotel & Country Club Abstraction;
- Severn Tunnel Great Spring Abstraction.

The most significant of these is the Severn Tunnel Great Spring Abstraction, which is located 6km SE of the Crownhill site. This is used for drinking water.

The SKM and Jacobs reports identify several exceedances in the groundwater quality. The contaminants in question were ammonia, manganese, BOD and iron. These are localised to the site and are not present downgradient. Monitoring data demonstrates that the level of contamination has significantly reduced during the 6 years of monitoring undertaken due to the removal of some of the compost as part of the original trials, the movement of wastes and turning of them to allow the compost to mature aerobically and the maturation of the compost to a more stable state.

Crownhill Topsoil and Aggregates have no current plans to utilise more of the compost, due to the complexity this adds to the Environmental Permitting process.

Hydrological Setting

As with much of the Army Training site, there are drains in and around the site. There is one drain which runs through the centre of the site, flowing south west. The second drain runs around the north of the site, flowing south to meet the first. These drains are ephemeral and dry up during periods of dry weather.

From mapping available, a surface water drain used to flow through the centre of Unit 1009. This was blocked upstream by Wormtech, with the water being diverted into the drain running along the north side of Unit 1009. This resulted in the flow ending up in the same location but reduced potential for leachate from green and food waste stored at the site to run into the drain. The drainage channel has since been backfilled.

The Castrogi brook is located west of the site. The drainage from the training facility eventually drains into this brook, which becomes the Neddem Brook further downstream. It is assumed that all surface water, if unimpeded, will eventually flow to the Severn Estuary. Surface water runoff from the Unit 1009 flows west along the drainage ditch along the southern boundary of the site and then south to a culvert beneath agricultural land on the western side of the MoD base. This culvert discharges into the Castrogi Brook.

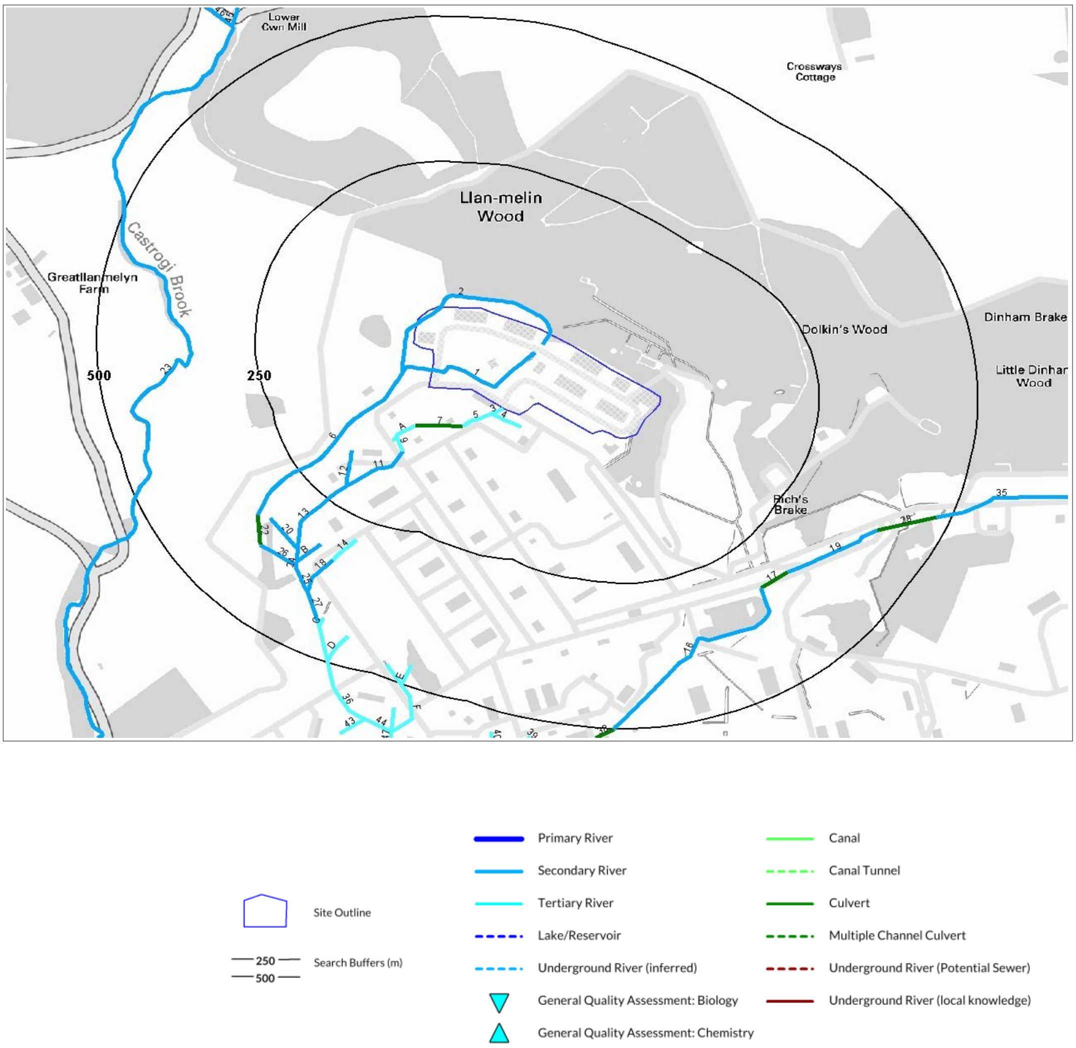


FIGURE 13: SURFACE WATER BODIES AROUND SITE

There are no surface water extractions within close proximity of the site. There is one extraction 1585m north of the site, which is upstream and therefor irrelevant to this study.

Previous Site Studies

Land Quality Assessment Report – SKM Enviros – April 2014:

SKM Enviros undertook a comprehensive Land Quality Assessment in April 2014. This study was subsequent to the removal of the Wormtech food waste and much of the green waste from within and around Unit 1009, by the Welsh Government. TheLQA2 report focussed on the impact of leachate from the green waste stockpiles on surface and groundwater and the residual risk to surface and groundwater from the remaining materials on site, subsequent to this removal. The study undertook a Tier 1 risk assessment with regards to this leachate, identifying the risks posed by the contamination to ground and surface waters, within Unit 1009 and the western section of the MoD Base.

The report identified localised but significant breaches of Environmental Quality Standards (EQS)/Drinking Water Standards (DWS) for leachable waste compounds, namely ammonia, manganese, BOD and iron. These exceedances were localised to the site, with no contamination being detected in wells down-gradient of the site, or within the Castrogi brook. This suggests that the contaminants are either static within the aquifer, dispersing slowly or diluted or filtered from the groundwater as it flows down-gradient. Or a combination of all of these mechanisms.

The risk assessment concluded that the risk to the groundwater local to the site is high due to the scale of contamination present within the samples taken within the site boundary. This contamination was predominantly manganese, with a lower level of contamination from ammonia. However, the report also concluded that the risk to the regional aquifer was low. This was due to the lack of contamination detected downgradient of the site boundary.

Prior to this report, SKME had undertaken 5 studies of the condition of the land at the site:

- Land Quality Assessment Desk Study (2006): This was a study into the potential for contamination as a result of effluent storage during military use. It concluded that there was very limited potential for historical contaminants at the site due to the length of time since the site was last used for this purpose;
- Environmental Assessment of Wormtech Site Facilities (2012): This was an on-site inspection of the Wormtech site, which concluded that a phased site investigation was required;
- Report on Intrusive Site Investigation Comprising Shallow Boreholes (2010): This study focused on the shallow boreholes which were installed on site. No aquifer was found, so it recommended that deeper boreholes be installed;
- Survey of Drainage Ditches South of the Wormtech Area (2012): This study was undertaken after sewage fungus was discovered in the drainage ditches south of the site. It was subsequently discovered that the composition of the waste was very similar to the water from the Wormtech leachate lagoon. As a result, the lagoon was pumped and the contents taken off site;
- Report on the Investigation of Groundwater Quality in the Limestone Aquifer (2010): This study was to determine whether the groundwater was being contaminated by the Wormtech facility. At the time, no contamination was detected within the groundwater in either boreholes.

<u>DTE Caerwent: Former Wormtech Area LQA2 Addendum – Jacobs – July 2016:</u>

The report was produced following a walkover site visit on the 12th – 14th April 2016. During this walkover, surface water samples were taken at 6 locations and attempted at another 2, where it was not possible to obtain a sample as the watercourse was dry.

Groundwater samples were taken from 10 boreholes, one of which is described as being up-gradient but from a review of the BH depth and with consideration of the topography of the site EcoVigour believes that this would not be significantly up-gradient.

Summary of Surface Water and Groundwater Sampling Locations

Location	Description
Surface Water Sampling Locations	
*SW202	New shallow sediment settlement pond within CTL site.
SW101	Onsite drainage ditch immediately southwest of FWA.
SW105	Onsite drainage ditch down-gradient of the FWA.
*SW201	New surface water monitoring location (onsite drainage ditch) near Building 715, situated between SW105 and SW102.
SW102	Onsite drainage ditch, SW part of MOD Caerwent at perimeter fence.
Field Culvert	Entrant to Cas Troggy culvert from field outside MOD Caerwent's SE boundary fence
SW103	On Cas Troggy brook, upstream of culvert entry.
SW104	On Cas Troggy brook, downstream of culvert entry.
Groundwater sampling locations	
BH103	Up-gradient borehole on northern edge of FWA close to building 845.
BH102	Southern edge of FWA
BH7	Southern edge of FWA
BH104	South-eastern edge of FWA.
BH105	South-western edge of FWA
BH105A	South-western edge of FWA (shallow borehole adjacent to BH105)
BH106	Down-gradient borehole on MOD Caerwent southern boundary
BH106A	Down-gradient borehole on MOD Caerwent southern boundary (shallow borehole adjacent to BH130)
BH107	Down-gradient borehole between FWA and MOD Caerwent southern boundary
BH130	Down-gradient borehole on MOD Caerwent southern boundary

Notes: * represents new surface water sampling locations.

Water quality parameters recorded for surface waters at MOD Caerwent generally revealed high electrical conductivity (EC) values, elevated temperatures and reduced dissolved oxygen (DO) at the monitoring points within the Former Wormtech Area (FAW). Together with the laboratory analysis results, which showed contaminant concentrations (biological oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen, copper, iron, mercury and manganese) in excess of Environmental Quality Standards (EQS) at locations in the Former Wormtech Area, is clear evidence of leachate contamination from the green wastes.

Contaminant concentrations reduced with distance from the FWA and no EQS exceedances were recorded in the sample from SW201 which was the furthest down-stream sample between the FWA and the Cas Troggy. It is therefore possible, although not certain, that even were increased rainfall to create a connected flow to the Cas Troggy from the FWA, that flows into the Cas Troggy may not exceed EQS.

Groundwater monitoring also recorded high EC and low DO values at boreholes located nearest to the Former Wormtech Area (FWA) (BH7 and BH102). Water quality parameters improved with distance from the FWA. Concentrations of ammoniacal nitrogen, manganese and iron recorded the greatest values and exceeded their respective EQS and/or drinking water standards (DWS) at boreholes located at the FWA and within its immediate vicinity. This suggests that leachate from the FWA is percolating into groundwaters. Copper and mercury have been detected in groundwater marginally above their EQS down-gradient of the FWA, mercury was also detected marginally above EQS in BH105 close to the FWA, but these are not considered significant.

Manganese and iron concentrations were recorded above EQS and DWS in several boreholes including those in the FWA. Unusually, concentrations of the metals in groundwater were higher than those measured in the surface water locations SW101 and SW202 which were clearly affected by leachate. This is suggestive of a contributing source of metal contamination other than the green wastes, most probably natural background mineralisation.

Monitoring in groundwater wells has shown the key leachate indicator compound, ammoniacal nitrogen is present at a concentration 9 times EQS and 7 times DWS in the well nearest the waste mounds in the FWA. Metal concentrations are also elevated in wells nearest the waste mounds but there is evidence that the metal contamination derives partly from the background geology.

Within the report, Jacobs make the following observations regarding the Unit 1009 site:

'Since Crownhill Topsoil Ltd (CTL) (note, Crownhill Topsoil is not a Limited Company) has taken over site management at the FWA within MOD Caerwent, the site appears organised and with no obvious housekeeping issues. The green waste mounds have been re-profiled to create room for CTL's activities including processing the green wastes. The roads in the FWA previously discoloured with wastes, soil and leachate residues are now largely clear; though leachate continues to be generated by the green wastes.

CTL has conducted recovery trials on the green wastes and has derived topsoils from the wastes without blending with other soils. Jacobs has observed very small quantities of plastics in the finished topsoil but CTL has stated that the materials have been tested and comply with BS3882 (2015): Specification for Topsoil. BS3882 allows for up to 0.5% deleterious material content in topsoil and the materials may therefore be compliant, however no validation testing has been undertaken as part of this study.'

DTE Caerwent: Former Wormtech Area LQA2 Addendum – Jacobs – November 2019:

A walkover survey including monitoring of surface water monitoring points and bore holes in February 2019. During the round, there was no flow from the on-site drainage ditches within or leading from the FWA. One surface water sample was collected from the attenuation pond within the FWA, however a modest flow was noted in the Cas Troggy.

Exceedances of EQS were not reported for the surface water sample. Further, no EQS exceedances were identified in the Cas Troggy brook.

Five of the twelve monitoring wells were unavailable for sampling during the February 2019 visit. Wells were either damaged (BH111, BH102 and BH7) or dry (BH103 and BH106A). Neither of the upgradient groundwater sampling locations (BH111 and BH103) were able to be sampled, and as such there is no indication of the groundwater quality prior to its passing through the site. None of the groundwater samples exceeded EQS for leachate indicator compounds or metallic contaminants. However, DWS was slightly exceeded for ammoniacal nitrogen in all boreholes, including those down-gradient of the FWA. In general, concentrations of leachate indicator compounds had remained similar to 2017 results, but had slightly increased in BH104 within the FWA.

Monitoring Locations for February 2019 Monitoring Round:

Location (*dry)	Description
Surface Water Sampling Locations	
SW201*	Onsite drainage ditch near Building 715, down-gradient of the FWA.
SW202	Lined shallow attenuation pond within the CTL site.
SW203*	Onsite drainage ditch immediately down-gradient of the FWA.
SW101*	Onsite drainage ditch immediately southwest of FWA.
SW102*	Onsite drainage ditch, SW extent of DTE Caerwent at perimeter fence.
SW103	On Cas Troggy brook, upstream of culvert entry.
SW104	On Cas Troggy brook, downstream of culvert, prior to it becoming Nedern Brook.
SW105*	Onsite drainage ditch down-gradient of the FWA.
Field Drain*	Downstream of SW102, outside DTE Caerwent's SE boundary fence.
Field Culvert*	Entrant to Cas Troggy culvert from field outside DTE Caerwent's SE boundary fence.
Groundwater Sampling locations	
BH111[#]	Up-gradient borehole to the NE of the FWA, near perimeter fence.
BH103*[###]	Up-gradient borehole on northern edge of FWA close to Building 845.
BH101	NW extent of FWA.
BH102[##]	Southern extent of FWA.
BH7[#]	Southern extent of FWA.
BH104	SE extent of FWA.
BH105	SW extent of FWA.
BH105A	SW extent of FWA (shallow borehole adjacent to BH130).
BH106	Down-gradient borehole on DTE Caerwent S boundary.
BH106A*	Down-gradient borehole on DTE Caerwent S boundary (shallow borehole adjacent to BH130).
BH107	Down-gradient borehole between FWA and DTE Caerwent S boundary.
BH130	Down-gradient borehole on DTE Caerwent S boundary.

[#] well damaged; could not be sampled

[##] well missing

[###] BH103 was not servicable during the 2017 monitoring round

The following observations were made by Jacobs during the February 2019 walkover:
'The February 2019 walkover survey confirmed that the volumes of green waste were little changed since the previous walkover survey undertaken in 2017. The green waste is located

in the same part of the site and forms two mounds, as observed in 2017. CTL confirmed that no measures to limit rainfall percolation through the stockpiles have been employed, such as sheeting or sealing of the surfaces. As such, minor amounts of leachate were observed at the base of the waste. There was no evidence of algal build-up which was observed during the 2016 visit. There was no evidence of leachate on the roads within the FWA, or pooling at the base of stockpiles. It should be noted that the survey took place during and following a sustained period of dry weather.

There were no obvious signs of changes to the size or height of the green waste stockpiles noted since the previous walkover visit in 2017. Jacobs was informed that there is no ongoing processing of the green waste, and CTL has no plans for its disposal or movement.

There appears to be a significantly lower volume of waste and aggregate stored at the CTL site in general, attributed to the revocation of the EP resulting in cessation of CTL's onsite material processing. One stockpile of processed topsoil was observed in Building 1008, which is noted to pre-date the EP revocation and is currently being sold.

Improvements were observed to drainage at the site since 2017, with the creation of attenuation ponds and existing drainage channels cleared of waste and vegetation. Runoff is now directed into these channels rather than allowed to freely drain across the site. The efficiency of this could not be assessed due to the dry weather preceding the visit. A small lined attenuation pond (20m x 4m) to the west of the site entrance is serviced by a land drain and manages runoff in this portion of the site. There was insufficient water at this location to retrieve a sample, although in future visits this location should be considered for additional surface water sampling.

Improvements to housekeeping within the FWA since 2017, were observed during the recent walkover. However, whilst roads were clear and wastes and aggregates separated, it should be noted that due to the revocation of the EP, site activity is more limited than that observed in 2017 i.e. no ongoing crushing or screening activities are currently undertaken at the site. The volume of material observed on site was low, and only one skip containing waste was present. The baled woodchip photographed on site in 2017 has been removed from the site.

Observations along the Drainage Pathways South of the Former Wormtech Area

The drainage ditch within and extending south west of the FWA was dry at the time of the site walkover, and samples could not be collected from monitoring points SW101 and SW203 (Plates 14 & 17). SW202 located within the FWA is now a lined attenuation pond and was sampled at its eastern corner.

Downstream of the FWA, drainage ditches within the central area of DTE Caerwent were all dry and monitoring points could not be sampled (SW105, SW201 and SW102). These ditches meet the drains connected to the FWA, approximately 340 m north-north-east of SW102. Inspection of these drainage ditches found them all to be dry and as a result there was no flow observed into the Cas Troggy brook from DTE Caerwent.

The Cas Troggy brook (SW103 and SW104) had a moderate flow, with low suspended sediments and an absence of odour, sheen or foam noted at both sampling locations.'

The Jacobs report states the following regarding the results of surface and groundwater monitoring:

'Groundwater pH was broadly neutral in all samples across the site. Temperature was highest within the FWA, in BH101, BH104 and BH105. This is potentially indicative of breakdown of organic materials within leachate.

EC values varied widely across the site with the highest recorded values within the FWA (BH101 and BH104 in particular). There is a clear trend of EC values decreasing with distance down-gradient of the FWA. This may be indicative of leachate percolation within the immediate vicinity of the FWA. However, the potential effect and presence of any leachate within the groundwater appears to be declining the greater the distance from the FWA.

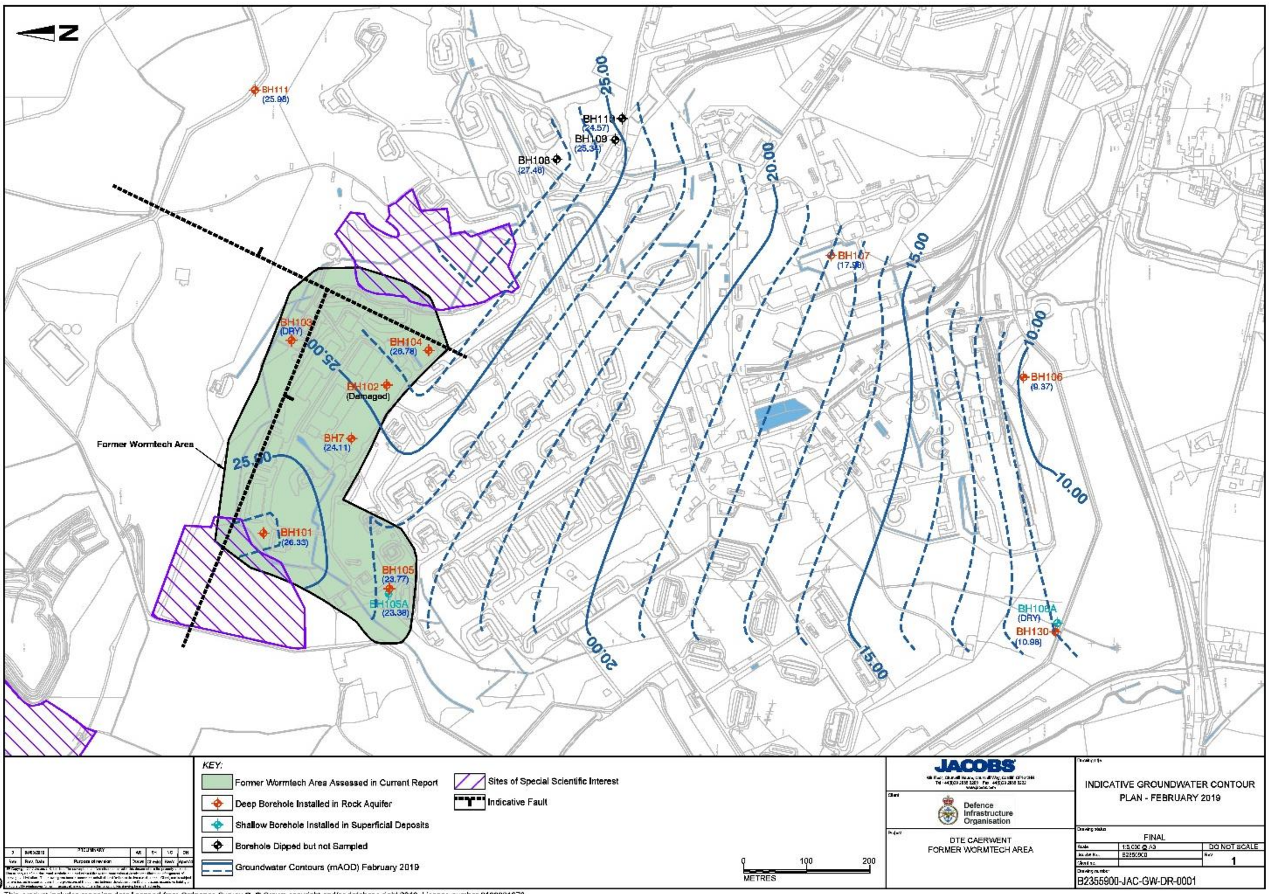
Redox potential was generally consistent across the site, between 74 – 91 mV and indicates a low positive oxidizing environment.

DO concentration is reasonable for groundwater samples, with the exception of BH104 and BH101. This is consistent with high EC in these samples and is suggestive of possible leachate contamination.

TDS concentrations in groundwater samples were all below 0.83 ppt, with highest concentrations observed in boreholes within the FWA.

An indicative groundwater contour plan has been produced based on groundwater levels recorded during the 2019 monitoring round. The indicative plan shows groundwater flowing in a southerly direction across the FWA and DTE Caerwent. It should be noted that due to the limited number of monitoring locations, this direction of flow remains indicative based upon dipped groundwater levels.

Indicative Groundwater Contours, BH Locations and Indicative Locations of Geological Faults



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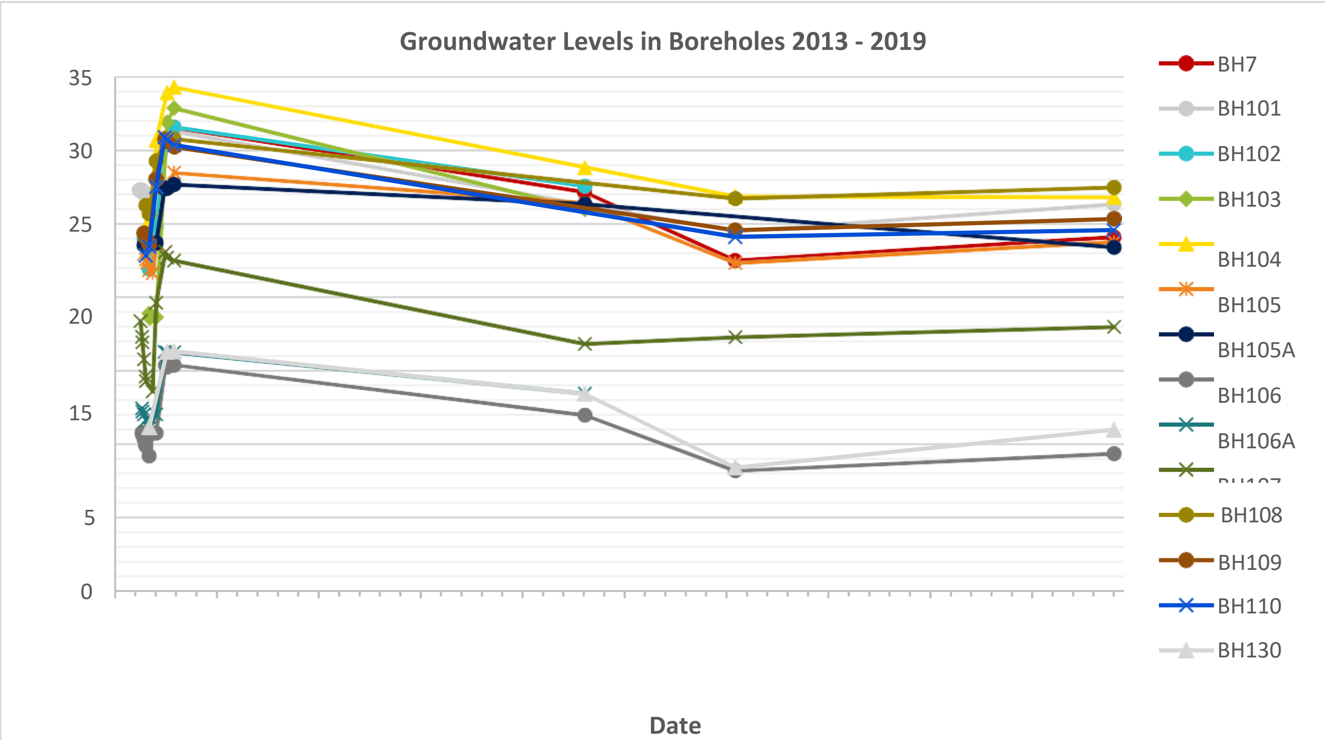
The figure below, shows changes in groundwater heights between the 2013 and 2014 LQA monitoring period and 2016 – 2019 monitoring rounds. The maxima and minima groundwater heights are provided in Table 4.4. BH108 to BH110 are located on the central landfill area, outside of the FWA monitoring zone and have been included to provide information on groundwater depth. This information indicates that groundwater levels during 2019 monitoring are at or just above their lowest recorded height. The levels recorded in BH104 and BH107 were significantly above minimum vales for the period 2013 – 2017, but still below historical maxima. Existing groundwater levels are attributed to the dry winter 2018 – 2019 season preceding the recent monitoring.

Changes in Groundwater Heights between 2013 and 2019:



Conceptual Site Model

The initial conceptual site model was created to assess the risk that the site poses prior to any additional mitigation being undertaken at the site.

Potential Sources of Contamination

Assessment of the present condition of the site and its activities was undertaken through several site visits by Jacobs and EcoVigour between 2014 and 2020. These assessments highlighted four potential sources of contamination which may affect surface and groundwater conditions locally, and potentially on a regional scale:

Runoff from inert waste

The site is to be used for the storage and processing of inert construction and demolition wastes. Wastes will be admitted to the site using a strict acceptance criteria procedure. Crownhill would suffer large financial and reputational damage if contaminated materials were to enter their feedstock and subsequently be present within their finished products.

The acceptance criteria process is set out within the Crownhill Topsoil and Aggregates Environmental Management System. This states:

'The site will only be permitted to accept inert waste i.e. wastes which do not contain organic materials or liquids. The storage of non-inert wastes can result in the generation of leachate which could impact the underlying aquifer. Most of the raw materials for the process are construction and demolition wastes and excavated soils sourced through construction works. A key control in the process is a duty of care check on the site from which wastes are received. This includes a site inspection for indicators of contamination, a review of any ground investigations undertaken for the site and additional ground investigation, sampling and testing if required.

Results from ground investigations will be screened against Waste Acceptance Criteria Limit Values for Inert Waste Landfill.

Samples of produced topsoil are taken at a rate of 1 sample per 1000t produced. Samples are submitted to a UKAS accredited laboratory and tested against a suite of determinands as described in BS5228, this includes, testing for:

- particle size analysis;
- stone content (2-20mm, 20-50mm, >50mm);
- pH and electrical conductivity values;
- exchangeable sodium percentage;
- major plant nutrients (N, P, K, Mg);
- organic matter content;
- C:N ratio;
- heavy metals (As, B, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn);
- total cyanide and total (mono) phenols;
- speciated PAHs (US EPA16 suite);
- aromatic and aliphatic TPH (C5-C35 banding);
- benzene, toluene, ethylbenzene, xylene (BTEX);
- asbestos screen

The following is a section for the Crownhill EMS:

'If indicators of contaminated materials are discovered (odours, discolouration, sheens on water, bubbling, hazardous waste items) within soils and aggregates received at the site, they will be rejected immediately and returned to the supplier. If it is not possible to immediately return these to the consignee (if transport needs to be arranged etc), wastes will be removed to the quarantine area in Building 1. As the wastes are within a building, rainwater will not be able to percolate through them and drainage from the building can be isolated into a tank, which would be emptied by tanker (following suitable sampling and testing, with determinands derived based on the nature of the waste, to enable the liquid waste to be accurately described)

Training will be provided for personnel in the recognition of the indicators of contaminated material and actions to be taken on discovery'.

Inert materials at the site can be separated into two categories, feedstock and product. Feedstock will be comprised of soils, rock, concrete, brick and ceramics. These are segregated into types for processing into products for sale. Feedstocks are then crushed and screened using the required ratio to achieve the required product. Products include:

Topsoil, which will contain a majority of fines from soils. This material is moisture critical and is stored in Building 5;

Sub-base materials, which will include some fine but predominantly granular materials;

Granular materials of varying grades.

There is potential that soils could be admitted onto site, which contain pockets of contaminated material, which over time could leach to the environment. Due to the duty of care process and the acceptance criteria, significant volumes of contaminated materials would not be accepted onto site or would be identified on being tipped and either removed immediately or quarantined for removal as soon as possible. The potential for pockets of contamination to leach will depend on a number of factors, including the bioavailability of the elements / compounds within the soils, the physical composition of the materials i.e. clays are more likely to lock up contaminants. Due to the low likelihood of significant volumes of contaminated materials being imported, in consideration of the overall volumes of materials on site, the risk of this being a significant source is low.

Inert wastes are stored predominantly on concrete surfaced areas but also on stone surfaced areas. Runoff from wastes stored on concrete surfaced areas, flows along the kerb line into attenuation ponds. Attenuation ponds are lined and have been constructed to remove suspended solids prior to discharge of the site runoff into the drain flowing along the southern boundary. Discharge from the ponds will be via a full retention hydrocarbon separator.

The risk of leachate from inert wastes is therefore considered to be low.

Fire Water

As all wastes stored on site are inert, there is no risk of combustion within waste materials.

Volumes of water likely to be used for fire fighting are difficult to predict as this depends on a number of factors, including the nature and extent of the fire.

A Fire Prevention Plan has been produced by Crownhill and this states the following:

‘The area of the site with the highest risk of fire is the workshop and adjacent site waste storage area. All other materials stored within the site are inert. If fire were to occur within this area it would most likely be due to vehicle fire or the combustion of stored oils within the workshop. From discussions with South Wales Fire and Rescue, these sorts of fires would be tackled using foam or if small scale CO_2.

If water is required for firefighting it will be abstracted from the attenuation ponds and the duck pond, this water will be recirculated back into the attenuation ponds. The outlet from the hydrocarbon separator would be shut off to prevent water leaving site. South Wales Fire and Rescue have told us that as part of their standard practice they deploy water filled booms to channel water away from sensitive receptors. A stock of sand bags will be stored at the site and these will be used to direct firewater.

If required, water flowing into the attenuation ponds could be recirculated, either at the outlet of the ponds so that suspended solids are removed or upstream of the pond.

An additional pond to retain firewater can be formed within the soil storage area. A 14m x 30m HDPE liner will be retained at the site as part of the firefighting inventory. A pond can be formed using plant on site and can be lined with the HDPE sheet. Firefighting water can then be diverted into here, through the construction of a drain and can be retained. This would provide an additional capacity of 275,000l of storage.

Water from this and other attenuation ponds will be tankered to the mains sewer if additional capacity is required.

Provision would need to be made to remove solids from the ponds, test this material and dispose of it within the Duty of Care for the material, following the fire.’

Hydrocarbon Leaks and Spills

Diesel is used for all plant on site. This is kept in a double-skinned tank within the workshop. Plant is refuelled only in this location, where a plant nappy is used to prevent spillages. Due to this, the risk of spillage of hydrocarbons is low.

Crownhill operates a fleet of haulage wagons, most of these are under 5 years old. Crownhill also operates plant at the site, some of this is under 5 years old and some of it is older. Once the site is operational, third party vehicles will enter the site. There is potential for these vehicles / plant to leak diffuse amounts of hydrocarbons or bulk hydrocarbons (0.5l to 5l) due to mechanical failure such as burst hydraulic hoses.

There is a spill response procedure in the EMS and spill kits and spill response equipment will be maintained on site.

Hydrocarbons should be considered as a possible source of contamination at site.

Silt from Inert Soil and Stone

There are large stockpiles of inert soil and stone which, as part of the site activity, is periodically screened and crushed to create a sellable product. Much of the material is stored within the covered sheds on site, however some of the material is stockpiled in the open on hardstanding. During periods of intense rainfall, surface runoff from these stockpiles can become contaminated with silt. In areas of the site which are stone surfaced, this will percolate into the ground. It is unlikely that silt would progress further than the upper layers of soil before it was filtered out.

Silt will be transported by site runoff into surface water, unless controls are put in place to prevent this.

Legacy Wastes from the Wormtech Facility:

These are not considered as a source as part of the operation of the Crownhill Topsoil and Aggregates facility but these wastes now lie just outside the boundary of the site. From surface and groundwater monitoring undertaken at Unit 1009, designated as the Former Wormtech Area (FWA) the results indicate that contamination was initially localised but that this spread a little further into the underlying shallow aquifer, over time but that contamination levels have reduced with time.

Some of the green wastes from the operation of the FWA are stockpiled adjacent to the site boundary. This has matured to a more stable form and from visual assessments, leachate emitted from the materials appears to be reducing i.e. leachate with algal blooms has not recently been noted at the site.

As part of these studies Jacobs have recommended that the wastes are covered to prevent the ingress of rainwater. They have suggested that initially, this is achieved by covering the wastes with plastic sheeting. We however have concerns about this, as there is potential for green wastes / compost to become anaerobic, which will exacerbate leaching potential. Crownhill do not want to include this material within their feedstock for their soil making process due to the complexity this brings to their Environmental Permit application due to the underlying SPZ1.

Dialogue should be established between the MoD/DOI, Natural Resources Wales and Crownhill to gain an understanding of each organisations aspirations for the management of these materials and how this can be incorporated into the operation of the site.

Pathways

Three potential pathways have been identified which would allow contaminants to enter surface water bodies or groundwater:

Surface Water Run-off

If the source material is subjected to water, surface runoff may occur, freeing suspended solids and potentially hydrocarbons from their source and channelling it through the drainage systems present on site. Site drainage discharges to open drainage channels which eventually discharge into the Castrogi Brook.

Leaching to Groundwater

Leaching to groundwater is the most likely to occur for material kept in the open. Rainwater will percolate through the source material and into the soil, where it will continue through the superficial deposits and into the aquifers within the bedrock.

Previous studies have found that the recharge at the site is dominated by dispersed recharge from incident rainfall across the site, rather than fast recharge and discharge associated with fast moving, highly permeable geology. This can be seen in Figure 12, where there are no significant peaks or troughs.

Jacobs have determined that there is a geological fault running north to south across the very eastern side of the site, which has potential to form an increased pathway for liquids from the surface into the underlying shallow aquifer.

The Castrogi brook, which runs adjacent to the site's western boundary, may be considered an area of concentrated recharge. This likely accepts some of the rain water from the site, although site drainage has been designed to channel the runoff from the problematic areas away from this.

Groundwater Migration

The movement of the groundwater via aquifer is a significant transport mechanism for potential contaminants. The SKM report identifies the flow of the groundwater to be via fractures/fissures. However, it does point out that there is no indication of large, well developed conduits, nor is there indication of large solutional developments. Borehole data suggests that the aquifer below the Caerwent training site is moderately heterogenous in nature, even though connectivity across the Crownhill site is limited.

Receptors

The identified receptors for contaminated ground and surface water are listed below:

Groundwater on Site

The ground water below the site forms part of the Source Protection Zone 1 for the Severn Tunnel Great Spring abstraction, and as such should be considered to be of significant importance. Although there are no abstraction points on site, the groundwater may discharge into streams to the south of the site, such as Neddem Brook.

Groundwater off Site

There are 4 abstraction locations which have been identified down gradient of the site. These are:

- Phillips Abstraction;
- Broome & Co Ltd Abstraction;
- Marriott St Pierre Hotel & Country Club Abstraction;
- Severn Tunnel Great Spring Abstraction.

The most significant of these is the Severn Tunnel Great Spring Abstraction, which is located 6km SE of the Crownhill site. This is used for drinking water.

Surface Water

There are a number of small drainage ditches across the Caerwent Army Training facility. These generally feed into the Castrogi brook to the west of the site. This stream becomes the Nedern brook south of the Army training site.

The Dinham Meadows SSSI has not been considered a receptor as it is situated up gradient of the site.

The Nedern Wetlands SSSI can be considered a minor receptor. Although some of the groundwater or surface water from the site may eventually end up at the Wetlands, it is located 2km downstream, and as such is unlikely to be affected by discharge from the site.

Risk Assessment

The risk assessment for this study has been carried out in two stages. Firstly, the initial assessment is undertaken on the site prior to any mitigation measures being in place. Should the risk identified be unacceptable, mitigation methods will be proposed, and the risk assessment repeated.

Compliance Points

The identification of compliance points is key in ensuring that the site can be monitored for potential contamination on identified receptors. They must be representative of the site discharge, so location is key. It is also vital that the correct assessment criteria be used to assign the maximum acceptable values for each potential contaminant.

Groundwater On Site

Borehole BH7 has been chosen as the Compliance Point for on-site groundwater monitoring. This is due to the fact that in previous investigations relating to the former Wormtech operations at the site, this borehole had the most exceedances of EQS and DWS. This suggests that this borehole is in an area of aquifer, which receives surface runoff from the site percolating into the aquifer. The borehole is also downgradient of site activities.

Groundwater Off Site

BH102 (once this has been reinstated) BH104, BH105 will be monitored every six months. From groundwater levels measures during the Jacobs April 2019 round of monitoring it appears that groundwater flow immediately below the site is to the SW and hence BH105 is proposed as the off site compliance point. As these groundwater contours have been developed from limited level information, BH104 will also be included.

This BH will be purged and sampled every six months. Purging will continue until compliance monitoring undertaken at the borehole stabilises and becomes consistent. Samples will then be taken and submitted to a UKAS accredited laboratory for analysis against the following parameters:

pH, EC, BOD, COD, Choride, Ammonia, Ammoniacal Nitrogen, Arsenic, Boron, Cadmium, Chromium, Copper (dissolved and bioavailable), Iron, Mercury, Manganese (dissolved and bioavailable), Nickel (dissolved and bioavailable), Lead (dissolved and bioavailable), Zinc (dissolved and bioavailable), TPH (speciated), EPH (C10-C40), SS.

Environmental Quality Standards (EQS) and Drinking Water Standards (DWS) are the most appropriate standards for the assessment of lab results.

Crownhill

Surface Water

Crownhill will establish surface water compliance points on the drainage ditch at the SW corner of the site (CHSW001) and at the discharge point into the Castrogi Brook (CHSW002). Monitoring will be undertaken monthly at these compliance points (except for periods when there is not flow), for suspended solids, BOD ATU, electrical conductivity, TPH (speciated), and ammonia.

Further sampling will be undertaken by Crownhill, with surface water samples from CHSW001-02 submitted for analysis against the same parameters as have been used within the Jacobs LQA plus EPH (C10-C40) and PAH16.

As there are no potable water surface water abstractions within the vicinity of the site, it has been determined that Environmental Quality Standards may be utilised as Compliance Points for contaminants.

Qualitative Risk Assessment Prior to Mitigation

Source	Identified Pollutant	Identified Receptors	Pathways to Receptors	Associated Hazard	Likelihood of Occurrence	Risk/Significance
Leachate from Fire Water	Phosphates; Sulphates Nitrates; Chlorinated dioxins/furans; BTEX, PAHs; Small organic compounds (formaldehyde, acrolein, butadiene, vinyl chloride, etc.); Metals.	Groundwater on-site	Leaching, Groundwater Migration	Medium	Low	Low
		Groundwater off-site	Groundwater Migration	Medium	Low	Low
		Surface Water	Surface Runoff, Groundwater Migration	Medium	Low	Low
Spilled / Leaking Hydrocarbons	TPH, PAH	Groundwater on-site	Leaching, Groundwater Migration	High	Medium	Medium
		Groundwater off-site	Groundwater Migration	High	Medium	Medium
		Surface Water	Surface Runoff, Groundwater Migration	High	Medium	Medium
Silt Contaminated Runoff	Suspended Solids	Groundwater on-site	Leaching, Groundwater Migration	Low	Low	Low
		Groundwater off-site	Groundwater Migration	Low	Low	Low

		Surface Water	Surface Runoff, Groundwater Migration	Medium	High	High
Contaminated soils imported to site.	Potential contaminants including TPH, PAH, Metals, Organics, etc	Groundwater on Site	Leaching, Groundwater Migration	Potentially High	Medium	Medium
		Groundwater off Site	Groundwater Migration	Potentially High	Medium	Medium
		Surface Water	Surface Runoff, Groundwater Migration	Potentially High	Medium	Medium

Mitigation Methods

As High risk activities have been identified for the site, it is necessary to incorporate mitigation measures to reduce this risk level.

Fire Water

The incorporation of a strict fire prevention plan will severely reduce the risk of fire occurring. Due to the limited volume of combustible material stored on site i.e all wastes are inert hence combustible materials are those linked to the operation of the facility only, it is anticipated that volumes of fire water would also be low.

If water is required for firefighting it will be abstracted from the attenuation ponds and the duck pond, this water will be recirculated back into the attenuation ponds. The outlet from the hydrocarbon separator would be shut off to prevent water leaving site. South Wales Fire and Rescue have told us that as part of their standard practice they deploy water filled booms to channel water away from sensitive receptors. A stock of sand bags will be stored at the site and these will be used to direct firewater.

If required, water flowing into the attenuation ponds could be recirculated, either at the outlet of the ponds so that suspended solids are removed or upstream of the pond.

An additional pond to retain firewater can be formed within the soil storage area. A 14m x 30m HDPE liner will be retained at the site as part of the firefighting inventory. A pond can be formed using plant on site and can be lined with the HDPE sheet. Firefighting water can then be diverted into here, through the construction of a drain and can be retained. This would provide an additional capacity of 275,000l of storage.

Water from this and other attenuation ponds will be tankered to the mains sewer if additional capacity is required.

Provision would need to be made to remove solids from the ponds, test this material and dispose of it within the Duty of Care for the material, following the fire.'

Inert Construction and Demolition Wastes

The acceptance criteria process is set out within the Crownhill Topsoil and Aggregates Environmental Management System. This states:

'The site will only be permitted to accept inert waste i.e. wastes which do not contain organic materials or liquids. The storage of non-inert wastes can result in the generation of leachate which could impact the underlying aquifer. Most of the raw materials for the process are construction and demolition wastes and excavated soils sourced through construction works. A key control in the process is a duty of care check on the site from which wastes are received. This includes a site inspection for indicators of contamination, a review of any

ground investigations undertaken for the site and additional ground investigation, sampling and testing if required.

Results from ground investigations will be screened against Waste Acceptance Criteria Limit Values for Inert Waste Landfill.

Samples of produced topsoil are taken at a rate of 1 sample per 1000t produced. Samples are submitted to a UKAS accredited laboratory and tested against a suite of determinands as described in BS5228, this includes, testing for:

- particle size analysis;
- stone content (2-20mm, 20-50mm, >50mm);
- pH and electrical conductivity values;
- exchangeable sodium percentage;
- major plant nutrients (N, P, K, Mg);
- organic matter content;
- C:N ratio;
- heavy metals (As, B, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn);
- total cyanide and total (mono) phenols;
- speciated PAHs (US EPA16 suite);
- aromatic and aliphatic TPH (C5-C35 banding);
- benzene, toluene, ethylbenzene, xylene (BTEX);
- asbestos screen

The following is a section for the Crownhill EMS:

'If indicators of contaminated materials are discovered (odours, discolouration, sheens on water, bubbling, hazardous waste items) within soils and aggregates received at the site, they will be rejected immediately and returned to the supplier. If it is not possible to immediately return these to the consignee (if transport needs to be arranged etc), wastes will be removed to the quarantine area in Building 1. As the wastes are within a building, rainwater will not be able to percolate through them and drainage from the building can be isolated into a tank, which would be emptied by tanker (following suitable sampling and testing, with determinands derived based on the nature of the waste, to enable the liquid waste to be accurately described)

Training will be provided for personnel in the recognition of the indicators of contaminated material and actions to be taken on discovery'.

Inert materials at the site can be separated into two categories, feedstock and product. Feedstock will be comprised of soils, rock, concrete, brick and ceramics. These are segregated into types for processing into products for sale. Feedstocks are then crushed and screened using the required ratio to achieve the required product. Products include:

Topsoil, which will contain a majority of fines from soils. This material is moisture critical and is stored in Building 5;

Sub-base materials, which will include some fine but predominantly granular materials;

Granular materials of varying grades.

There is potential that soils could be admitted onto site, which contain pockets of contaminated material, which over time could leach to the environment. Due to the duty of care process and the acceptance criteria, significant volumes of contaminated materials would not be accepted onto site or would be identified on being tipped and either removed immediately or quarantined for removal as soon as possible. The potential for pockets of contamination to leach will depend on a number of factors, including the bioavailability of the elements / compounds within the soils, the physical composition of the materials i.e. clays are more likely to lock up contaminants. Due to the low likelihood of significant volumes of contaminated materials being imported, in consideration of the overall volumes of materials on site, the risk of this being a significant source is low.

Inert wastes are stored predominantly on concrete surfaced areas but also on stone surfaced areas. Runoff from wastes stored on concrete surfaced areas, flows along the kerb line into attenuation ponds. Attenuation ponds are lined and have been constructed to remove suspended solids prior to discharge of the site runoff into the drain flowing along the southern boundary. Discharge from the ponds will be via a full retention hydrocarbon separator.

The risk of leachate from inert wastes is therefore considered to be low.

Hydrocarbons from Vehicle and Plant Movements

All fuel and oil storage is in the eastern section of the site. The majority of plant and vehicle movements will also take place in this area of the site. Therefore, surface runoff from the eastern section of the site will be discharged via a series of attenuation ponds discharging via a Full Retention Hydrocarbon Separator to remove residual hydrocarbons.

The western sector of the site, will be little used with only the buildings being used for soil storage. Therefore runoff from this area will be discharged via a series of three attenuation ponds.

Some areas of the site are surfaced with compacted stone. This has limited permeability which could result in hydrocarbons being able to enter the underlying groundwater. A robust spill response procedure will be put in place. If hydrocarbons are spilt to concrete surfaced areas, they will be contained using absorbent booms / pads / granules. Contaminated soils and aggregates will be excavated and placed into plastic lined skips within the quarantine building, awaiting disposal.

Spill kits will be maintained in the workshop and within vehicles and plant. Staff will be given training in spill control and the use of spill kits and spill response materials.

Silt Contaminated Runoff

A series of three attenuation ponds have been constructed to receive runoff from the eastern section of the site. These have a total surface area of 550m^2. These have been lined with a HPDE liner to prevent infiltration.

A series of three attenuation ponds, have been constructed to receive runoff from the western section of the site. These have a combined surface area of 550m^2 and are lined with an HDPE liner.

Both of these ponds discharge into the large drain which runs along the southern boundary of the site. This is dry for the majority of the year with only a low flow during sustained periods of heavy rainfall. There is therefore additional attenuation and infiltration capacity within this.

Revised Conceptual Model

With the mitigation measures described above in place, the conceptual model becomes significantly different. The likelihood of all risks occurring have significantly reduced.

Qualitative Risk Assessment Post Mitigation

Source	Identified Pollutant	Identified Receptors	Pathways to Receptors	Associated Hazard	Likelihood of Occurrence	Risk/Significance
Leachate from Fire Water	Phosphates; Sulphates Nitrates; Chlorinated dioxins/furans; BTEX, PAHs; Small organic compounds (formaldehyde, acrolein, butadiene, vinyl chloride, etc.); Metals.	Groundwater on-site	Leaching, Groundwater Migration	Medium	Low	Low
		Groundwater off-site	Groundwater Migration	Medium	Low	Low
		Surface Water	Surface Runoff, Groundwater Migration	Medium	Low	Low
Spilled / Leaking Hydrocarbons	TPH, PAH	Groundwater on-site	Leaching, Groundwater Migration	Medium	Low	Low
		Groundwater off-site	Groundwater Migration	Medium	Low	Low
		Surface Water	Surface Runoff, Groundwater Migration	Medium	Low	Low
Silt Contaminated Runoff	Suspended Solids	Groundwater on-site	Leaching, Groundwater Migration	Low	Low	Low
		Groundwater off-site	Groundwater Migration	Low	Low	Low
		Surface Water	Surface Runoff, Groundwater Migration	Medium	Low	Low
Contaminated soils imported to site.	Potential contaminants including TPH, PAH, Metals, Organics, etc	Groundwater on Site	Leaching, Groundwater Migration	Low	Low	Low
		Groundwater off Site	Groundwater Migration	Low	Low	Low
		Surface Water	Surface Runoff, Groundwater Migration	Low	Low	Low

Conclusions

The primary potential sources of contamination which have been identified by this report are:

- Leachate from fire water in the event of a fire at the site;
- Leachate from the spillage of hydrocarbons;
- Silt contaminated runoff from inert soil and stones;
- Leachate / runoff from contaminated / out of spec soils imported to site.

The initial risk assessment identified that the risk to local groundwater was moderate due to the storage and use of hydrocarbons on site.

The ground water is at particular risk as the bedrock below the site is a principle aquifer, forming part of the Severn Estuary Source Protection Zone.

Previous studies by SKM Enviros / Jacobs have identified that leachate from the Wormtech legacy materials stockpiles on site travels to the aquifer locally. Due to this, it can be expected that if any liquids released at the site are uncontrolled, they too have potential to enter groundwater beneath the site.

However, the study also found that the contamination of the groundwater, from the previous use of the site as a green waste facility, was local to the site, and contamination was either not identified or significantly reduced in groundwater tested further down the hydraulic gradient. This, along with the slow recharge rate of the groundwater, indicates that the time taken for water to flow off site is significant enough to allow contaminants to filter out of the aquifer or degrade within the aquifer.

Although the contamination of the regional aquifer is likely extremely limited, it is still necessary to implement mitigation measures to ensure that the local aquifer is not contaminated through site activity. This document highlights a series of measures which will be put in place which significantly reduce the likelihood of the site having an impact on this aquifer.

It was identified that the highest risk to surface water at the site is through silt contaminated runoff. However, there is some risk to this receptor from the other sources identified. Provided that the mitigation measures specified are implemented at the site, the risk to surface water and groundwater from site activities, will be reduced to an acceptable level.

It is recommended that monitoring at the compliance points identified be undertaken monthly for surface water and every six months for groundwater, as described above. Monitoring should also take place following incidents such as hydrocarbon spillage or a fire on site, which requires significant volumes of water to be used to extinguish it.

Appendix 1: Site Layout and Exploratory Hole Location Plan (Large Scale)

Appendix 2: Site Layout and Exploratory Hole Location Plan (Small Scale)

Appendix 3: Indicative Groundwater Contour Plan

Appendix 4: Jacobs Land Quality Assessment Report – LQA2 2016

Appendix 5: Jacobs Land Quality Assessment Report – LQA2 2019