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DEPOSIT FOR RECOVERY PERMIT APPLICATION

WHEALDREAM HOLIDAYS & LEISURE
WENDRON, HELSTON, CORNWALL

HYDROGEOLOGICAL RISK ASSESSMENT

January 2026

Commissioned by: A&J Waste Services Ltd.

Issue: V2

Project Reference: NS_0119_12

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1.0 INTRODUCTION

1.1 Project Introduction and Aims

A&J Waste Services Ltd. has commissioned NSugg Ltd. to undertake a Hydrogeological Risk Assessment (HRA) to support a Deposit for Recovery Environmental Permit application at Whealdream Holidays & Leisure (Whealdream), near Helston, Cornwall.

Whealdream ('the site') comprises an existing golf course and associated facilities, and planning permission was granted by Cornwall Council in December 2024 (reference: PA24/03864) for:

Construction of a golf range and associated covered bays building with cafe, together with a new 18 hole footgolf / rugby golf course, new maintenance shed and water storage lagoon and extensive native planting scheme. Ground modelling to be undertaken using imported inert materials"

Section 10 of the Design and Access Statement[1] prepared in support of the planning application confirms approximately 102,000m^3 of fill is required to achieve the proposed landform. This HRA supports a bespoke Deposit for Recovery permit application for the importation and deposit of this material.

The Waste Recovery Plan[2] confirms that the imported material shall comprise entirely inert wastes suitable for the development.

This HRA has been prepared, in accordance with the relevant policy and guidance detailed below, to ensure that the proposed waste recovery at Whealdream will not result in a discernible discharge of hazardous substances to groundwater and will not result in pollution of groundwater by non-hazardous pollutants.

1.2 Relevant Policy & Guidance

This HRA has been prepared in accordance with the Environment Agency's current guidance on risk assessments for permit applications[3] to determine the site's compliance with the relevant requirements of the Environmental Permitting (England and Wales) Regulations 2016.

The hydrogeological conceptual site model is developed, to characterise the source-pathway-receptor terms and identify whether there is potential for input of any hazardous substances or non-hazardous pollutants to groundwater. A tiered risk assessment approach is followed, based on the findings of the conceptual model, with increased level of assessment required where there is an increased risk to groundwater.

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[1] Weller Designs Ltd., 23 April 2024, Design and Access Statement for The Construction of a Golf Range and Associated Covered Bays Building with Cafe, together with a New 18-Hole Footgolf Course, New Maintenance Shed & Water Storage Lagoon and Extensive Native Planting Scheme. Ground Modelling to Be Undertaken Using Imported Inert Materials at Whealdream Holiday & Leisure.

[2] Land & Mineral Management, June 2025, Whealdream Holiday & Leisure, Waste Recovery Plan.

[3] Environment Agency, February 2016 (last updated: April 2018), Guidance: Groundwater Risk Assessment for your Environmental Permit.

The Environment Agency's technical guidance on groundwater protection[4] has also been relied on regarding the discernibility of hazardous substances in groundwater.

1.3 Sources of Information

In addition to the above guidance, this HRA has consulted and relied on documents submitted within the 2024 planning application (reference: PA24/03864) and the approved Waste Recovery Plan[2].

The Environment Agency has been consulted for details of local licensed abstractions from groundwater and surface water. Cornwall Council has been consulted for details of local private water supplies.

Published documents, maps and online resources are referenced as appropriate.

[4] Environment Agency, March 2017, Guidance: Groundwater Protection Technical Guidance.

2.0 HYDROGEOLOGICAL CONCEPTUAL SITE MODEL

2.1 Introduction

This section of the report develops the hydrogeological conceptual site model based on a desk study review of the site development proposals, published mapping and reports and relevant third-party information.

2.2 Source

2.2.1 Site Location and Topography

Whealdream is located off the B3297, approximately 2km north-north-east of Helston town centre, Cornwall. The site extends to 6.9ha., as indicated by the red line on Figure 1 and currently comprises a golf course and football golf course.

Figure 1. Site Location Plan (extracted from Weller Designs Ltd. planning drawing number 901.06 'Application Boundary Plan'

Review of Ordnance Survey mapping indicates that site levels fall gently across the majority of the site, towards the south, south-west and west; topographic gradients increase at the western boundary towards the adjacent River Cober. Site levels range from approximately 118mAOD in the north-east corner to approximately 107mAOD at the south-western boundary.

2.2.2 Historic & Surrounding Land Uses, Including Evidence of Land Contamination

There is a long history of mining in the region, primarily for tin, but also tungsten, arsenic, copper and zinc[5], with Ordnance Survey mapping confirming the presence of historic mine shafts within 0.5km to the east of the site.

The 2024 Archaeological Assessment[6] prepared in support of the planning application confirms:

- *A mine is recorded at Boscadjack along the south-eastern boundary of the site, with its large system of tunnels most probably running within the confines of the site,*
- *A further mine at Wheal Dream is recorded c.50m to the north-east of the site.*
- *The corn mills, stamping mills, and quarries that flank the River Cober to the north of the site further evidence the industrial nature of the landscape during the post medieval period, as do the Cober Viaduct and the extant track bed for the Helston Railway (MCO54583; which once ran c.300m to the south-west of the site.*

The site is outside the Wendron Mining District[7], but the above evidence suggests significant historic local mine workings, with potential workings extending beneath the site at depth.

The Environment Agency has undertaken baseline monitoring to assess the impact of abandoned metal mines in Cornwall on rivers and estuaries. This information is reviewed in detail in the relevant sections of this HRA but confirms the potential for metals contamination of groundwater and surface water from natural mineralisation, mine adits, drainage levels and spoil heaps.

Figure 2 presents an extract of the Environment Agency's historic landfill map and confirms the presence of Trannack Quarry landfill approximately 100m west of the site, and separated from the site by the River Cober.

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[5] British Geological Survey, 1997, Technical Report WF/97/11, Mineral Resource Information for Development Plans. Phase One Cornwall: Resources and Constraints.

[6] Southwest Archaeology, April 2024, Wheal Dream Golf Course, Results of an Archaeological Assessment.

[7] www.cornishmining.org.uk

Figure 2. Environment Agency Historic Landfill Map

Limited data are provided within the Environment Agency dataset, but Trannack Quarry is reported to have received inert waste and liquid sludge. No other historic landfills are indicated within a 2km radius of the site.

Review of the Environment Agency's online Permitted Waste Sites dataset confirms there are no currently authorised landfill sites within the vicinity of the site.

The only significant, identified potential sources of land contamination are associated with agricultural land use and the historic local mine workings.

2.2.3 Site Development Proposals

Approximately 102,000m^3 of inert fill shall be imported and deposited to achieve the approved landform for the golf range, golf course and associated works; the final masterplan is presented as Figure 3.

Figure 3. Final Masterplan **(extracted from Weller Designs Ltd. planning drawing number 901.17 'Final Masterplan Plan')**

Cross-sections through the development area, prepared by Weller Designs Ltd, are included as Appendix A and confirm the deposition of imported material across the site to thicknesses of up to approximately 5m. An average thickness of approximately 1.5m is inferred, based on a fill volume of 102,000m^3 and site area of 69,062m^2.

2.2.4 Source Term

The Waste Recovery Plan[2] confirms that all imported material will meet the inert waste acceptance criteria (WAC) limits set out in Section 2.1.2.1. of the 2003/33/EC Council Decision Annex and reproduced in Table 1.

Table 1: Inert WAC Leaching Limit Values

Parameter	Liquid to Solid ratio (L/S)		C_0 (the first eluate of percolation test at L/S = 0.1 l/kg) mg/l
	L/S = 2l/kg mg/kg dry substance	L/S = 10l/kg mg/kg dry substance	
As	0.1	0.5	0.06
Ba	7	20	4
Cd	0.03	0.04	0.02
Cr total	0.2	0.5	0.1
Cu	0.9	2	0.6
Hg	0.003	0.01	0.002
Mo	0.3	0.5	0.2
Ni	0.2	0.4	0.12
Pb	0.2	0.5	0.15
Sb	0.02	0.06	0.1
Se	0.06	0.1	0.04
Zn	2	4	1.2
Chloride	550	800	460
Fluoride	4	10	2.5
Sulphate	560*	1000*	1 500
Phenol index	0.5	1	0.3
DOC**	240	500	160
TDS***	2 500	4 000	—

Table notes:
* If the waste does not meet these values for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1500 mg/l as C_0 at L/S = 0.1 l/kg and 6000 mg/kg at L/S = 10 l/kg.
** If the waste does not meet these values for DOC at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH between 7.5 and 8.0. The waste maybe considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500 mg/kg.
*** The values for total dissolved solids (TDS) can be used alternatively to the values for sulphate and chloride.

The above inert WAC limits have been used to inform the source term concentrations for the HRA in Section 3.

2.3 Geology

The following review of the geological site setting is based on British Geological Survey mapping[8] and the local geological memoir[9].

[8] British Geological Survey, 1990, Sheet 352: Falmouth, Solid & Drift.

[9] Leveridge, BE, Holder, MT, and Goode, AJJ, 1990. Geology of the country around Falmouth. Memoir of the British Geological Survey, Sheet 352.

The site lies in the south-west of the Carnmenellis Granite intrusion, which formed in the Carboniferous period and intruded into Devonian strata. The site lies on an outcrop of coarse-grained granite, with near-vertical joints and mineral veins at surface in the local vicinity. The Devonian Mylor Slate Formation, which outcrops within 250m to the south-west of the site, lies within the metamorphic aureole of the granite intrusion.

The granite is overlain by Alluvium, associated with the River Cober, to the immediate north-west of the site. No superficial deposits are indicated within the site boundary.

The regional hydrogeological map[10] describes the Carnmenellis Granite as highly fractured and having undergone a long history of alteration. Deep boreholes (>2.5km) and mines confirm the composition of the granite does not alter with depth.

The Alluvium is described[10] as fine-grained sand, silt and clay with occasional gravel lenses associated with valley bottoms and grades into Head in the upper parts of the valley.

Figure 4 presents an extract of the regional geological map, with the approximate site boundary outlined in red.

[10] British Geological Survey, 1990, The Carnmenellis Granite – Hydrogeological, Hydrogeochemical and Geothermal Characteristics (hydrogeological map).

Figure 4. Published Geological Map **(extract from British Geological Survey 1990 Sheet 352)**

There is evidence of local, small-scale granite quarrying within 0.5km to the west of the site, including Trannack Quarry which is restored via landfilling, as discussed above.

There is a long history of mining in the region, with the mineral veins within and close to the granite predominantly carrying tin, with tungsten and arsenic in places. In the rocks immediately surrounding the granite, copper and arsenic may be found, while further out the presence of tin reduces and zinc may be present[5].

The geological map (Figure 4) confirms the presence of mineral veins at surface within approximately 200m to the north-east of the site. As outlined in Section 2.2.2, the site is outside the Wendron Mining District, but there is evidence of significant historic local mine workings, with potential workings extending beneath the site.

2.4 Hydrogeology

2.4.1 Aquifer Characteristics

The Carnmenellis Granite intrusion is classified as a Secondary A Aquifer[11]; these comprise *permeable layers that can support local water supplies and may form an important source of base flow to rivers.*

The superficial Alluvium associated with the River Cober to the north-west of the site is also classified as a Secondary A Aquifer.

Review of Cranfield University's Soilscapes viewer confirms the soils are classified as Soilscape 9: freely draining, acid loamy soils over rock.

The site is not located within or in the vicinity of a Groundwater Source Protection Zone or Drinking Water Safeguard Zone for groundwater.

The Environment Agency's Groundwater Vulnerability Maps (accessed via Natural England's online MAGIC mapping system[11]) show the vulnerability of groundwater to a pollutant discharged at ground level, based on the hydrological, geological, hydrogeological and soil properties. The groundwater vulnerability beneath the site is classified as High, reducing to Medium-High immediately to the north-west, where Alluvium overlies the bedrock.

Areas with high groundwater vulnerability are defined as: *areas able to easily transmit pollution to groundwater. They are characterised by high leaching soils and the absence of low permeability superficial deposits.*

The granite has low primary permeability, with groundwater flow predominantly via fractures, joints and mine workings. However, primary permeability is often enhanced near surface due to weathering[15].

The permeability of the granite reduces rapidly with depth due to the fractures becoming tighter and less common, with the effective base of the aquifer typically reported as 30m to 40m below ground level[12].

The reported granite transmissivity ranges from 0.1m^2/day to 26m^2/day[12]. Assuming an effective saturated aquifer thickness of 30m, this equates to a permeability range of 0.0033m/day to 0.867m/day.

[11] Natural England's online MAGIC mapping system: Magic Map Application (defra.gov.uk) accessed 29th July 2025.

[12] Environment Agency, 2000, R&D Publication 68, The Physical Properties of Minor Aquifers in England and Wales.

2.4.2. Licensed Abstractions, Private Water Supplies & Springs

It is reported that boreholes drilled into the granite have a 95% probability of striking water-bearing fractures within 20m below ground level, with borehole yields rarely exceeding 100m^3/day and averaging approximately 50m^3/day[10]. Borehole yields are generally only suitable for private water supplies[15]. The local geological memoir for the area around Falmouth[9] reports a mean yield of 37m^3/day for abstraction boreholes within the granite.

Cornwall Council has provided details of private water supplies in the vicinity of the site[13]. Six active private water supplies are registered within a 1km radius of the site boundary; locations are indicated on Drawing 1 and details of each supply are included within Table 2.

Table 2: Private Water Supplies within 1km Radius of Site

Ref.	**Address & NGR**	**Source**	**Use**	**Distance from site**
PWS1	The Old Stables, Rowes Lane, Trevenen TR13 0PS NGR: SW 67524 29979	Borehole	Single domestic dwelling	600m east
PWS2	Pendennis, Bar View Terrace, Trannack TR13 0DQ NGR: SW 66188 30341	Well	Single domestic dwelling	700m north-west
PWS3	Trebray, Bar View Terrace, Trannack TR13 0DQ NGR: SW 66225 30396	Borehole	Domestic	700m north-west
PWS4	Tranvue, Trannack TR13 0DE NGR: SW 66055 30311	Borehole	Single domestic dwelling	700m north-west
PWS5	Bar View Terrace, Trannack, TR13 0DQ NGR: SW 66260 30481	Well	Single domestic dwelling	700m north-west
PWS5	Higher Trannack Farm, Trannack, TR13 0DQ NGR: SW 66292 30501	Borehole	Single domestic dwelling	700m north-west
PWS6	Prospect Farm, Trannack, TR13 0DE NGR: SW 65966 30350	Borehole	Domestic	800m north-west

Table Notes: Reference relates to Drawing No. 1.

The Environment Agency has provided details of licensed abstractions from groundwater and surface water in the vicinity of the site[14]. Three licensed abstractions are located within a 1km radius of the site boundary; locations are indicated on Drawing 1 and details are included within Table 3.

[13] Cornwall Council, 23rd July 2025, Freedom of Information Request response.

[14] Environment Agency, Devon, Cornwall & Isles of Scilly enquiries team, 11th August 2025, Ref: EIR2025/18214, Whealdream, Cornwall.

Table 3: Licensed Abstractions within 1km Radius of Site

Ref.	Licence, Holder & NGR	Annual Limit (m^3)	Source	Use	Distance from site
S1	15/48/232/S/014, South West Water (no grid reference provided)	Not provided	River Cober	Potable Water Supply	Unknown
S2	SW/048/0232/001/R01, Western Hydro Ltd. NGR: SW 66969 30203	14,832,432	River Cober	Hydroelectric Power Generation	150m north-east (upstream)
S3	15/48/232/S/012, Cornwall Council NGR: SW 676 311	224,007	River Cober	General Use (gully cleaning)	1.2km north-east (upstream)

Table Notes: Reference relates to Drawing No. 1.

The granite aquifer supports a number of small, private water supplies locally, as inferred from the regional aquifer characteristics. However, larger scale abstractions, including for public water supply, are limited locally to the River Cober. The closest groundwater abstractions are more than 500m from the site and no abstractions are identified within 1km downstream (south or south-west) of the site.

2.4.3 Groundwater Levels and Flow

The effective infiltration for the Carnmenellis granite is dependent on local soils and vegetation but typically in the range 500 to 700 mm/year[15].

The regional hydrogeological map[10] confirms the groundwater table within the granite is shallow, usually less than 10m below ground level, and typically follows a subdued form of the topography. Most groundwater flow occurs via fractures and is shallow and local, forming baseflow to rivers and discharging as springs.

Therefore, regional groundwater flow in the granite is typically radial, away from the high ground towards valleys, with local variation due to springs (typically where significant fractures emerge at ground surface). Perched water tables are reported, but typically there is good hydraulic continuity between the weathered granite and solid bedrock. Hydraulic gradients are often steep, indicative of low aquifer permeability[15].

The regional hydrogeological map presents generalised groundwater level contours, recognising that it is difficult to predict groundwater levels in low permeability fractured aquifers and noting that boreholes may not necessarily encounter groundwater at these levels. Figure 5 presents an extract of the hydrogeological map with the approximate site boundary outlined in red and the generalised groundwater contours indicated as purple lines and relative to mAOD.

Groundwater beneath the site is assumed to discharge to the adjacent River Cober, with a general westerly or south-westerly flow direction. Groundwater levels of approximately 100mAOD to 105mAOD can be inferred beneath the site, based on the regional hydrogeological map, site levels and local topography.

[15] Environment Agency, 2004, Technical Report NC/99/74/16, Baseline Report Series: 16. The Granites of South-West England.

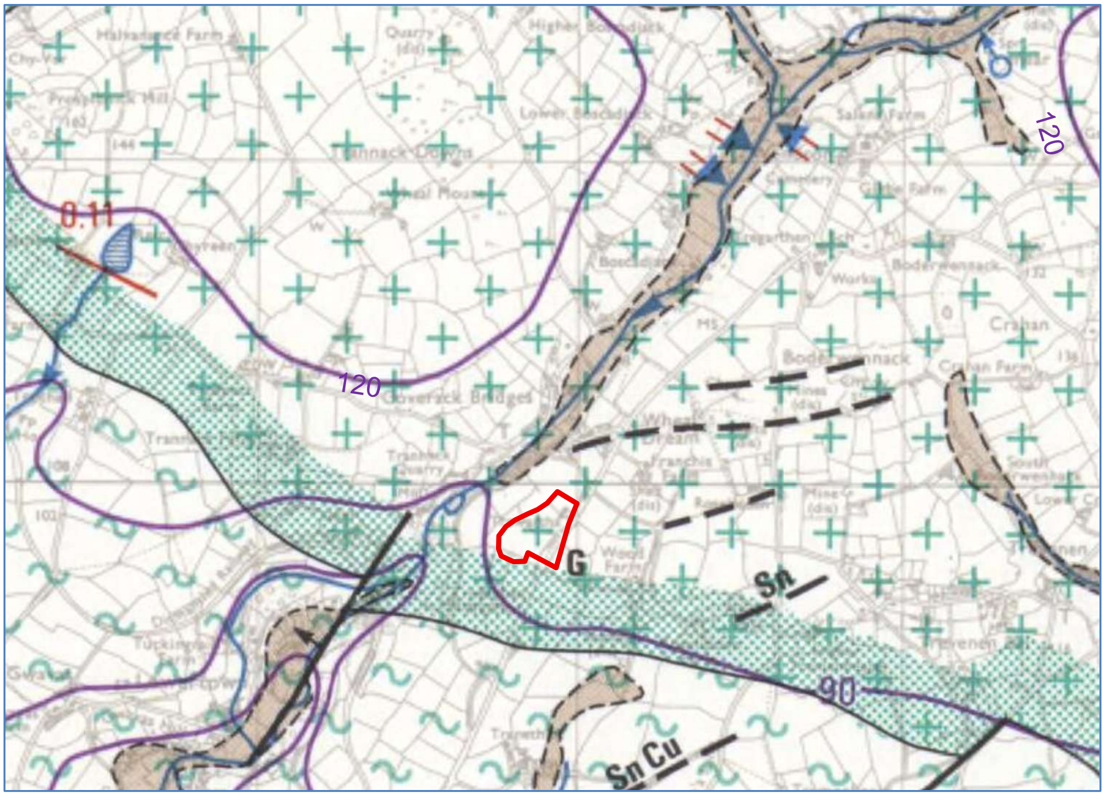

Figure 5. Extract of Hydrogeological Map for the Carnmenellis Granite[10].

2.4.4 Groundwater Quality

Groundwater within the granite typically has low total dissolved solid content and may be acidic[10], reflecting rainfall recharge with a limited degree of water-rock interaction due to short residence times.

As groundwater is typically shallow, it is susceptible to surface pollution sources. Mining activity can also have a significant impact on groundwater quality; acid mine drainage, produced by the oxidation of sulphide ore minerals, can result in acidic groundwater with high concentrations of iron, sulphate and trace metals (copper, lead, zinc and arsenic)[15].

The local geological memoir[9] confirms:

- Shallow groundwater in the granite is typically acidic (pH 4 to 7) and soft, with local trace concentrations of metals such as copper and zinc due to metalliferous mineralisation.
- Concentrations of copper and zinc are usually less than 0.1mg/l and 0.3mg/l respectively but levels of up to 2mg/l copper and 16mg/l zinc have bene recorded. Locally elevated iron and manganese are often associated with the acidic groundwater. Arsenic also occurs in the mineralisation zones and whilst local data are limited, concentrations of 0.01mg/l of arsenic are not uncommon in rivers and streams within the adjacent Penzance region.
- The use of agricultural fertilisers has led to increased nitrate levels, which typically remain less than 0.8mg/l, but concentrations of up to 20mg/l are noted.

A 2016 study of Cornish private water supply abstractions[16] noted that 5% of the private water supplies tested had arsenic concentrations in excess of 10μg/l (the UK Drinking Water Standard), due to the mining legacy and mineralisation.

Data reviewed within the baseline report for the granites of south-west England[15] confirms median dissolved copper and zinc concentrations of 7.5μg/l and 8.4μg/l respectively. The report states that arsenic is largely immobile in the acidic and oxic groundwater of the granite, where arsenic readily adsorbs onto metal oxides. However, as noted above, concentrations in excess of the UK Drinking Water Standard are reported.

2.4.5 Water Framework Directive Groundwater Bodies

Under the Water Framework Directive (WFD) the UK is split into River Basin Districts, each subdivided into smaller management units known as Water Bodies. The majority of the site overlies the West Cornwall Groundwater Body (ID: GB40802G800100); the south-eastern boundary of the site overlies the South Cornwall Groundwater Body (ID: GB 40802G800200).

In accordance with the requirements of the WFD, groundwater bodies are classified based on their quantitative and qualitative status. The quantitative status is classified as ‘good’ or ‘poor’ based on a large-scale assessment of the quantity of water available as baseflow to watercourses and water dependent ecosystems and the quantity available for groundwater abstractions. The qualitative status of a groundwater body is also classified as ‘good’ or ‘poor’ based on the concentrations of a range of key pollutants, the quality of groundwater baseflow to watercourses and contributing to water-dependent ecosystems and the quality of groundwater abstractions.

Information on the status of the West Cornwall and South Cornwall Groundwater Bodies has been obtained from the Environment Agency’s online Catchment Data Explorer and is summarised in Table 4 for the 2019 (Cycle 3) assessment.

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[16] British Geological Survey news, 09/05/2016, Toxic arsenic exposure discovered in Cornish private water supplies.

Table 4: WFD Groundwater Body Assessment

Parameter	West Cornwall (2019)	South Cornwall (2019)
Water Body ID	GB40802G800100	GB40802G80000
Surface Area	601.042 km^2	885.9 km^2
Water Body Type	Groundwater	Groundwater
Overall Status	**Poor**	**Poor**
Quantitative Status	**Good**	**Good**
Chemical Status	**Poor**	**Poor**
Chemical Elements:		
Chemical Dependent Surface Water Bodies	Poor	Poor
Drinking Water Protected Areas	Poor	Poor
Chemical Groundwater Dependent Terrestrial Ecosystems	Good	Good
Chemical Saline Intrusion	Good	Good
General Chemical Test	Poor	Good
Reasons for Not Achieving Good Status	Agriculture and rural land management (poor pesticide, nutrient and livestock management) Mining and quarrying (abandoned mine)	Agriculture and rural land management (poor pesticide, nutrient and livestock management) Mining and quarrying (abandoned mine)

It is noted that all water bodies fail chemical status for the 2019 assessment due to Environment Agency changes in methods and increased evidence base, with four groups of global pollutants (uPBTs) causing these failures. However, the assessment also confirms the groundwater bodies do not achieve good status due to impacts from agriculture and rural land management and abandoned mines.

2.5 Hydrology

2.5.1 Hydrological Setting

The Environment Agency's Catchment Data Explorer confirms that the site lies within the surface water catchment of the River Cober, which flows in a south-westerly direction, passing within 30m of the site's western boundary.

Locally, flow was diverted from the River Cober via weirs and sluices into leats used historically to power mills (agricultural corn mills and stamp mills for processing metalliferous ore)[17].

[17] GG Matthews, Helston History
https://freepages.rootsweb.com/~helstonhistory/history/kennelpage.htm

The site-specific Flood Risk Assessment (FRA) for the proposed development[18] confirms the Helston Leats are fed from an intake off the River Cober, near Wendron (approximately 1.25km-east north of the site) via a 3km supply channel which flows along the western site boundary.

Figure 6 presents the hydrological site setting and confirms the alignment of the leat supply channel and River Cober.

Figure 6. Hydrological Site Setting

The site-specific FRA confirms the site lies entirely within low probability Flood Zone 1, defined as land with less than 0.1% annual probability of flooding, and assessed as being at low or very low risk of flooding from all sources.

2.5.2 River Cober – Flow Data

The UK Centre for Ecology & Hydrology (CEH)[19] reports data for two river flow monitoring stations on the River Cober:

- 48801: River Cober at Trenear, approximately 1.25km upstream of the site; and
- 48006: River Cober at Helston County Bridge, approximately 2.7km downstream of the site.

Catchment and flow monitoring statistics for the River Cober are summarised in Table 5.

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[18] Cora IHT, July 2024, Whealdream Holiday and Leisure, Flood Risk Assessment and Drainage Strategy.

[19] https://nrfa.ceh.ac.uk/

Table 5: River Cober Flow Monitoring Data

Parameter	48801: River Cober at Trenear	48006: River Cober at Helston County Bridge
Grid Reference	SW675311	SW655273
Catchment Area	26.5km^2	37.5km^2
Monitoring Record	1988-2023	1968-2023
Mean Flow	0.471m^3/s	1.005m^3/s
95% Exceedance (Q95)	0.07m^3/s	0.185m^3/s
Base Flow Index	0.73	0.73

The base flow index is a measure of the proportion of river flow derived from groundwater storage; the more permeable the rock and soils of the catchment, the higher the base flow index. A base flow index of 0.73 is indicative of a moderately permeable catchment (low permeability clay catchments typically report a base flow index of 0.15 to 0.35 and high permeability Chalk catchments have a base flow index greater than 0.9)[19].

Review of the Flood Estimation Handbook (FEH) online web service indicates the River Cober has a catchment area of 28.1km^2 to the downstream boundary of the site. Assuming a linear relationship between river flow and catchment area, the following approximate flow statistics are inferred for the River Cober adjacent to the site, based on the available CEH flow data:

- Mean flow: 0.549m^3/s
- Q95: 0.087m^3/s

2.5.3 River Cober – Water Quality

The Environment Agency undertook baseline monitoring during 2022-2024 to identify rivers and estuaries polluted by abandoned metal mines, with pollution confirmed where the concentration of one or more of the six target substances (arsenic, cadmium, copper, lead, nickel and zinc) exceeds the relevant Environmental Quality Standard (EQS). The stretch of the River Cober adjacent to the site is not shown as a 'river polluted due to abandoned metal mines', based on the Environment Agency's 2022-2024 water quality monitoring[20].

However, the Environment Agency report confirms upstream and downstream stretches of the river are polluted:

In the Upper River Cober catchment, the Medlyn Stream is polluted by copper, zinc and cadmium. Below the confluence with the Medlyn Stream, the River Cober is also polluted by copper for a short distance, as shown by data collected at the monitoring site at Trenear Bridge.

The Lower River Cober is polluted by zinc in all stretches below the confluence of the Mellangoose Stream. The Mellangoose Stream is polluted by copper, zinc and cadmium throughout.

[20] Environment Agency, 12 March 2025, Research and analysis, West Cornwall and Fal Management Catchment: baseline length of rivers and estuaries polluted by abandoned metal mines.

Figure 7 presents an extract of the Environment Agency's baseline monitoring results, with the stretches of watercourse polluted by abandoned metal mines highlighted in red.

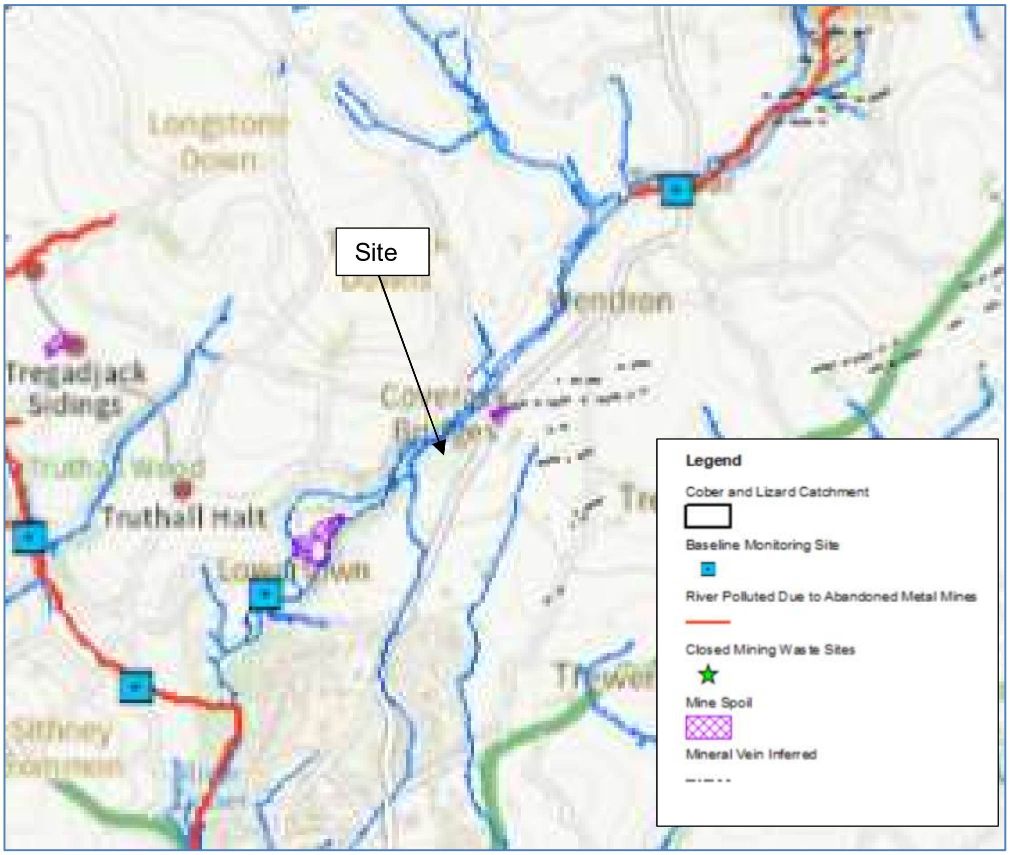


Figure 7. Environment Agency Rivers & Estuaries Polluted by Abandoned Metal Mines

The Environment Agency baseline data indicate that the River Cober adjacent to the site is not significantly polluted by abandoned metal mines, with metal concentrations below relevant EQS limits. However, monitoring locations are limited, and there is evidence of copper, zinc and cadmium contamination of the River Cober upstream and downstream of the site.

2.5.4 Water Framework Directive Surface Water Bodies

The central and north-western parts of the site lie within the catchment of the Upper River Cober WFD water body; the south-eastern part of the site lies within the catchment of the Lower River Cober WFD water body, as indicated on Figure 8.

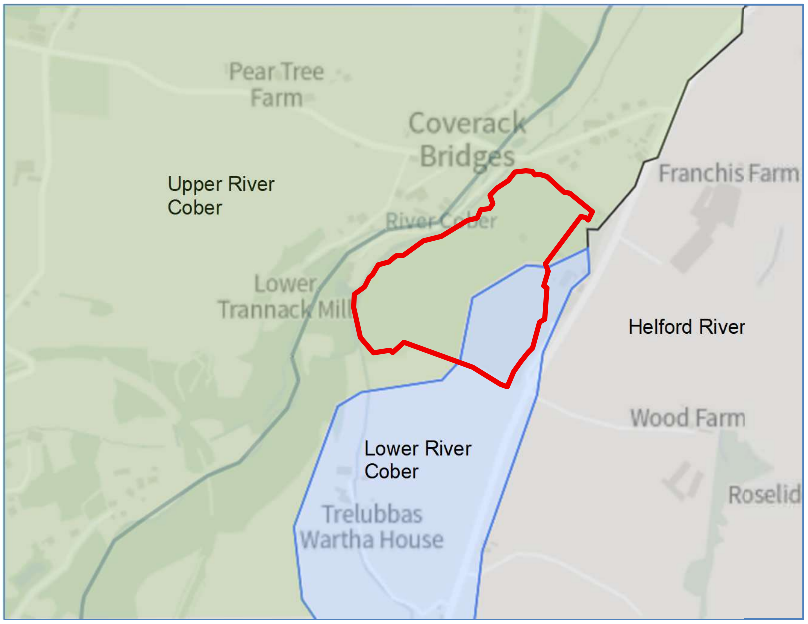


Figure 8. Water Framework Directive Surface Water Catchments

Data for these catchments are summarised in Table 6 for the 2022 (Cycle 3) assessment.

Table 6: River Cober, WFD Surface Water Body Assessment (2022)

Parameter	**Upper River Cober**	**Lower River Cober**
Water Body ID	GB108048001171	GB108048001172
Length	21.414km	6.36km
Catchment Area	29.128km^2	19.287km^2
Water Body Type	River (not designated artificial or heavily modified)	River (heavily modified)
Ecological Status	**Poor**	**Moderate**
Chemical Status	**Fail (2019)**	**Fail (2019)**

The Lower River Cober has an ecological status of moderate, described as a moderate change from natural conditions as a result of human activity, with some impact on wildlife and fisheries.

The Upper River Cober has an ecological status of poor, described as a significant change from natural conditions as a result of human activity, with noticeable changes in the biological communities and the overall functioning of the ecosystem.

The Upper River Cober reported 'poor' biological quality elements for fish. Reasons for not achieving good status are listed as natural mineralisation (zinc), abandoned mines, surface water abstractions (hydrological regime). In addition, mercury and PBDE (polybrominated diphenyl ethers) are listed, with no identified sector responsible.

Reasons for not achieving good status for the Lower River Cober are: abandoned mines and natural mineralisation (copper), agriculture and rural land management (poor soil, nutrient and livestock management), physical modification (urban and transport, and flood protection structures), surface water abstractions (hydrological regime). In addition, mercury and PBDE are listed, with no identified sector responsible.

It is noted that all river water bodies in England ‘fail’ chemical status in 2019 because the method of assessment of chemical status changed and the evidence base increased.

2.5.5 Drinking Water Protected Areas

Review of Natural England’s online MAGIC mapping system indicates that the north-western part of the site, which lies within the surface water catchment of the Upper River Cober, is within the Upper River Cober Drinking Water Protected Area (DWPA) for surface water. This DWPA is indicated on Figure 9 and represents an area identified as being at risk of failing the drinking water protection objectives of the Water Environment (Water Framework Directive) (England & Wales) Regulations 2017 due to ammonia and mecoprop. These contaminants are typically associated with agricultural land use.

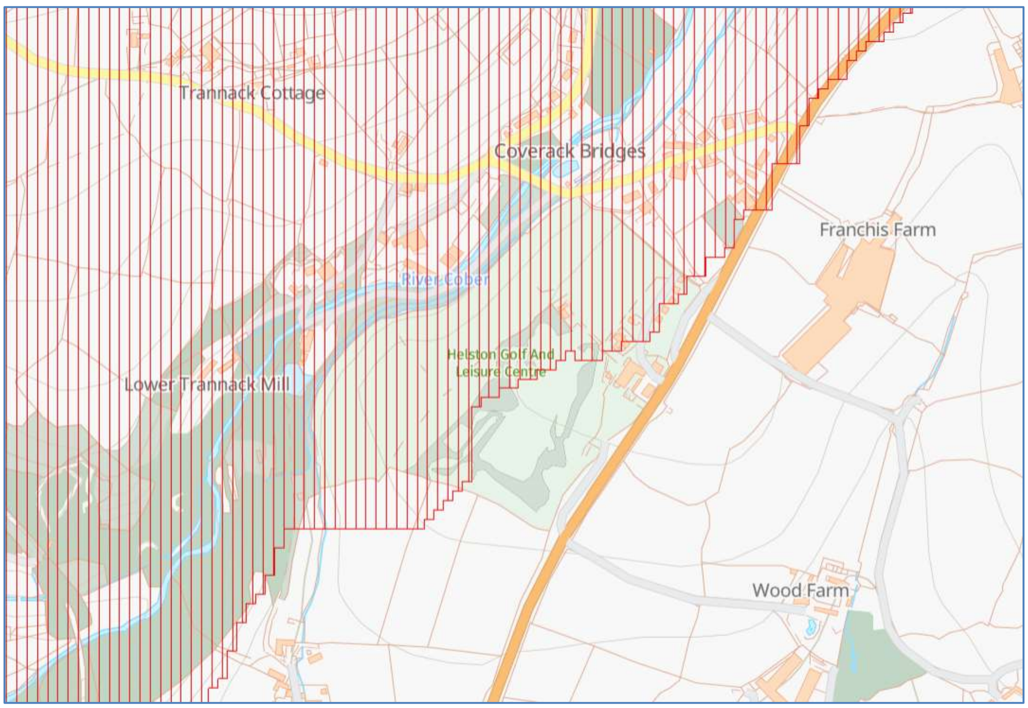


Figure 9. Upper River Cober Drinking Water Protected Area (Surface Water)

Section 2.4.2 presents details of local abstractions from surface water and confirms three licensed abstractions from the River Cober within a 1km radius of the site, including a potable water supply abstraction.

2.6 Hydrogeological Conceptual Site Model

The information in Sections 2.1 to 2.5 has informed the hydrogeological conceptual site model of the proposed deposit for recovery operation at Whealdream, as summarised below and on Drawing 2.

Source The site extends to 6.9ha, with approximately 102,000m^3 of inert material to be imported and deposited to achieve the approved landform. The material shall comprise inert waste only, and by definition will not undergo any significant physical, chemical or biological transformations. The total leachability and pollutant content of inert waste must not endanger the quality of surface water or groundwater. Appropriate waste acceptance procedures shall be in place, to ensure deposited material meets the inert WAC limits, as detailed in Table 1. Therefore, based on the inert nature of the material, the potential for leachate to contain discernible concentrations of hazardous substances or elevated concentrations of non-hazardous pollutants is very low.

Pathway The site overlies the Carnmenellis granite bedrock and the unsaturated pathway comprises a probable thin weathered horizon overlying low primary permeability, fractured granite. The inferred direction of groundwater flow is to the south-west, towards the adjacent River Cober. Rapid flow pathways are probable, via fractures and/or potential mine workings, although the hydraulic connectivity of such features is generally limited. The unsaturated zone and groundwater flow pathways offer potential for biodegradation and retardation of potential contaminants.

Receptors The granite beneath the site is classified as a Secondary A aquifer and supports local private water supplies. Groundwater beneath the site is assumed to discharge to the River Cober which bounds the site to the west. The River Cober supports a number of licensed abstractions locally. The groundwater body and the River Cober are Water Framework Directive water bodies. No site-specific data are available, but the baseline groundwater and surface water quality is likely to be influenced by natural metal mineralisation, historic mining activity and local agricultural land use. The primary receptor is groundwater in the granite aquifer beneath the down-gradient site boundary; the River Cober is a secondary receptor.

3.0 HYDROGEOLOGICAL RISK ASSESSMENT

This HRA follows a tiered approach, in accordance with current Environment Agency guidance.

3.1 Qualitative Risk Screening

Qualitative risk screening aims to assess whether the potential discharge from the activity is acceptable and will not therefore require further assessment. Risk screening considers the nature of the site (source), the sensitivity of the surrounding water environment, the hazards posed and the likelihood of the risk happening.

Whealdream is located within a moderately sensitive hydrogeological setting, overlying a Secondary A aquifer with groundwater assumed to discharge to the adjacent River Cober.

The site would only accept inert material; however, it is recognised that inert WAC limits for a number of pollutants exceed relevant water quality standards (refer to Section 3.2.2).

Therefore, based on the sensitivity of the water environment, a generic quantitative hydrogeological risk assessment is considered appropriate, to assess the risks posed by the site.

3.2 Generic Quantitative Risk Assessment

3.2.1 Modelling Approach and Software

The generic quantitative risk assessment has been undertaken using ConSim, the Environment Agency's recommended software tool for assessing the risk posed to groundwater by contaminants leaching from contaminated ground.

ConSim has been used in a deterministic modelling approach, using fixed, single value input parameters considered representative of the source, pathway and receptor terms at Whealdream. The model allows for retardation and biodegradation within the unsaturated and saturated flow pathways and dilution with groundwater beneath the site, to determine the resultant concentration of contaminants in groundwater at the down-gradient site boundary.

3.2.2 Source Term

Whealdream will accept inert waste only, in accordance with the inert WAC limits detailed in Table 1.

Table 7 converts the inert WAC limit for each parameter into an equivalent leachate source term (mg/l) and reviews this source concentration against the relevant water quality standards to determine risk factors. Freshwater Environmental Quality Standards (EQS) limits and UK Drinking Water Standards (DWS) are considered, together with Minimum Reporting Values (MRVs) for hazardous substances in groundwater. Risk factors are derived by dividing the source term concentration by the relevant water quality standard, with risk factors for the River Cober based on freshwater EQS limits and risk factors for groundwater based on the UK DWS or MRV as appropriate. As the inert WAC limits represent the maximum permitted concentration, these are compared against the maximum allowable concentration (MAC) EQS limit where one is available.

Table 7: Derivation of Source Term Risk Factors for Inert Waste

Parameter	Inert WAC Limit L/S = 10l/kg mg/kg dry substance	Equivalent Inert Leachate Source Term (mg/l)	Water Quality Standard (mg/l)		Risk Factor	
			Freshwater EQS	UK DWS / MRV*	River	Ground water
As	0.5	0.05	0.05 (AA)	0.005 (AA)*	1	10
Ba	20	2.0	N/A	1.0	-	2
Cd	0.04	0.004	0.0006 (MAC)	0.005	6.7	<1
Cr total	0.5	0.05	0.032 (MAC)	0.050	1.6	1
Cu	2	0.2	0.001 (AA, bioavailable)	2.0	200	<1
Hg	0.01	0.001	0.00007 (MAC)	0.0005 (AA)*	14.3	2.0
Mo	0.5	0.05	N/A	0.07	-	<1
Ni	0.4	0.04	0.034 (MAC)	0.020	1.2	2.0
Pb	0.5	0.05	0.014 (MAC)	0.005 (AA)*	3.6	10
Sb	0.06	0.006	N/A	0.005	-	1.2
Se	0.1	0.01	N/A	0.01	-	1.0
Zn	4	0.4	0.0109 (AA, bioavailable)	N/A	36.7	-
Chloride	800	80	250 (AA)	250	<1	<1
Fluoride	10	1.0	3000 (MAC)	1.5	<1	<1
Sulphate	1000	100	400 (AA)	250 (guide)	<1	<1

Table notes:
Cadmium EQS based on water hardness of 50-100mg/l, indicative of soft water.
Barium DWS after GOV.UK guidance: Natural mineral water – rules for local authorities. Molybdenum DWS after former WHO guideline value.
MRVs after UK Technical Advisory Group on the WFD, September 2016, Concentrations in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided.
EQS limits are based on the MAC (maximum allowable concentration) where available. If no MAC limit is available, the AA (annual average) limit is applied.

Review of Table 7 confirms elevated risk factors of ≥10 for arsenic, copper, mercury, lead and zinc for groundwater beneath the site and/or the River Cober. It is noted that the EQS limits for copper and zinc are based on the bioavailable content of these metals only; therefore, the risk factors are worst case.

However, it is considered appropriate to assess these substances as priority contaminants at Whealdream and they can be summarised as follows:

- Arsenic – representative of a metalloid commonly associated with contaminated soils. Classified as a hazardous substance. Naturally occurring in mineral veins and potentially present at low levels in local groundwater and surface water.
- Copper and zinc – representative of heavy metals commonly associated with contaminated soils. Classified as non-hazardous pollutants. Naturally occurring in mineral veins and potentially present at low levels in local groundwater and surface water
- Mercury and lead – representative of heavy metals commonly associated with contaminated soils. Classified as hazardous substances.

3.2.3 Environmental Assessment Levels

An Environmental Assessment Level (EAL) is a value set at the compliance point and is the maximum concentration allowable at that point in order to protect the receptors. EALs for groundwater receptors are based on the relevant water quality standard with due consideration of baseline, up-gradient groundwater quality where known. EALs for surface water receptors are based on EQS limits.

No site-specific groundwater quality data are available; therefore, it is assumed that background concentrations of the priority substances remain below the relevant DWS (or MRV for hazardous substances).

The EALs for groundwater at the down-gradient site boundary and for the River Cober are derived in Table 8.

Table 8: Proposed Environmental Assessment Levels

Non-Hazardous Pollutant	**UK Drinking Water Standard (mg/l)**	**Freshwater EQS**	**Resultant EAL (mg/l)**	
			Groundwater	**River Cober**
Copper	2.0	0.001	2.0	0.001
Zinc	N/A	0.0109	N/A	0.0109
Hazardous Substance	**MRV in groundwater (mg/l)**	**Freshwater EQS**	Resultant EAL (mg/l)	
			Groundwater	River Cober
Arsenic	0.005	0.05	0.005	0.05
Lead	0.005	0.014	0.005	0.014
Mercury	0.0005	0.00007	0.0005	0.00007

Table notes: refer to Table 7 for derivation of water quality standards.

3.2.4 Model Parameterisation

Appendix B presents the parameterisation of the ConSim model. The source is based on the site development proposals and the inert WAC limits. The parameterisation of the unsaturated pathway and the groundwater flow pathway beneath the site is based on the conceptual site model, with ‘most likely’ values specified. Appendix B includes the derivation of each model parameter. In the absence of site-specific data, the parameterisation of the generic risk assessment is based on the site setting and published sources.

3.2.5 Model Results

The primary receptor is groundwater, prior to discharge to the River Cober, and current Environment Agency guidance[4] confirms the relevant compliance point is groundwater just below the water table (after dilution has occurred), at the down-gradient site boundary. The resultant concentrations in groundwater based on ConSim modelling, are presented in Table 9. The model has been used in a deterministic approach, with ‘most likely’ input values; therefore the 50%ile resultant concentrations have been reviewed. Model result time slices were set every 10 years (between 0 and 5000 years) to ensure breakthrough concentrations were detected. The time to peak concentration is included in Table 9.

Table 9: ConSim Model Results

Parameter	Source Term (mg/l)	Peak Predicted Concentration in Groundwater, Down-Gradient boundary (mg/l) (50%ile)	EAL (mg/l)	
			Groundwater	River Cober
Copper	0.2	0.0012 (5000 years)	2.0	0.001 (AA, bioavailable)
Zinc	0.4	0.0028 (210 years)	N/A	0.0109 (AA, bioavailable)
Arsenic	0.05	0.00032 (3200 years)	0.005	0.05
Lead	0.001	0.00033 (3475 years)	0.005	0.014
Mercury	0.05	8.8E-06 (21 years)	0.0005	0.00007

The model results confirm that the peak predicted concentrations of zinc, arsenic, lead and mercury in groundwater at the down-gradient site boundary remain below the relevant EALs for groundwater and for the River Cober. The peak concentration of copper in groundwater at the down-gradient boundary marginally exceeds the EAL for the River Cober at 5000 years. However, this is not considered significant, as the EAL relates to the bioavailable content of copper and there is no allowance for dilution of groundwater with river flow or background concentrations within the HRA.

Section 2.5.2 derives a mean flow for the River Cober in the vicinity of the site of 0.549m^3/s, equivalent to 17,325,122m^3/year. The average annual groundwater throughflow beneath the site is 23,238m^3/year, based on ConSim model results. Therefore, based on the parameterisation of the HRA and available data, the River Cober provides a dilution factor of approximately 745. Therefore, it is concluded that there would be no discernible discharge of hazardous substances, and the discharge of non-hazardous pollutants would be limited to ensure no pollution of groundwater at the down-gradient site boundary or the River Cober.

The HRA does not make allowance for potential background concentrations of metals associated with natural mineralisation within the granite or mining related discharges; natural background concentrations in groundwater and the River Cober may exceed the assumed source term concentrations.

3.3 Sensitivity Analysis - Rogue Load Assessment

The permit and associated waste acceptance procedures should ensure only strictly inert wastes are accepted, in accordance with the inert WAC limits and assumptions of the quantitative HRA. However, there is a low residual risk of ‘rogue loads’ of non-inert waste being accepted at the site, with leachate concentrations potentially exceeding the values assumed in the HRA.

The parameterisation of the HRA is already conservative, in that it assumes 100% of the imported waste generates leachate at concentrations equivalent to the inert WAC limits.

However, a sensitivity analysis has been undertaken to assess the potential impact of increased leachate concentrations on the water environment. Source term concentrations have been increased by 20% above the inert WAC limits and the model results are presented in Table 10.

Table 10: Rogue Load Assessment - ConSim Model Results

Parameter	Source Term (Inert WAC Limit + 20%) (mg/l)	Peak Predicted Concentration in Groundwater, Down-Gradient boundary (mg/l) (50%ile)	EAL (mg/l)	
			Groundwater	River Cober
Copper	0.24	0.0012	2.0	0.001 (AA, bioavailable)
Zinc	0.48	0.0035	N/A	0.0109 (AA, bioavailable)
Arsenic	0.06	0.00040	0.005	0.05
Lead	0.0012	0.00039	0.005	0.014
Mercury	0.06	1.19E-05	0.0005	0.00007

The results of the rogue load assessment, with 20% increased source term concentrations, are comparable to the original model results, with only marginal exceedance of the EAL for copper at the River Cober without dilution and without consideration of background water quality.

The modelling indicates the resultant groundwater concentrations have limited sensitivity to the considered change in source term concentrations.

3.4 Risk Assessment Summary

The generic quantitative risk assessment developed using ConSim and based on the site-specific hydrogeological conceptual model has demonstrated there would be no discernible discharge of hazardous substances and the discharge of non-hazardous pollutants would be limited to not cause pollution.

The risk assessment assumes the acceptance of inert waste material only, managed via appropriate waste acceptance procedures. No further technical precautions are considered necessary, based on the findings of the HRA.

3.5 Proposed Monitoring Schedules

Routine surface water quality monitoring of the adjacent leat is proposed, upstream and downstream of the site. The leat is the closest watercourse to the site and is therefore considered the primary surface water receptor. The stretch of the River Cober adjacent to the site is separated from the site by the leat and is potentially influenced by land uses on the opposite bank; therefore, it is not considered appropriate to monitor water quality of the River Cober.

Surface water monitoring of the leat will provide a dataset of baseline (pre-operational) and operational water quality data and will support subsequent permit surrender. The proposed monitoring schedule is presented as Table 11, with indicative monitoring locations included on Figure 10; final locations will be confirmed on site based on long-term safe access and will subsequently be geo-referenced / marked on site, for accurate repeat monitoring.

Table 11: Proposed Surface Water Monitoring Schedule

Location	Monitoring Frequency	Laboratory Schedule
Leat Upstream	**Pre-Operational**: Three baseline samples (ideally obtained during different flow conditions and at least one month between sampling events) **Operational:** Quarterly	General parameters: pH, electrical conductivity, chloride, sulphate, BOD, COD, hardness EQS priority metals: arsenic, copper, mercury, lead, zinc (metals to be analysed for dissolved content)
Leat Downstream		

Figure 10. Proposed Surface Water Monitoring Locations

3.6 Climate Change

The Environment Agency's climate change guidance[21] confirms that daily temperatures, sea levels, river flows and rainfall are predicted to increase in the future, and summers are predicted to become drier, due to climate change. The proposed operational life of the deposit for recovery facility at Wheal dream is just two years; therefore, climate change is not applicable during the operational phase.

The potential impacts of climate change have been considered for the long-term, restored site, with the surface water drainage strategy[18] designed with appropriate climate change allowances for predicted rainfall intensity.

Increased rainfall, due to climate change, may result in increased infiltration and percolation rates through the inert fill. However, groundwater throughflow within the underlying aquifer and flow rates in the River Cober would also increase due to climate change; therefore, negligible impact is predicted on the resultant contaminant concentrations in groundwater

[21] GOV.UK, April 2023, Guidance – Climate Change: risk assessment and adaptation planning in your management system.

and surface water. It is concluded that there would be no discernible discharge of hazardous substances and the discharge of non-hazardous pollutants would be limited to not cause pollution, with allowance for climate change.

4.0 REPORT SUMMARY AND CONCLUSIONS

This HRA supports a Deposit for Recovery permit application at Whealdream near Helston, Cornwall. Approximately 102,000m^3 of inert fill shall be imported and deposited across the 6.9ha site, to achieve the approved landform.

Whealdream is located in the south-west of the Carnmenellis Granite intrusion, and the local area has been subject to historic metal mining, with mine workings potentially extending beneath the site. The granite is typically weathered near surface, grading into hard rock with low primary permeability and groundwater flow predominantly via fractures and flooded mine workings. Groundwater beneath the site is assumed to discharge to the adjacent River Cober.

Local groundwater and surface water quality is likely to be influenced by agricultural land use and the natural metal mineralisation of the granite, together with any influence from historic mine workings.

The granite is classified as a Secondary A aquifer, with groundwater beneath the site and the adjacent River Cober representing Water Framework Directive waterbodies. No superficial deposits overlie the granite within the site boundary. Therefore, the local water environment has moderate to high sensitivity.

Whealdream is a proposed inert deposit for recovery facility; therefore, by definition, the waste will not undergo any significant physical, chemical or biological transformations. Appropriate waste acceptance procedures will be adopted to ensure deposited material meets the inert WAC limits.

A generic quantitative HRA has been prepared, due to the site's sensitive water environment. The hydrogeological conceptual site model has informed the risk assessment model developed using ConSim. The source term of the HRA is conservative, by assuming all waste generates leachate at the inert WAC limit values. The inert WAC limits for arsenic, copper, mercury, lead and zinc exceed relevant water quality standards and these have been included as priority contaminants for the site. Metals are likely to be naturally present in background groundwater due to the granite mineralisation; as a conservative approach, this is not considered in the HRA.

The primary receptor is groundwater in the granite beneath the down-gradient site boundary; the adjacent River Cober represents a secondary receptor.

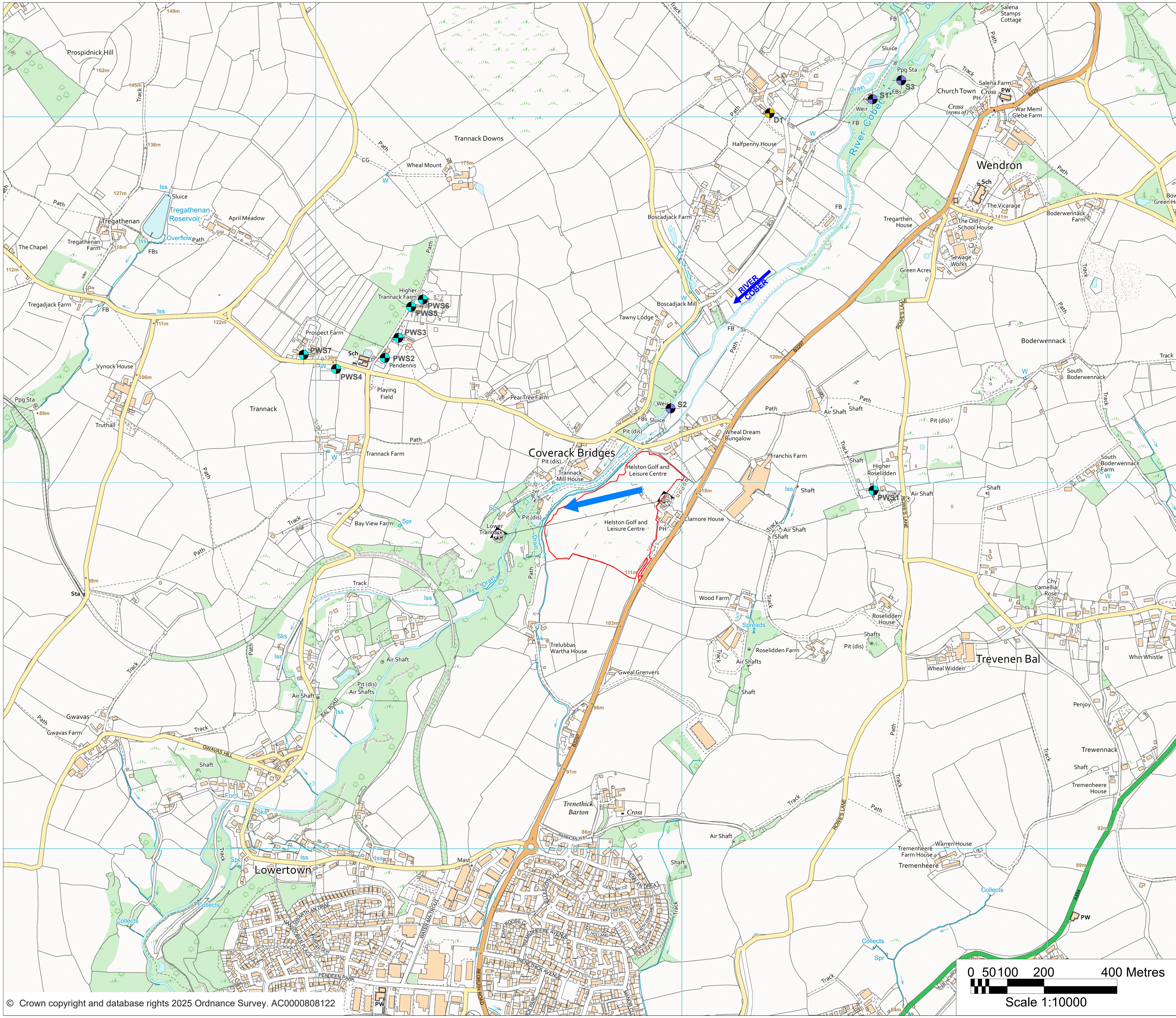
Due to the lack of site-specific data and nature of the development, the ConSim model has been developed as a deterministic model, with 'most likely' input parameter values selected and the 50%ile results reviewed. The model indicates there would be no discernible discharge of hazardous substances to groundwater or the River Cober and the discharge of non-hazardous pollutants would be limited and not cause pollution. Therefore, the proposed development meets the relevant requirements of the Environmental Permitting (England and Wales) Regulations 2016. No technical precautions are considered necessary, beyond appropriate waste acceptance procedures. Surface water monitoring of the adjacent leat is proposed, upstream and downstream of the site, to provide a water quality dataset for the baseline (pre-operational) conditions and during the site's operation. This will support the site's subsequent permit surrender.

5.0 CLOSURE

This report has been prepared by Nicola Sugg (trading style of NSugg Limited) with all reasonable skill and care, and in accordance with the services agreed with A&J Waste Services Ltd. Relevant information provided by Land & Mineral Management and A&J Waste Services Ltd. has been accepted in good faith as being accurate and valid. This report is based on the relevant guidance and legislation in force at the date of the report and should be reviewed if such guidance and legislation are amended or superseded.

This report is for the exclusive use of A&J Waste Services Ltd; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from Nicola Sug

DRAWINGS



NOTES

1. For Cross-section A-A' refer to Drawing 002.

LEGEND

- Site Boundary
- Private Water Supplies within a 1km radius of the site (Details of Private Water Supplies provided by Cornwall Council, 23rd July 2025)
- Licensed abstractions from groundwater or surface water within a 1km radius of the site (Details of Licensed Abstractions provided by the Environment Agency, 11th August 2025)

  *Public water supply abstraction from River Cober, grid reference not provided
- Permitted discharges to surface water or groundwater within a 0.5km radius of the site (Details of Permitted Discharges provided by the Environment Agency, 11th August 2025)
- Inferred Direction of Groundwater Flow

N W E S

A&J Waste Services Ltd.

SITE	**Whealdream Holidays & Leisure**
PROJECT	**Hydrogeological Risk Assessment (Ref: NS_0119_12)**
DRAWING TITLE	**Local Hydrogeology and Hydrology**
DRAWING NUMBER: **001**	REVISION: 0
SCALE: 1:10,000 @ A3	DATE: 03.09.2025

Nicola Sugg
Consultant Hydrogeologist & Hydrologist
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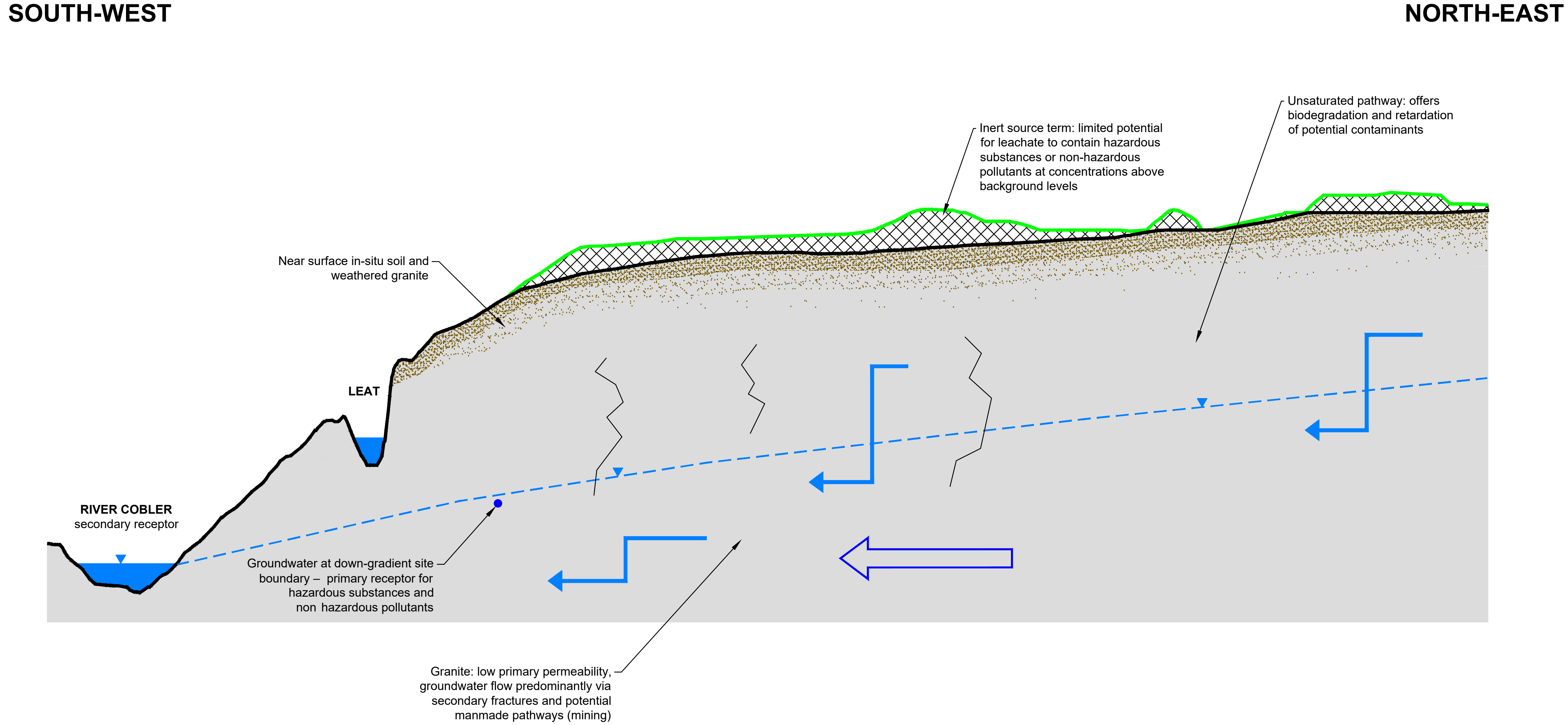
CROSS-SECTION A-A'



NOTES

1. Line of cross-section is indicated on Drawing 001.

Reference:
Weller Designs Limited, Whealdream Holiday & Leisure, Layout & Grading Plan, 901.02 Rev A, 01-07-2024.

Landform based on Idox LiDAR DTM 1m (Contains public sector information licensed under the Open Government Licence v3.0).

LEGEND

- Inferred Groundwater table
- Existing landform
- Proposed landform
- Imported inert material
- Near surface in-situ soil and weathered granite
- Inferred Direction of Groundwater Flow

A&J Waste Services Ltd.

SITE
Whealdream Holidays & Leisure

PROJECT
Hydrogeological Risk Assessment (Ref: NS_0119_12)

DRAWING TITLE
Schematic Hydrogeological Conceptual Model (CROSS-SECTION A-A')

DRAWING NUMBER	REVISION
002	0
SCALE	DATE
NOT TO SCALE	05.09.2025

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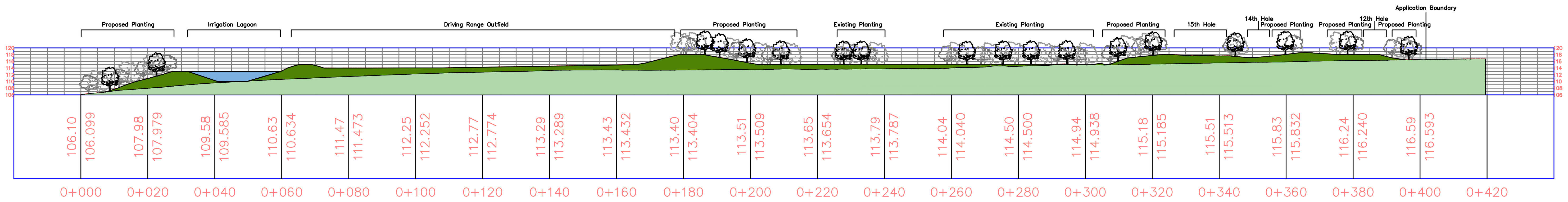
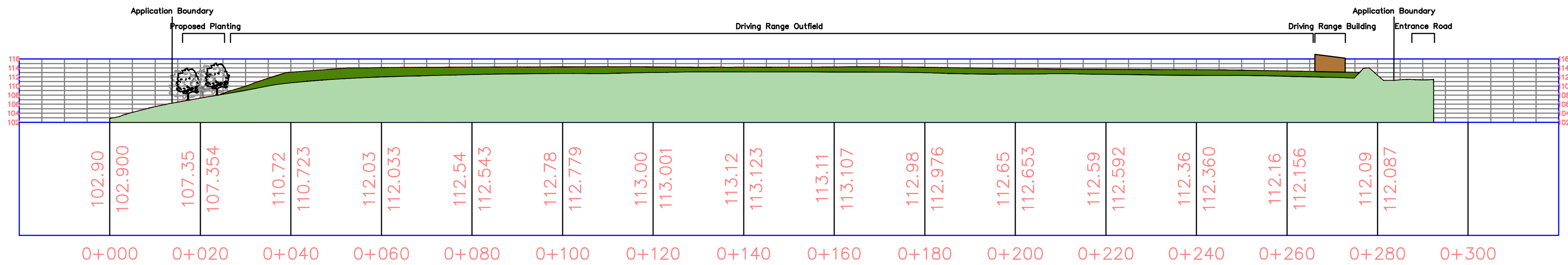
APPENDIX A

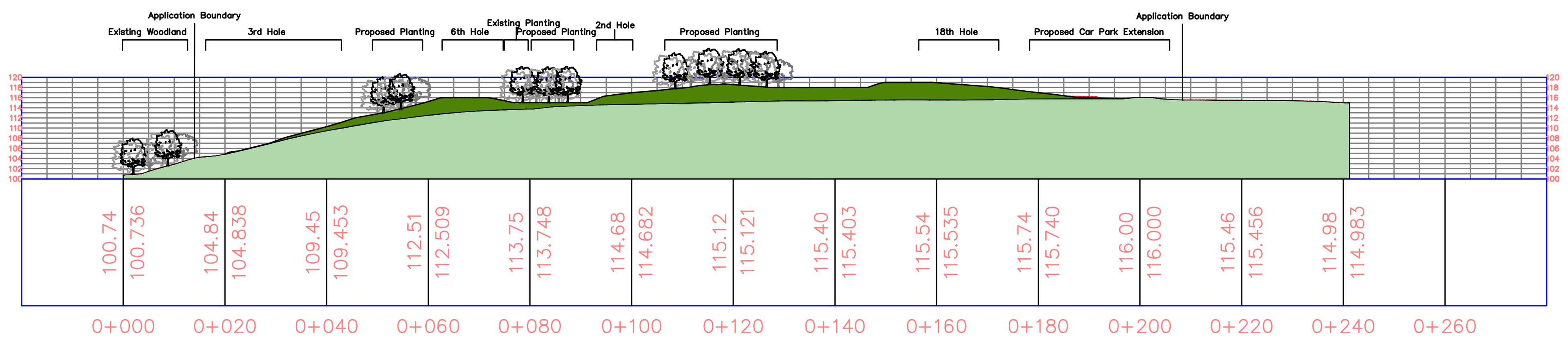
AA PROFILE



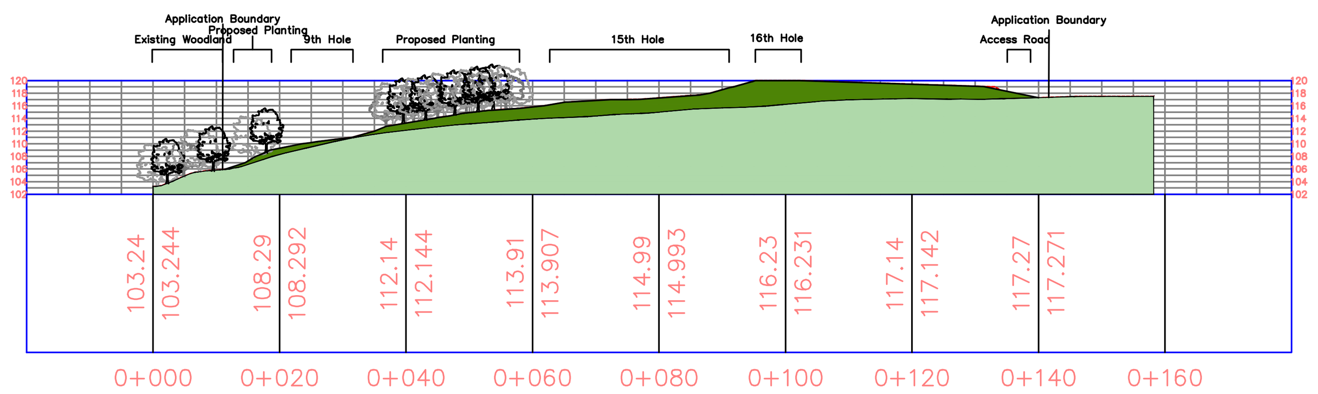
BB PROFILE



CC PROFILE



DD PROFILE



0m 100m

Existing Topography Levels

Proposed Topography Levels

Project Name: Whealdream Holiday & Leisure	Checked By: BW	Revision No:	
Drawing Name: Cross Sections Plan	Scale: 1:1000 @ A1	Rev A - footpath added, car park spaces defined on inset plan	
Drawing Number: 901.03 Rev A	Date: 03/07/2024		Weller Designs Limited Golf Course Architects
Drawn By: AR			

APPENDIX B

CONSIM MODEL PARAMETERISATION

SOURCE – INERT WASTE		
Parameter	**Value**	**Derivation**
Infiltration (mm/year)	294	Average Annual Rainfall: 1118mm/year (FEH rainfall data) Evapotranspiration (ET): 530mm/year (typical value for the area, after Environment Agency Baseline Report Series: 16. The Granites of South-West England. Average rainfall (1118) – ET (530) = 588mm/year. 50% loss assumed to surface water runoff and effective golf course drainage (based on NCB, 1982, Water in the Coal Mining Industry nomogram)
Thickness (m)	1.48	Site area (application boundary): 69,062m^2 Waste input (Waste Recovery Plan): 102,000m^3 Inferred average waste thickness = 1.48m
Dry Bulk Density (g/cm^3)	1.6	Typical value for soils (ConSim defaults)
Air Filled Porosity (fraction)	0.20	Typical total porosity for soils (0.35) less water filled porosity (0.15)
Water Filled Porosity (fraction)	0.15	Typical specific retention for soils
Source term concentrations, measured as leachable concentration (mg/l)	Arsenic: 0.05 Copper: 0.2 Mercury: 0.001 Lead: 0.05 Zinc: 0.4	Equivalent to the inert WAC limits (worst-case)

UNSATURATED PATHWAY – WEATHERED GRANITE		
Parameter	**Value**	**Derivation**
Unsaturated Pathway Thickness (m)	10	Assumed value based on local topography and assuming groundwater levels beneath the site are in continuity with the River Cober. Groundwater in the granite is typically within 10m of the ground surface, but the site is relatively elevated above the River Cober. A groundwater level beneath the site of 100 to 105mAOD is consistent with the regional hydrogeological map and represents an unsaturated zone thickness of 10 – 15m.
Unsaturated Hydraulic Conductivity (m/s)	$6.0x10^{-6}$m/s	South-west granite transmissivity ranges from 0.1m^2/day to 26m^2/day (average:13m^2/day) based on dataset in the EA's Minor Aquifer Properties Manual Assuming typical effective aquifer thickness of 25m (base of aquifer reported as 30-40m below ground level and assuming 10m unsaturated zone), this equates to a permeability of 0.52m/day ($6.0x10^{-6}$m/s). This value is also within the ConSim default range for weathered granite ($3.3x10^{-6}$m/s to $5.2x10^{-5}$m/s)
Water Filled Porosity (fraction)	0.05	Total porosity of 34% - 57% is anticipated for weathered granites (ConSim defaults). 5% specific retention assumed based on typical trends between porosity and specific retention (LandSim)
Dry Bulk Density (g/cm^3)	2.3	Typical value for granite (ConSim defaults)
Vertical Dispersivity (m)	1.0	After ConSim approach (10% of pathway length)

AQUIFER PATHWAY – GRANITE		
Parameter	**Value**	**Derivation**
Thickness (m)	30	Effective base of granite aquifer is reported as 30-40m below ground level. 10m unsaturated zone assumed.
Dry Bulk Density (g/cm^3)	2.3	Typical value for granite (ConSim defaults)
Mixing Zone Thickness (m)	10	Conservative value after local topography, inferred groundwater table and proximity to river. (Mixing zone is equivalent to between 105mAOD and 95mAOD)
Hydraulic Conductivity (m/s)	$6.0x10^{-6}$m/s	South-west granite transmissivity ranges from $0.1m^2$/day to $26m^2$/day (average:$13m^2$/day) based on dataset in the EA's Minor Aquifer Properties Manual Assuming typical effective aquifer thickness of 25m (base of aquifer reported as 30-40m below ground level and assuming 10m unsaturated zone), this equates to a permeability of 0.52m/day ($6.0x10^{-6}$m/s).
Effective Porosity (fraction)	0.15	Porosity of 17% is reported for the Carnmenellis Granite at 12.9m below ground (EA, Minor Aquifer Properties Manual).
Hydraulic Gradient	0.04	Assumed value based on the hydraulic gradient representing a subdued reflection of the topography between the site and the River Cober. Groundwater flow is in a south-westerly direction beneath the site. Distance from the up-gradient (north-east) site boundary to the river = 500m. Assume groundwater level falls from 105mAOD (10mbgl) to 85mAOD (river level) (i.e. 20m) over this distance. I = 20/500 = 0.04
Longitudinal Dispersivity (m)	3.0	After ConSim approach (10% of pathway length)
Lateral Dispersivity (m)	0.9	After ConSim approach (3% of pathway length)

BIODEGRADATION AND RETARDATION PARAMATERS ASSUMED WITHIN THE GRANITE (UNSATURATED PATHWAY & AQUIFER PATHWAY)		
Parameter	**Value**	**Derivation**
Retardation Parameters		
Partition Coefficient (ml/g)	Arsenic: 25 Copper: 40 Mercury: 0.1 Lead: 27 Zinc: 1.6	Minimum default values for acidic pH conditions indicative of Granite (ConSim)
Degradation Half Lives		
No biodegradation assumed		

No allowance for potential background contaminant levels in groundwater.

APPENDIX C

Project Details

Title: Whealdream
Project Number: NS_0119_12
Prepared By: NSugg
Date: 2025-08-06 19:24:20
Client Name: A&J Waste Services Ltd.
Comments:
HRA to support waste recovery permit application
Consim version 2.05

Simulation Level

Level 3

Simulation Parameters

Iterations 1001
Timeslices:1, 10, 11, 21, 31, 41, 51, 61, 71, 81, 91, 100, 101, 111, 121, 131, 141, 151, 161, 171, 181, 191, 200, 201, 211, 221, 231, 241, 251, 261, 271, 281, 291, 301, 311, 321, 331, 341, 351, 361, 371, 381, 391, 401, 411, 421, 431, 441, 451, 461, 471, 481, 491, 501, 511, 521, 531, 541, 551, 561, 571, 581, 591, 601, 611, 621, 631, 641, 651, 661, 671, 681, 691, 701, 711, 721, 731, 741, 751, 761, 771, 781, 791, 801, 811, 821, 831, 841, 851, 861, 871, 881, 891, 901, 911, 921, 931, 941, 951, 961, 971, 981, 991, 1000, 1001, 1011, 1021, 1031, 1041, 1051, 1061, 1071, 1081, 1091, 1101, 1111, 1121, 1131, 1141, 1151, 1161, 1171, 1181, 1191, 1201, 1211, 1221, 1231, 1241, 1251, 1261, 1271, 1281, 1291, 1301, 1311, 1321, 1331, 1341, 1351, 1361, 1371, 1381, 1391, 1401, 1411, 1421, 1431, 1441, 1451, 1461, 1471, 1481, 1491, 1501, 1511, 1521, 1531, 1541, 1551, 1561, 1571, 1581, 1591, 1601, 1611, 1621, 1631, 1641, 1651, 1661, 1671, 1681, 1691, 1701, 1711, 1721, 1731, 1741, 1751, 1761, 1771, 1775, 1781, 1791, 1801, 1811, 1821, 1831, 1841, 1851, 1861, 1871, 1881, 1891, 1901, 1911, 1921, 1931, 1941, 1951, 1961, 1971, 1981, 1991, 2000, 2001, 2011, 2021, 2031, 2041, 2051, 2061, 2071, 2081, 2091, 2101, 2111, 2121, 2131, 2141, 2151, 2161, 2171, 2181, 2191, 2201, 2211, 2221, 2231, 2241, 2251, 2261, 2271, 2281, 2291, 2301, 2311, 2321, 2331, 2341, 2351, 2361, 2371, 2381, 2391, 2401, 2411, 2421, 2431, 2441, 2451, 2461, 2471, 2481, 2491, 2501, 2511, 2521, 2531, 2541, 2551, 2561, 2571, 2581, 2591, 2601, 2611, 2621, 2631, 2641, 2651, 2661, 2671, 2681, 2691, 2701, 2711, 2721, 2731, 2741, 2751, 2761, 2771, 2781, 2791, 2801, 2811, 2821, 2831, 2841, 2851, 2861, 2871, 2881, 2891, 2901, 2911, 2921, 2931, 2941, 2951, 2961, 2971, 2981, 2991, 3001, 3011, 3021, 3031, 3041, 3051, 3061, 3071, 3081, 3091, 3101, 3111, 3121, 3131, 3141, 3151, 3161, 3171, 3181, 3191, 3201, 3211, 3221, 3231, 3241, 3251, 3261, 3271, 3281, 3291, 3301, 3311, 3321, 3331, 3341, 3351, 3361, 3371, 3381, 3391, 3401, 3411, 3421, 3431, 3441, 3451, 3461, 3471, 3481, 3491, 3501, 3511, 3521, 3531, 3541, 3551, 3561, 3571, 3581, 3591, 3601, 3611, 3621, 3631, 3641, 3651, 3661, 3671, 3681, 3691, 3701, 3711, 3721, 3731, 3741, 3751, 3761, 3771, 3781, 3791, 3801, 3811, 3821, 3831, 3841, 3851, 3861, 3871, 3881, 3891, 3901, 3911, 3921, 3931, 3941, 3951, 3961, 3971, 3981, 3991, 4001, 4011, 4021, 4031, 4041, 4051, 4061, 4071, 4081, 4091, 4101, 4111, 4121, 4131, 4141, 4151, 4161, 4171, 4181, 4191, 4201, 4211, 4221, 4231, 4241, 4251, 4261, 4271, 4281, 4291, 4301, 4311, 4321, 4331, 4341, 4351, 4361, 4371, 4381, 4391, 4401, 4411, 4421, 4431, 4441, 4451, 4461, 4471, 4481, 4491, 4501, 4511, 4521, 4531, 4541, 4551, 4561, 4571, 4581, 4591, 4601, 4611, 4621, 4631, 4641, 4651, 4661, 4671, 4681, 4691, 4701, 4711, 4721, 4731, 4741, 4751, 4761, 4771, 4781, 4791, 4801, 4811, 4821, 4831, 4841, 4851, 4861, 4871, 4881, 4891, 4901, 4911, 4921, 4931, 4941, 4951, 4961, 4971, 4981, 4991, 5000, 10000

Water Quality Standard

User Defined

Source

Whealdream
Dry Bulk Density [g/cm³] SINGLE(1.6)
Air Filled Porosity [fraction] SINGLE(0.2)
Water Filled Porosity [fraction] SINGLE(0.15)
Thickness [m] SINGLE(1.48)
Contaminated Land
Declining Source Term

Overall Unsaturated Zone Thickness [m] SINGLE(10)

Infiltration

Infiltration [mm/year] SINGLE(294)

Source Inventory:

Arsenic
Measured as Leachable Concentrate
Leachate Concentration [mg/l] SINGLE(0.05)
Inorganic
Partition Coefficient [ml/g] SINGLE(25)

Copper
Measured as Leachable Concentrate
Leachate Concentration [mg/l] SINGLE(0.2)
Inorganic
Partition Coefficient [ml/g] SINGLE(40)

Lead
Measured as Leachable Concentrate
Leachate Concentration [mg/l] SINGLE(0.05)
Inorganic
Partition Coefficient [ml/g] SINGLE(27)

Mercury
Measured as Leachable Concentrate
Leachate Concentration [mg/l] SINGLE(0.001)
Inorganic
Partition Coefficient [ml/g] SINGLE(0.1)

Zinc

Measured as Leachable Concentrate

Leachate Concentration [mg/l] SINGLE(0.4)

Inorganic

Partition Coefficient [ml/g] SINGLE(1.6)

Unsaturated Pathway: Unsaturated Weathered Granite

Active

Porous Medium

Thickness [m] SINGLE(10)

Dry Bulk Density [g/cm³] SINGLE(2.3)

Vertical Dispersivity [m] SINGLE(1)

Water Filled Porosity [fraction] SINGLE(0.05)

Unsaturated Conductivity [m/s] SINGLE(6e-006)

Unsaturated Pathway Contaminants

Arsenic

Partition Coefficient [ml/g] SINGLE(25)

Copper

Partition Coefficient [ml/g] SINGLE(40)

Lead

Partition Coefficient [ml/g] SINGLE(27)

Mercury

Partition Coefficient [ml/g] SINGLE(0.1)

Zinc

Partition Coefficient [ml/g] SINGLE(1.6)

Aquifer Pathway

Thickness [m] SINGLE(30)
Dry Bulk Density [g/cm³] SINGLE(2.3)
Mixing Zone Thickness [m] SINGLE(10)
Hydraulic Conductivity [m/s] SINGLE(6e-006)
Effective Porosity [fraction] SINGLE(0.15)
Hydraulic Gradient SINGLE(0.04)
Groundwater Flow Direction (degrees), 245.00
Longitudinal Dispersivity [m] SINGLE(3)
Lateral Dispersivity [m] SINGLE(0.9)

Contaminant Inventory

Arsenic
Partition Coefficient [ml/g] SINGLE(25)

Copper
Partition Coefficient [ml/g] SINGLE(40)

Lead
Partition Coefficient [ml/g] SINGLE(27)

Mercury
Partition Coefficient [ml/g] SINGLE(0.1)

Zinc
Partition Coefficient [ml/g] SINGLE(1.6)

Receptor

Whealdream Receptor	X 6655.468461	Y 9789.186909

Input Correlations

No Correlations

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