BURO HAPPOLD

Sustainable Distillery Research Centre.
United Mines Landfill

Ground Engineering Desk Study

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1 Introduction

1.1 General

This report presents the results of a Ground Engineering Desk Study of a part of the former United Mines Landfill ('the Site') on behalf of Cornish Geothermal Distillery Company Ltd ('the Client'). The purpose of this study is to establish the environmental, geological, hydrological and hydrogeological conditions present at the Site that may result in potential contamination or ground-related risks to support an outline planning application. The Site covers some 0.85 hectares is located in United Downs, near Redruth, TR16 5HU and is approximately centred at NGR SW 74487 41359. The redline boundary is provided as Figure 1-1 and an aerial image is provided as Figure 1-2. A Drawing showing the proposed development is included as Appendix A.

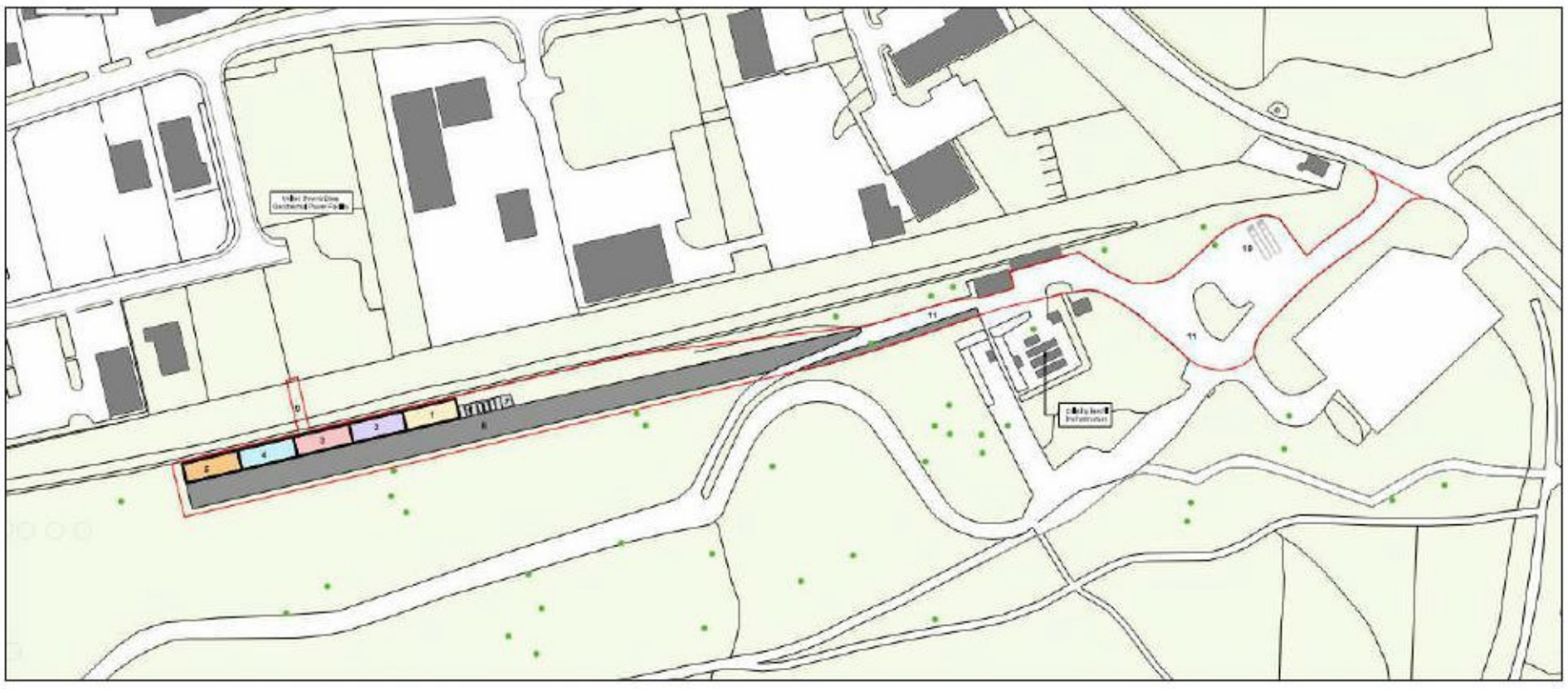


Figure 1-1 - Redline boundary and proposed layout for the Site.

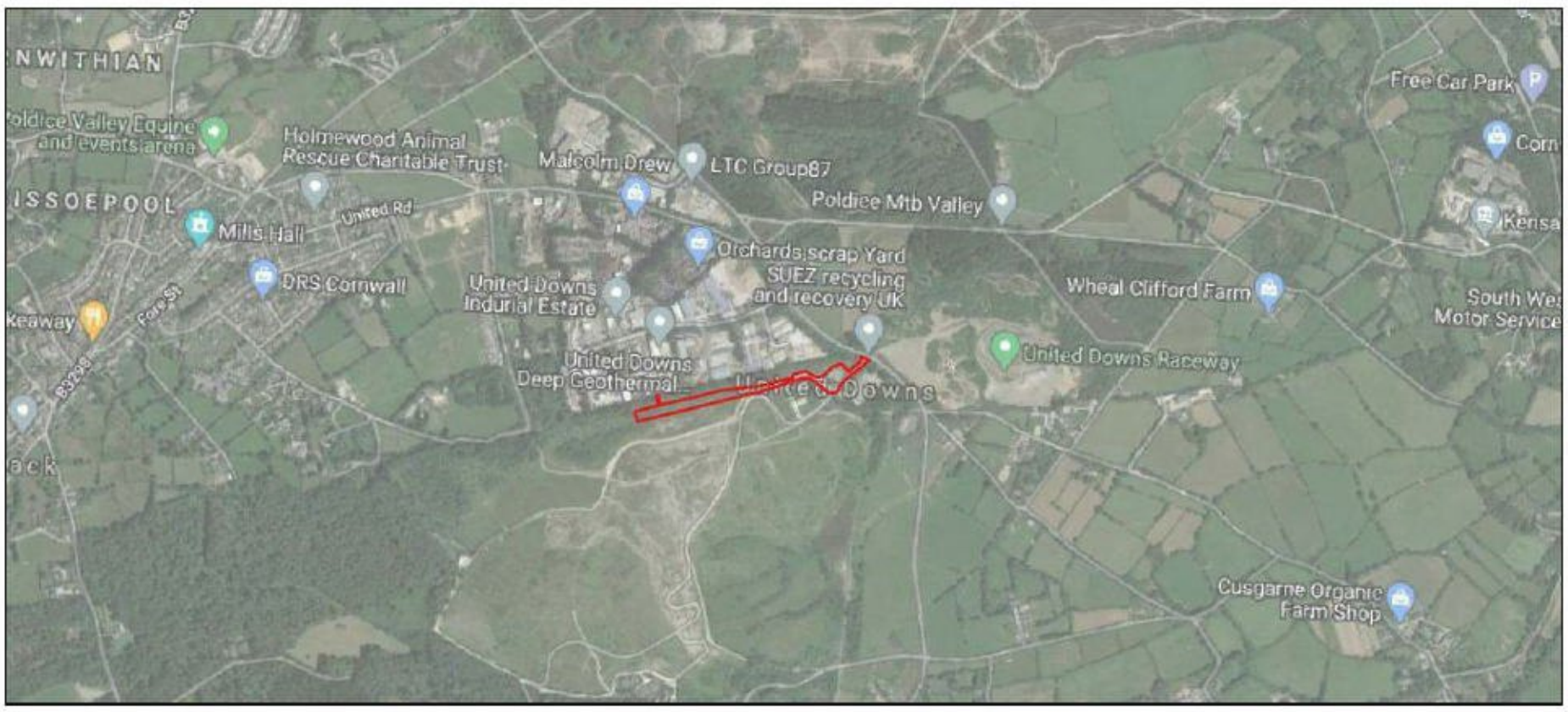


Figure 1-2 - Aerial image showing Site location (Google Hybrid, 2021).

1.2 Study aims and objectives

The overall aim of this study was to carry out a geoenvironmental and geotechnical assessment of the Site in order to inform the Client's understanding of potential ground-related risks associated with the proposed redevelopment. This report provides information relevant to redevelopment in accordance with the requirements of the National Planning Policy Framework (NPPF) [1] and also with respect to any potential liability under Part 2a of the Environmental Protection Act 1990 [2]. The work was carried out in general accordance with LCRM [3], the relevant British Standard [4], the Environment Agency Guiding Principles [5] and other current good practice guidance. The particular objectives were:

- To determine the historical and current use of the Site and its surroundings;
- To determine the geological, geotechnical, mining and geoenvironmental conditions from geological maps and site investigations;
- To assess the potential location, nature and extent of any ground and groundwater contamination and the environmental sensitivity of the Site;
- To assess the potential risks to people and the environment (natural and built) associated with ground contamination (solid, liquid or gas) both in the site's existing condition and for the proposed future use;
- To identify any geotechnical potential constraints;
- To construct an initial Conceptual Site Model and carry out a preliminary contaminated land risk assessment, in general accordance with the LCRM [3];
- To prepare a report based upon all of the above suitable to inform the Client about potential risks related to ground conditions and also suitable to support a planning application in accordance with NPPF [1]
- To determine the status of the Site with respect to Part 2a of the Environmental Protection Act 1990 and the nature and extent of any associated environmental liabilities; and
- To evaluate the potential need for and scope of any subsequent ground investigations and/or remedial action or design.

1.3 Information sources

The principal sources of information for this desk study report include: historical and current topographic maps, public register information (Appendix B) a previous Desk Study Report by Arup (Appendix C, prepared for a larger area of land that encompasses the Site), a walkover survey and information available from the Environment Agency websites and other online sources. This report is therefore based upon information obtained from third party sources, together with observations from the site walkover survey. The third party data has been accepted as face value and has not been independently verified. Buro Happold can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information.

1.4 Competence

This work reported here was carried out by geoenvironmental scientists and engineers from Buro Happold. Buro Happold is a consulting engineering company that manages its work under various Quality Management Systems that are certified to ISO 9001. The work itself was carried out by the staff with relevant qualifications, training and experience. This overall technical responsibility for the work was held by a Technical Director with substantial experience in the assessment of land affected by contamination who is a Chartered Geologist and registered SiLC (Specialist is Land Contamination) and SQP (Suitably Qualified Person).

2 Current land use and proposed development

2.1 Site location

The Site is an elongate parcel of land covering approximately 0.85 ha, located in United Downs, near Redruth, TR16 5HU and is approximately centred at NGR SW 74487 41359. It is located on land to the south of the United Downs Industrial Estate and at the northern edge of the former United Mines landfill site. It is accessed from the service road of the former landfill site.

2.2 Proposed development

The proposed development is a Sustainable Distillery Research Centre. The Centre will develop pioneering patent-pending technologies aimed at decarbonising the distillery sector, from malting and fermentation, to distillation and maturation, using geothermal heat and power. The application for outline planning permission describes the proposed development as "Sustainable Distillery Research Centre including demonstrator geothermal energy centre; demonstrator spirit distillery; demonstrator spirit cask maturation pods; areas for research and development; laboratory; spirit cask processing; filling and repair (cooperage); warehousing; and ancillary storage, office space, presentation room, kitchen, rest area and WC; with associated service road, vehicle turning head and parking area, drainage and utilities". It is understood that the buildings / structures of the Centre will be low rise and lightly loaded.

The rationale for the Site's location is due to being adjacent to the United Downs Deep Geothermal Power Project (UDDGP), which is located within the United Down Industrial Estate. The aim of the UDDGO project it to produce power and eat from the hot granite rocks deep below the ground in the area. The Sustainable Distillery Research Centre will make use of both and heat from the UDDGP source. The redline boundary and proposed site layout is shown by Figure 2-1. An indicative cross-section is provided as Figure 2-2. This indicates that the majority of the area (approximately 70%) would be used as service roads and space for vehicle turning. The proposed buildings cover about 15% of the area, with the remainder (15%) of the Site comprising soft landscaping.

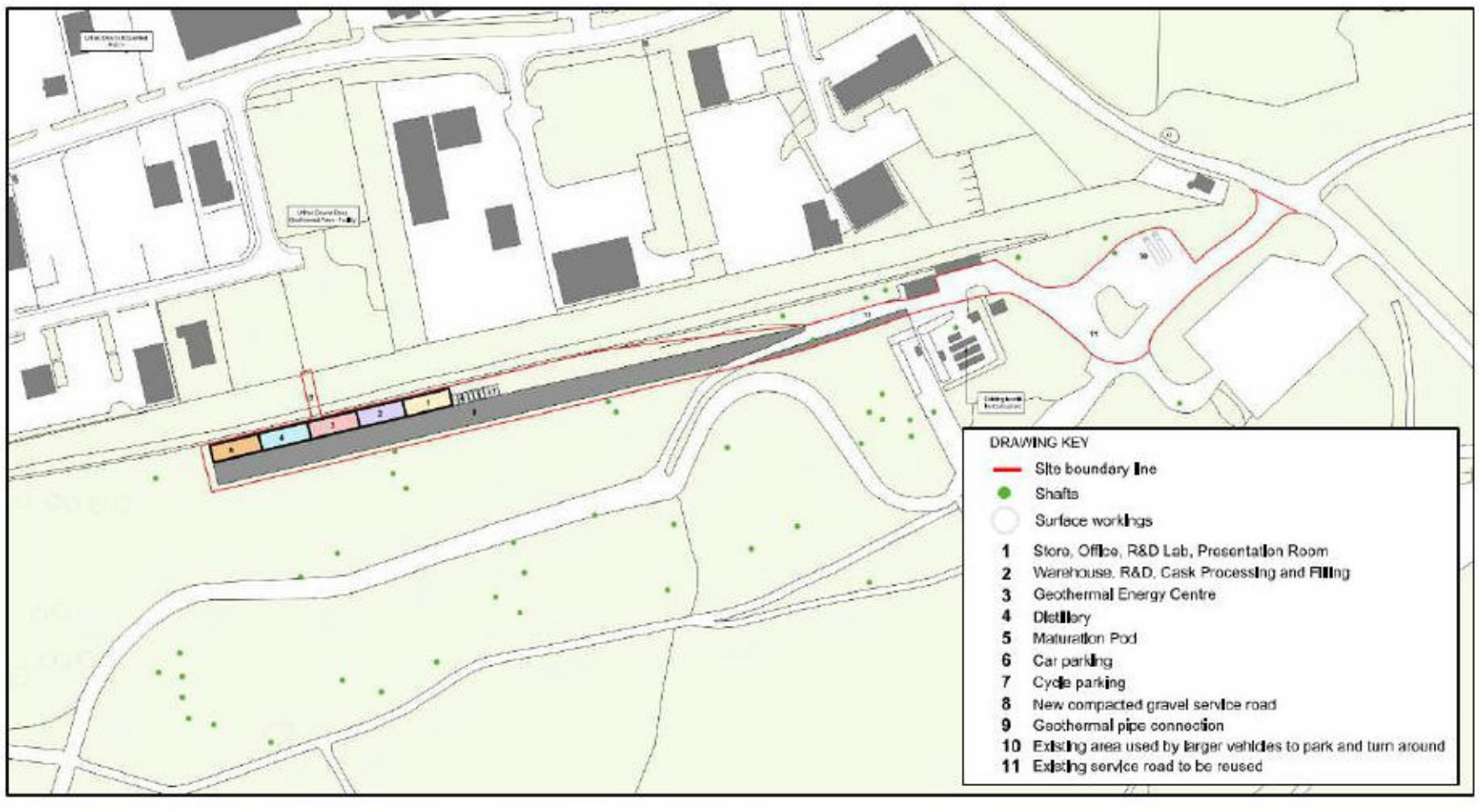
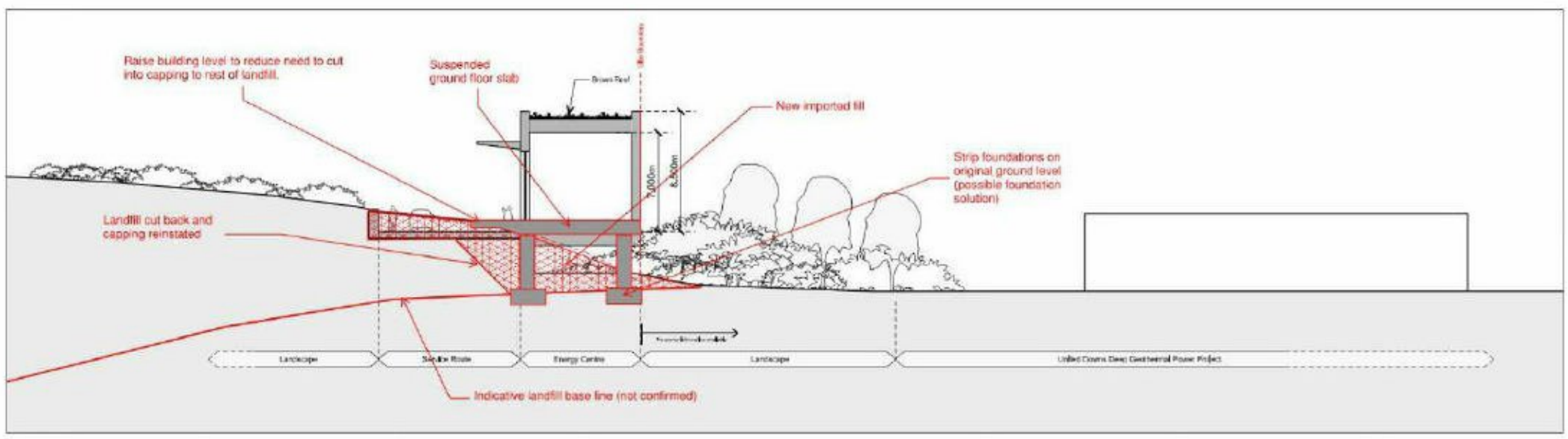


Figure 2-1 - Site redline boundary and proposed development.



01 Short Section North-South

Figure 2-2 - Indicative section showing possible building construction and foundation solution.

2.3 Topography

The Site is uneven to tread but is generally relatively flat, with levels ranging between about 95mAOD and 100mAOD. A steep bank slopes down parallel and adjacent to the northern boundary, before sloping upwards again between the Site and the neighbouring United Downs Industrial Estate.

2.4 Current activities on Site

A walkover survey of the Site was undertaken by Olivia French (Assistant Project Manager – Ward Williams Associates) on 23rd February 2021. This walkover was undertaken with Sue Webb (site contact – from Cornwall Council). The site walkover proforma and photographic record from that visit are included as Appendix D but is summarised here for ease of reference.

The Site is accessed from the east via the access road to the United Downs Landfill. Upon entry, it comprises a short section of the access road, a vehicle turning area, and a length of track that leads towards a set of two portacabins. In the northeast, there is also a closed-up (possibly remediated) mine shaft. The location of the mine shaft is covered by concrete (flush to ground surface) and surrounded by protective fencing to prevent access. One of the portacabins (noted above) falls within the redline boundary. Both portacabins use electricity and water and one is used by technical staff at Cornwall Council who are responsible for the monitoring of gas generation and managing the associated infrastructure at the landfill. One of these portacabins is also reported to house a transformer. Beyond the portacabins, a section of track (mixture of hardstanding and compacted gravel) continues in a westerly direction for approximately 80m further.

Beyond and surrounding the access roads / tracks, the Site is generally rough and uneven ground, in part open and vegetated in places. The northern boundary is densely vegetated / overgrown. No invasive species were observed during the site walkover. Sue Webb (Cornwall Council) noted that Japanese knotweed is known to be present in the wider area (i.e. not within the Site boundary) and its presence is currently controlled.

Much of the western part of the Site has undergone landfilling. Sue Webb noted that there is a large amount of landfill infrastructure below ground and gas manifolds, gas wells and dewatering chambers were evident at the surface. An 'as-built' gas layout plan was provided by Sue Webb detailing the above but was unavailable for inclusion in this report. The condition / contents of the below ground wastes were noted to be unknown.

2.5 Utilities and services

The Site is known to be underlain with infrastructure associated with the management of the United Mines landfill, however, the details of which (i.e. as-built drawings) are included in a previous desk study of the whole of the United Mines landfill site (included here as Appendix C).

2.6 Current activities in the surrounding area

The observations from the 23rd February 2021 walkover on the surrounding area, along with additional detail from Google Maps and other online sources, are summarised below.

North
United Downs Industrial Estate is present immediately beyond the northern boundary and extends to about 600m distant. No detailed site walkover of this area has been undertaken, but online sources indicate land uses to include: granite suppliers, a wheel shop, a welding shop, steel fabricators, the United Downs Deep Geothermal Project, car and metal scrap yards, and a scaffolding company, amongst others.

East
Adjacent to the east is an unnamed road that leads from United Downs (north) towards Frogpool (south). On the other side of that road is the United Downs Raceway, which has gated access. Buro Happold undertook a site walkover of this parcel of land in January 2020. Facilities here include the racetrack and surrounding spectator areas (including seating, decking, shipping containers and gravelly embankments). The racetrack area was secured by herras fencing. There was some evidence of fly tipping in area surrounding the racetrack and evidence of historical mining (including capped / covered mine shafts and mining spoil). Aside for the United Downs Raceway, the area to the east is generally undeveloped

South
The Site is located on the northern edge of the United Mines landfill, which extends up to approximately 600m south. To the immediate southeast of the Site (outside of the landfill area) is the United Mines Household Recycling Centre. No site walkover of this has been undertaken, but it appears to comprise an area of hardstanding covered by a series of skips for sorting and recycling household materials. About 40m west of this and adjacent to the Site's southern boundary is a compound for the management of landfill infrastructure. The United Mines landfill itself has been restored. The surface is part vegetated, with a series of tracks to navigate the area. There is also a bridleway that runs approximately east to west across its surface.

West
The area to the west is generally grassland and woodland. Bissoepool (predominantly residential) is present from about 400m northwest.

3 Environmental setting

3.1 Geology

The anticipated site geology (Figure 3-1) has been determined with reference to the relevant 1:50,000 BGS Map, Sheet 352 – Falmouth, the Groundsure Report (Appendix B) and local BGS borehole logs (Appendix E). These sources indicate that the Site is underlain by bedrock of the Mylor Slate Formation – a slate and siltstone, locally known as Killas Mudstones. This is likely to have been worked, associated with the known history of mining in the area. The western part of the Site falls within a known area of landfilling associated with the United Mines Landfill. Here, the Mylor Slate bedrock is likely to be overlain by an unknown thickness of landfill wastes (exact contents unknown).

The Site is within the inferred metamorphic aureole of the Carnmenellis intrusion, meaning the Mylor Formation is likely to have undergone subsequent metamorphism (hornfels facies). In the wider area, this bedrock has been intruded by quartz-porphyry, felsite and microgranite dykes, locally referred to as Elvan. These generally trend ESE-WNW, i.e. parallel to the bedding of the Mylor Slate. Associated with these intrusions are mineral lodes (principally copper ore, but also tin, iron, arsenic and zinc in the wider area). Mineral lodes are shown at the surface within the Site boundary. About 300m west is an area of faulting, orientated approximately north-south. A landslip is shown associated with this faulting.

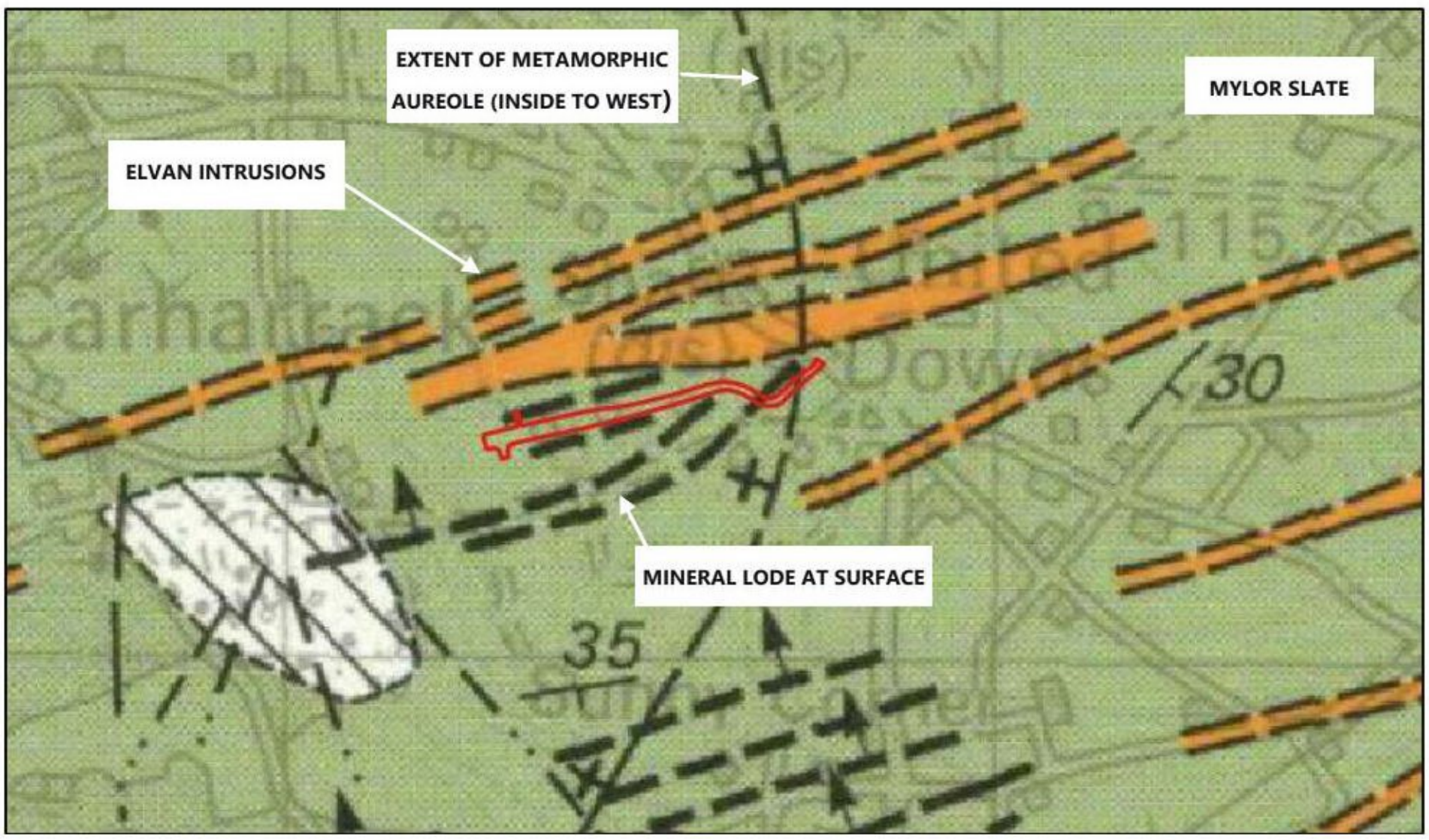


Figure 3-1 - Excerpt of BGS Sheet Map 352, Falmouth. Site shown by redline.

3.2 Mining

3.2.1 Metalliferous mining

The Site is located within an area previously worked for tin and copper. The available historical maps do not indicate presence of any shafts within the Site boundary, however there are several in the immediate vicinity.

Item	Location [on / off-site]	Information	Potential to impact
BritPits	250 to 500m	Two records located 256m S, related to United Mines for copper and tin extraction (both ceased). Noted that working is wholly underground with access by shaft, adit or drift. One record located 409m S, related to United Mines for extraction of igneous and metamorphic rock (ceased). Noted to be a surface mineral working.	Yes
Surface ground workings	On-site	Refuse heaps, unspecified heaps and mines waste disposal site identified from historical mapping records.	Yes
Underground workings	On-site	Disused tin and copper mine and unspecified disused shafts identified from historical mapping records.	Yes
Non-coal mining	On-site	Underground mining is known to have occurred within or very close to the area. Potential for difficult ground conditions should be investigated. Potential for localised subsidence is at a level where it should be considered. Commodity noted to be a vein mineral (unnamed).	Yes
Mining cavities	100 to 250m	Three records identified 148m S (Ale and Cakes, United Mines, Gwennap United). One record 181m S.	Yes
Tin mining	On-site	The Site is within an area where tin mining is reported to have occurred. This does not mean that the site is definitely directly affected by further consideration of tin mining is advised.	
No records of the following within 500m: natural cavities, historical mineral planning areas, JPG mining areas, coal mining, brine areas, gypsum areas, clay mining.			

3.2.2 Regulated mining search

The details of the mining search the whole of the United Mines landfill site are included in a previous desk study to which appropriate reference should be made (included here as Appendix C).

3.3 Hydrogeology

The Site is underlain by a Secondary A Aquifer in bedrock – defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. There are no current or historic groundwater or potable water abstractions within 1km. The groundwater is classed as 'High' vulnerability, meaning the ground conditions can easily transmit pollution to groundwater. The Site is not within a Source Protection Zone.

No records of depth to groundwater have been found for the site. Both depth to groundwater and direction of flow will be locally influenced by mine drainage interconnections, in particular the Great County Adit. The Great County Adit is an extensive system of underground near-horizontal tunnels built at an average of 80-100m depth to drain tin and copper mines between Redruth and Bissoe in west Cornwall. The Great County Adit drained into the Carnon River near Point Mills (approximately 1.5km east), which feeds into the Restronguet Creek, a tributary of Carrick Roads. Although no longer maintained, the adit continues to drain groundwater in the area.

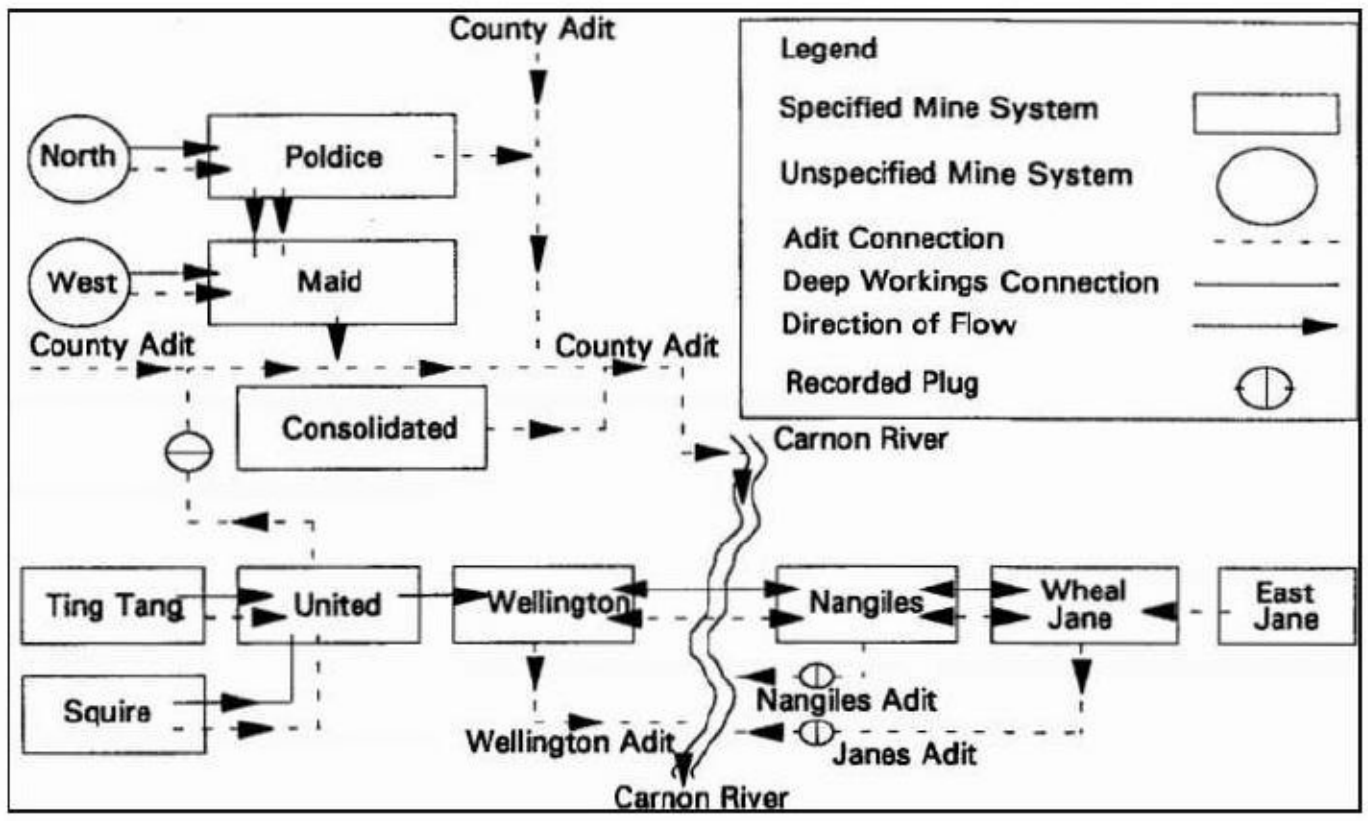


Figure 3-2 - Schematic flow diagram of mine drainage and interconnections.

3.4 Hydrology and drainage

There are no identifiable natural surface water features within the Site boundary. However, the Site is located within two of the catchments (West Catchment and East Catchment) used to regulate and control surface waters within the United Mines Landfill (see Section 5.1.3 for detail and Drawings in Appendix A).

Within the Western Catchment, surface water runoff from the northeast of the landfill and from a drain along the western boundary drain to the Sparry Lane pond (an attenuation pond). From the Sparry Lane Pond, water is pumped via a rising main and discharges to an existing culvert, near to the existing leachate treatment plant in the southern reaches of the United Mines Landfill area. This in turn discharges to the existing lined ditch and eventually a tributary of the Hicks Mill Stream.

Within the Eastern Catchment, contour drains have been installed on the eastern flank of the landfill to ensure there is no surface water runoff toward Horses Lane. An open channel has been installed adjacent to part of the west-east bridleway to the north of the landfill. This, together with a lined channel adjacent to part of the landfill haul road, discharges to a French drain and then to a soakaway.

The main channel of the Hicks Mill Stream is about 1km south of the Site.

3.5 Geotechnics

The presence of Made Ground / fill materials as well as the mining features described above, will have implications for the geotechnical design of foundations and pavements.

3.6 Flood risk

The gov.uk 'Flood maps for planning' service indicates that the Site is within Flood Zone 1, meaning there is a less than 1 in 1,000 annual probability of river or sea flooding.

3.7 Natural hazards

Regulatory data relating to ground stability for the Site is summarised in Table 3-1 below with the full information presented in full in Appendix B.

Table 3-1 Potential natural hazards.

Potential hazard	Hazard rating	Description
Shrink swell	Negligible	Ground conditions are predominantly non-plastic.
Running sands	Negligible	Running sand conditions are not thought to occur whatever the position of the water table. No identified constraints on land use due to running conditions.
Compressible deposits	Negligible	Compressible strata are not thought to occur.
Collapsible deposits	Very low	Deposits with potential to collapse when loaded and saturated are unlikely to be present.
Landslides	Very low	Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered.
Natural ground subsidence	Negligible	Soluble rocks are either not thought to be present within the ground, or not prone to dissolution. Dissolution features are unlikely to be present.

3.8 Radon

The Indicative Atlas of Radon for England and Wales [6] and the Groundsure report indicates that the site is in a Radon Affected Area. The Site is partially in an area where between 10 and 30% of properties are above the Radon Action Level, and partially >30%. Therefore, full radon protection measures are required on new buildings.

3.9 Archaeology and land designations

The Site is located about 20m outside of the Cornwall and West Devon Mining Landscape World Heritage Site. The Grade II listed Eldos Engine House (Ivey House) is located about 20m northwest of the Site, and the Grade II listed United Mines Engine House is about 215m northeast.

3.10 Unexploded Ordnance

A Preliminary UXO Risk Assessment has been carried out by Buro Happold in accordance with CIRIA C681 [7] and is included in Appendix F. In addition to the consideration of the potential for aerial delivered UXO, consideration has also been given to mitigation factors, namely: (i) the extent of post-war development); and (ii) the extent of proposed intrusive works. The assessment concluded that the risks associated with UXO are Low. Therefore, there is no requirement for a detailed UXO risk assessment.

4 Site setting

4.1 Site history

The Site history and that for the surrounding area has been completed using historic maps from the Groundsure Report (Appendix B) 1880 to 2021, plus additional maps included in the Arup Desk Study (Appendix C). This history is summarised in Table 4-1 below. Key changes in land use are shown by Figure 4-1 to Figure 4-4.

Table 4-1 - Summary of site history and history of the surrounding area

Date	Site history	History of the surrounding area
1880 1:2,500	Site is located within United Mines area (tin and copper mining). Site is impacted by surface ground workings. A corner of a building (unlabelled) associated with the mine encroaches into the Site.	Site is located within United Mines area (tin and copper mining). Surface ground workings and numerous shafts present. Nearest shafts are immediately adjacent to the Site. Structures associated with the mine are present adjacent to the south (unlabelled buildings, chimneys). Roads and tracks cross the mine area. There are residential properties present from about 250m southeast.
1888 1:10,560 ***Figure 4-1***	No significant change. United Mines is labelled as disused.	United Mines is labelled as disused. Surrounding area to at least 750m distant is impacted by mining. Miner's Arms (Public House) is about 250m north. A Chemical Works and Stream Works (tin) are present about 400m southwest. A stream (unlabelled) flows in a generally southeasterly direction the Stream Works. Great Consolidated Mine (tin and copper mining) is labelled about 600m north, disused. There are a number of residential settlements in wider area (>750m distant).
1906-1908 1:10,560	The whole Site surface is shown to be covered by shingle / stones. Building encroaching onto Site is no longer present.	A wider area surrounding the Site is shown to be impacted by surface ground workings and covered by shingle. Buildings / chimney adjacent to Site no longer present. Locations of many shafts no longer shown and general area is covered by numerous 'Old Shafts'. There is an Engine Works about 250m northwest. Terrence Works (arsenic and tin) is present in former location of Chemical Works and Stream Works. Outer Wood, Inner Wood, and Old Arsenic Works Wood are present from about 500m west.
1908 1:2,500	No significant change.	No significant change.
1958 1:10,560	No significant change.	Terrance Works is no longer present.
1969-1970 1:2,500	Site and surrounding area mapped as covered by rough pasture.	Site and surrounding area mapped as covered by rough pasture. Disused shafts still evident.
1970-1971 1:2,500	No significant change.	No significant change.
1973-1974 1:10,000	No significant change.	There is a Go-Kart Track about 250m east. Residential developments in the surrounding area have expanded, nearest about 500m distant. Buildings associated with Tregarlands Farms are about 250m north. United Downs is labelled about 250m north. Miner's Arms is no longer present. There is a Sewage Works 650m south.
1980	No significant change.	No significant change.

Date	Site history	History of the surrounding area
1:10,000		
1992 1:10,000 ***Figure 4-2***	Site is part of wider United Mines Waste Disposal Site. The Site itself is clear with no evidence of landfilling or landfill infrastructure within it.	Site is part of wider United Mines Waste Disposal Site. A building labelled as a Waste Recycling Centre is adjacent to the southeast of the Site. A large part of the former United Mines area is shown as an area of landfilling. This is adjacent to the Site in the southeast, but generally about 100m distant. United Downs Industrial Park is adjacent to the north.
1994 1:2,500	There is a narrow area of ground workings adjacent and parallel to the northern boundary.	Two electricity substations (150m northwest. 100m north) and a tank (200m north) are shown within United Downs Industrial Park. Other buildings / features are unlabelled.
2000 (excerpt from Arup Desk Study) ***Figure 4-3***	Area of landfilling associated with the United Mines Waste Disposal Site has expanded north to include most of the Site.	Area of landfilling associated with the United Mines Waste Disposal Site has expanded north to include most of the Site. Landfilling extends up to the boundary with the United Downs Industrial Park.
2001 1:10,000	Landfilling no longer evident. A small, unlabelled building / structure is present.	United Mines Waste Disposal Site is still labelled, however area of landfilling no longer evident (note that map shows very little detail). Waste Recycling Centre building is no longer present. There is a short stream / brook from adjacent to the southern boundary, orientated perpendicular to the boundary.
2010	Western half of the site is shown to be grassland / vegetated.	No significant change.
2021 ***Figure 4-4***	A new road enters the United Mines Waste Disposal Site form the east. A short section of this is within the boundary.	The new road entering the United Mines Waste Disposal Site generally runs parallel to the Site (about 50m distant), in part over the former landfill area, and joins with wider network in the west. The stream is no longer shown.

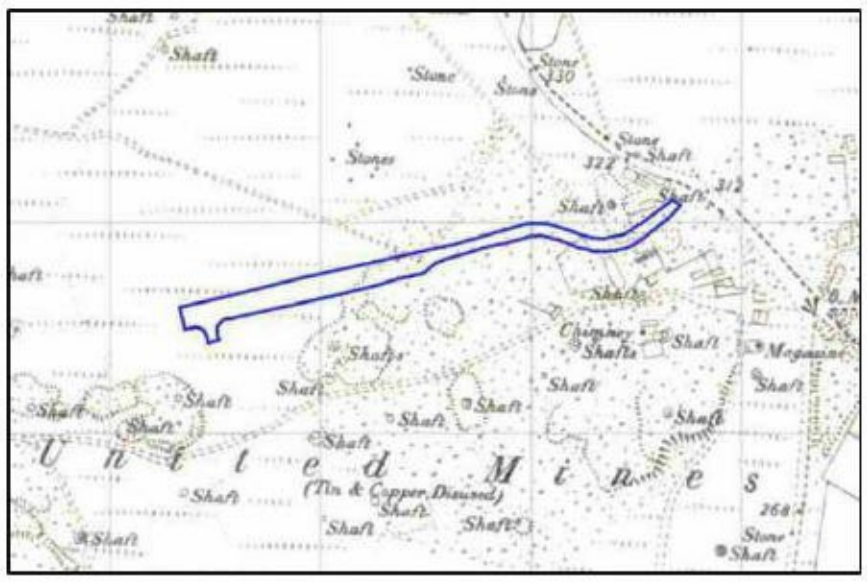


Figure 4-1 – 1888 map excerpt (1:10,560)

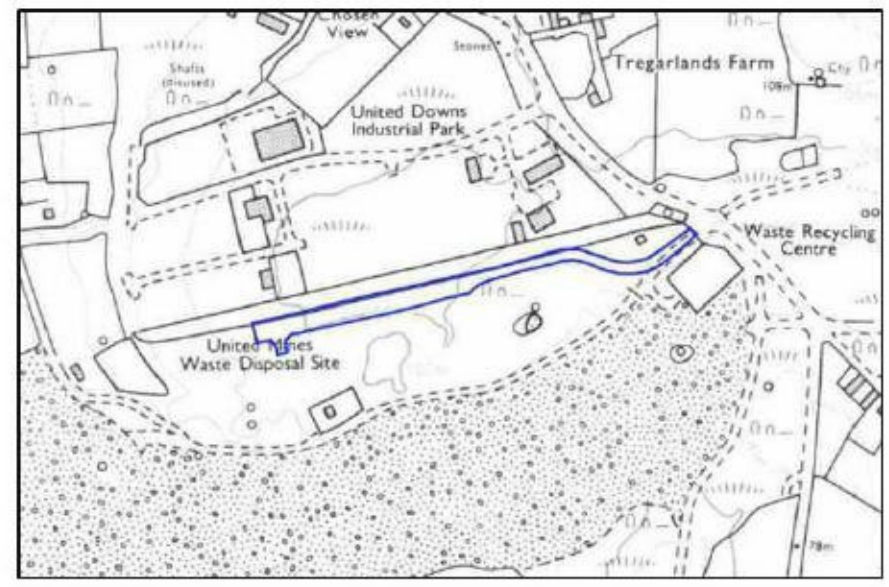


Figure 4-2 – 1992 map excerpt (1:10,000)

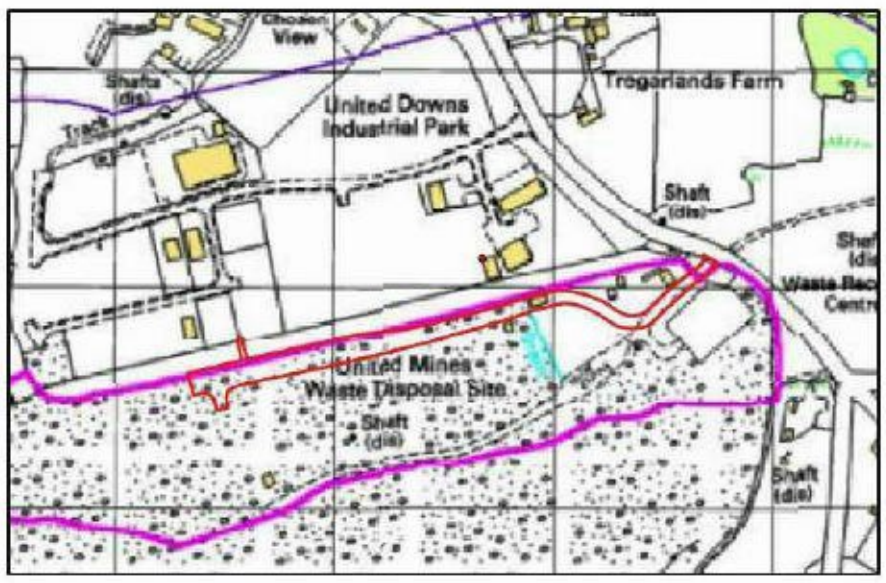


Figure 4-3 – 2000 map excerpt, obtained from Arup Desk Study Report (Appendix C). Redline denotes Site boundary, pink line denotes the area assessed by Arup.

Figure 4-4 – 2021 map excerpt (1:10,000)

4.2 Regulatory data

Regulatory data relating to potentially contaminative uses is summarised in Table 4-2 below. This information was obtained from the Groundsure Report, presented in full in Appendix B.

Table 4-2 - Summary of regulatory data

Item	Location [on/off site]	Information	Potential to impact
Past land use			
Historical industrial uses	On-site	Refuse heap (1908), mines waste disposal site (1992), unspecified disused mines (1958), unspecified disused shafts (1974-1980), disused tin and copper mine (1879-1908).	Yes
	Within 100m	Unspecified heap, unspecified shafts, unspecified disused shafts, refuse heap, industrial park, disused distillery, unspecified pit, chimney.	Yes
	100 to 250m	Refuse heap, unspecified heap, unspecified shaft, magazine, disused distillery, waste recycling centre, engine house, unspecified pit, chimney.	No
	250 to 500m	Unspecified old shafts, refuse heap, unspecified pit, old clay pit, unspecified disused mine, tin stream works, unspecified quarry, chemical works, chimney, engine house	No
Historical tanks	Within 100m	One record. Located 85m SE, dated 1997.	Yes
	100 to 250m	Two records. 193m N, dated 1969 and 214m N, dated 1997.	No
	250 to 500m	Five records. nearest 366m N and dated 1969.	No
Historical energy features	100 to 250m	Three records. 130m N, dated 1997. Two records related to 140m NW, dated 1988 to 1997.	No
None of the following were recorded within 500m: historical petrol stations; historical garages; historical military land.			
Waste and landfill			
Active or recent landfill	On-site	S I T A, Landfill Site, United Downs, St. Day. Operated by Cornwall Council. Landfill accepted >10 T/D with capacity >25,000T excluding inert waste.	Yes
Historical waste sites	On-site	Four records identified. Three related to a Waste Disposal Site identified from historical mapping, dated 1988, 1992 and 1997. One identified from a historic planning application (ref: CC12/0792/96/S). The scheme comprised provision of building for recycling facilities with storage area and three roller shitter doors. Submitted 1996.	Yes

Item	Location [on/off site]	Information	Potential to impact
	Within 100m	Two records of a Waste Recycling Centre located 7m SE and identified from historic mapping.	Yes
	100 to 250m	Record located 107m S from historic planning application (ref: PA14/08286). Scheme comprises temporary extension to the household waste recycling centre (including the area used for container storage / vehicle parking) at the former United Mines landfill site. The associated works include sewer systems, landscaping, infrastructure, enabling works and access roads. Dated 2014. Waste Recycling Centre identified 161m E from 1992 mapping. Record located 179m N from historic planning application (ref: PA12/09322) related to Plot 23, United Downs Industrial Park. Scheme comprises change of use of the land to scrap metal storage and processing (Waste Transfer Station). Dated 2014. Two Scrap Yards identified 188m N and 229m N, both dated 1997.	Yes
	250 to 500m	One record 268m N (Plot 10, United Downs Industrial Estate) identified from historic planning application (ref: CC12/0414/96/S). Scheme related to construction of a Waste Transfer Station for clinical wastes. Dated 1996.	No
Licensed waste sites	Within 100m	One record located 3m NW, attributed to United Mines Civic Amenity Site. Waste Management License (no: 20572) related to a Special Waste Transfer Station. License issued 28/07/1994. Five records attributed to 74m SE. All related to operation of United Mines Civic Amenity Site. Permit to operate: a Special Waste Transfer Station (issued 1994, modified 2007), three records related to a Household Waste Amenity Site (two permits issued 1994, modified 2007 and one issued 1994, modified 2016), a Co-Disposal Landfill (issued 1993, modified 2004)	Yes
	250 to 500m	Fourteen records. Nearest 269m N, related to Chosen View Metal Recycling (metal recycling site).	No
Waste exemptions	Within 100m	Record 9m NW attributed to United Mines Landfill Site for using waste exemption (use of sludge for the purposes of re-seeding a wastewater treatment plant). Record 9m NW attributed to United Mines Household Waste Recycling Centre for storage of waste in a secure place. Record 9m NW attributed to St Day Race Way for use of waste in construction.	Yes
	100 to 250m	18 records. Nearest 147m N, related to storage of waste in a secure place.	No
	250 to 500m	7 records. Nearest 291m N, related to storage of waste in a secure place.	No
None of the following were recorded within 500m of the site: historical landfill (BGS records), historical landfill (LA/mapping records), historical landfill (EA/NRW records).			
Current industrial land use			
Recent industrial land uses	Within 100m	Chimney, container and storage, glass fibre services, distribution and haulage, waste recycling centre, shaft, concrete products, stone quarrying and preparation, tank, industrial coatings and finishings, vehicle bodybuilders.	No
	100 to 250m	Consumer products, motoring, construction services, electricity substation, cleaning equipment and supplies, construction and tool hire, Flogas, construction services, electricity substation, shaft, vehicle breakdown and recovery services, gas governor, engineering services, repair and servicing, motoring, tank, chimneys, United Mines Landfill Scheme – Landfill Gas (DECC), United Downs Industrial Park, scrap yard.	No
Hazardous substance storage / usage	100 to 250m	One record located 111m N attributed to Flogas UK at United Downs Industrial Park, related to the application for the storage of up to 50 tonnes of liquified petroleum gas.	No

Item	Location [on/off site]	Information	Potential to impact
Licensed industrial activities [Part A(1)]	Within 100m	One record related to 3m north. Attributed to County Environmental Services Ltd for waste landfill >10 T/D with capacity >25,000T excluding inert waste. Last notified as effective in October 2004. 31 records related to 77m SE. All relate to operation of United Mines Landfill. Permits relate to: waste landfilling, associated processes, disposal of non-hazardous waste involving biological treatment, combustion of waste derived fuel. Operators listed as County Environmental Services, SITA UK Limited and Suez Recycling and Recovery UK Ltd. Last noted as effective October 2020.	Yes
	250 to 500m	Three records related to 284m E. Attributed to Cornwall Council and related to the use of United Mines Landfill for waste landfilling and associated processed. Permits issued September 2009 and last noted as effective October 2020.	Yes
Licensed discharges to controlled waters	250 to 500m	One record located 360m N related to release of trade discharges – site drainage. Permit issued 1995 and revoked 2010. Two records located 422m NW, both related to trade discharges – site drainage. Receiving water listed as soakaway. One permit issued 1995 and revoked 2012, the other has been effective since 2012.	No
Pollution incidents	Within 100m	Incident dated 2002 and located 38m SE related to release of dust. Minor (Category 3) impact to air and no impact (Category 4) to water and land. Incident dated 2002 and located 73m S related to landfill odour. Minor (Category 3) impact to air and no impact (Category 4) to water and land.	No
	100 to 250m	Incident dated 2003 and located 137m SE related to inert materials and wastes. Minor (Category 3) impact to water and land. No impact (Category 4) to air. Two incidents dated 2019 and located 199m NW related to release of smoke and household wastes. Significant (Category 2) impact to land and air and no impact (Category 4) to water.	No
	250 to 500m	Eight records. All had no (Category 4) or minor (Category 3) impact to water, land and air.	No
Pollution inventory substances	Within 100m	Three records located 77m SE, all related to United Mines Landfill. The pollution inventory includes reporting on annual emissions on certain regulated substances to air, controlled water and land. The data given is for the most recent complete year available. Methane released to air. Reporting threshold is 10000kg, quantity released 232000kg. Carbon dioxide released to air. Reporting threshold is 10000000kg, quantity released 16100000kg. All other released as wastewater and to air were below the reporting thresholds.	Yes
None of the following were recorded within 500m of the site: current or recent petrol stations, electricity cables, gas pipelines, sites determined as contaminated land, COMAH sites, regulated explosive sites, historical licensed industrial activities, licensed pollutant release [Part A(2)/B], radioactive substance authorisations, pollutant release to surface waters (red list), pollutant release to public sewer, list 1 dangerous substances, list 2 dangerous substances			
Environmental designations			
SSSIs	>1km	West Cornwall Bryophytes located 1132m N (favourable condition). Wheal Gorland located 1844m NW (unfavourable – declining).	No
Nitrate Vulnerable Zones	On-site	Site is located in a Nitrate Vulnerable Zone due to eutrophic water.	No
SSSI Impact Risk Zones	On-site	Site is located in a SSSI Impact Risk Zone. Consultation required with regards to: infrastructure projects; minerals, oil and gas; residential; air pollution; combustion; waste / landfill; discharge of water to ground; and water supply.	Yes

Item	Location [on/off site]	Information	Potential to impact
None of the following were recorded within 2km of the site: Ramsar Sites, Special Areas of Conservation, Special Protection Areas, National Nature Reserves, Local Nature Reserves, Designated Ancient Woodland, Biosphere Reserves, Forest Parks, Marine Conservation Zones, Green Belt, Proposed Ramsar Sites, Possible Special Areas of Conservation, Potential Special Protection Areas, Nitrate Sensitive Areas.			
Visual and cultural designation			
World Heritage Sites	Within 100m	Cornwall and West Devon Mining Landscape is located 20m NE.	Yes
Listed Buildings	Within 100m	Eldos Engine House (Ivey House) – Grade II listed – located 23m NW.	Yes
	250 to 500m	United Mines Engine House – Grade II listed – located 213m NE.	Yes
None of the following were recorded within 250m: Area of Outstanding Natural Beauty, National Parks, Conservation Areas, Scheduled Ancient Monuments, Registered Parks and Gardens			
Agricultural designations			
Agricultural Land Classification	On-site	Grade 4 – poor quality agricultural land. Land with severe limitations which significantly restrict the range of crops and / or level of yields.	No
None of the following were recorded within 250m: Open Access Land, Tree Felling Licenses, Environmental Stewardship Schemes, Countryside Stewardship Schemes.			
Habitat designations			
Priority Habitat Inventory	Within 100m	Calaminarian grassland located from 29m NE. Deciduous woodland located from 135m W. Lowland heathland located from 242m S.	No
Habitat Networks	On-site	Site is located in a Network Enhancement Zone 1. Identified as an area suitable for the expansion of habitat networks (based primarily on the priority habitat inventory) through restoration and habitat creation. Habitat no specified.	Yes
Open Mosaic Habitat	On-site	Site identified as Open Mosaic Habitat (low confidence). Mosaic habitats are brownfield sites that are identified under the UK Biodiversity Action Plan as priority habitat due to the habitat variation within a single site, supporting an array of invertebrates.	Yes
None of the following were recorded within 250m: Limestone Pavement Orders			

5 Available reports / information

5.1 Arup Desk Study

5.1.1 General

A Desk Study Report prepared by Arup in 2019 for a wider area of the United Downs Landfill site was available for review and is included in Appendix B. That report includes a range of information related to the permitting and operations of the United Downs Landfill. The following sections summarise the key information that is applicable to the Site. Full reference should be made to the Arup Desk Study for more complete information.

5.1.2 United Mines Landfill

Permitting history

The Site falls within the permitted area related to the operations at the former United Mines Landfill. Landfilling operations at the United Mines Landfill commenced in 1974 under Waste Management License (WML) 20530 issued to CES in November 1993. Pollution Prevention and Control (PPC) Permit, reference BK2429IG, was issued on the 18th August 2004 to CES, superseding the landfilling aspects of WML 20520. This was transferred to SITA in November 2006 (transfer reference MP3439MH). The United Mines Landfill was then regulated under Environmental Permit MP3439MH/V004, and three permit variations were granted between 2009 and 2017. An application to transfer the permit to Cornwall Council was made in June 2019, reference EPR/UP3035QX/T001, with the transfer completed in September 2019. The permit was last noted as effective in October 2020. United Mines Landfill was categorised as landfilling of more than 10 tonnes per day (T/D) with a capacity of greater than 25,000 tonnes excluding inert waste. It is a Local Authority Landfill and is now under the remit of the Local Authority, having been passed over following closure by Suez. Local authority records indicate the site accepted domestic, commercial, trade and special wastes (primary asbestos and oil). The landfill accepted wastes until 2010.

Environment Agency records

The Environment Agency records show the United Mines Landfill to be registered to County Environmental Services Ltd in 1992 and 1998 with a "very large" input rate of greater than 250,000 tonnes per year. Authorised wastes were listed to have included (but not limited to): ammonia, arsenic, cadmium, barium, copper and chromium compounds, cyanides, organic and other acids, polyester resins, synthetic adhesive wastes, lead/acid batteries, mercury compounds, various forms of asbestos, difficult-non-specific wastes, toxic and special wastes, fuels, oils and greases, tar, bitumen and asphalts and solid putrescible wastes.

Prosecutions relating to authorised processes

The United Downs Landfill site was reportedly prosecuted in January 2002 for the contravening of the conditions of its waste management license, under the EPA90 Prosecution Act. The site was found guilty of contravening their licensed and fined. No further details of this event have been provided.

5.1.3 Landfill construction and design

Landfill cells

The Site is located in the north of the United Mines Landfill facility. The wider landfill is divided into two distinct areas: 1) dilute and attenuate; and 2) the extension area. These are summarised below:

1) The "dilute and attenuate" landfill is split into Phase 1, Phase 2, Phase 3, Phase 4A and Phase 4B, as shown by the wider area on Figure 5-1.

2) The "extension area" is comprised of engineered fill cells, with a full mineral liner, artificial basal line and a leachate drainage blanket. It is split into Phase 1, Phase 2, Phase 3A, Phase 3B, Phase 4A and Phase 4B (i.e. the same nomenclature as the "dilute and attenuate" landfill but referring to different areas). Phase 4B was reportedly not constructed. The extension area is 'piggy backed' over the dilute and attenuate landfill.

The Site falls within Phase 2 and Phase 3 of the dilute and attenuate landfill area, see Figure 5-1.

Capping design

Capping of the landfill was completed between 1999 and 2012. The Arup Desk Study report includes drawings showing the capping boundaries across the landfill. The capping phases do not correspond with the waste cell phases. The Drawings show that the Site falls within the Phase 2 and Phase 4/05 capping areas (see Figure 5-2). The details of how the engineered capping phases are tied together are unknown. A summary of the capping works for these areas is provided below:

Table 5-1 - United Mines Landfill capping works.

Cap / Restoration Phase ID and date	Capping barrier	Restoration
Phase 2 1999	0.3m site processed material <20mm, GCL, 0.3m site processed material.	0.7m subsoil and 0.15m topsoil.
Phase 4/05	0.1m site processed material, 1mm LLDDPE, 0.3m site processed material.	0.55m subsoil and 0.15m topsoil, locally subsoil 1050mm in tress planting areas.

Leachate management and monitoring

The Arup Desk Study report notes that leachate level and quality monitoring is undertaken across the United Downs Landfill Site in accordance with the landfill permit and the Monitoring Management Plan. However, the Monitoring Management Plan was not available for review in the preparation of their report. Arup assumed that leachate levels are controlled via a system of gas extraction leachate treatment and disposal.

Collected leachate is pumped to the leachate treatment plant located in the southern area of the United Downs Landfill site (about 500m south of the Site). Treated leachate subsequently discharges to a sewer under a trade effluent consent. The 2018 monitoring report (prepared by Suez – not available for review by Buro Happold) indicated that the leachate treatment plant has reduced operational performance, with a proportion of the leachate requiring removal via tanker for offsite disposal. There are reported to be no compliance limits in terms of leachate levels for the dilute and disperse area.

Landfill gas management

The current permit for the United Mines Landfill requires the operator to collect landfill gas and to use this to produce energy. If the landfill gas cannot be used to produce energy, the permit states that the operator should use appropriate measures to flare or treat the gas in accordance with an approved landfill gas management plan. Management of landfill gas at the United Mines Landfill is subcontracted to CLP Envirogas. In-waste gas extraction wells are connected to two 10003kW landfill gas engines in the gas utilisation compound, and an enclosed ground-flare is used when the engines are unavailable.

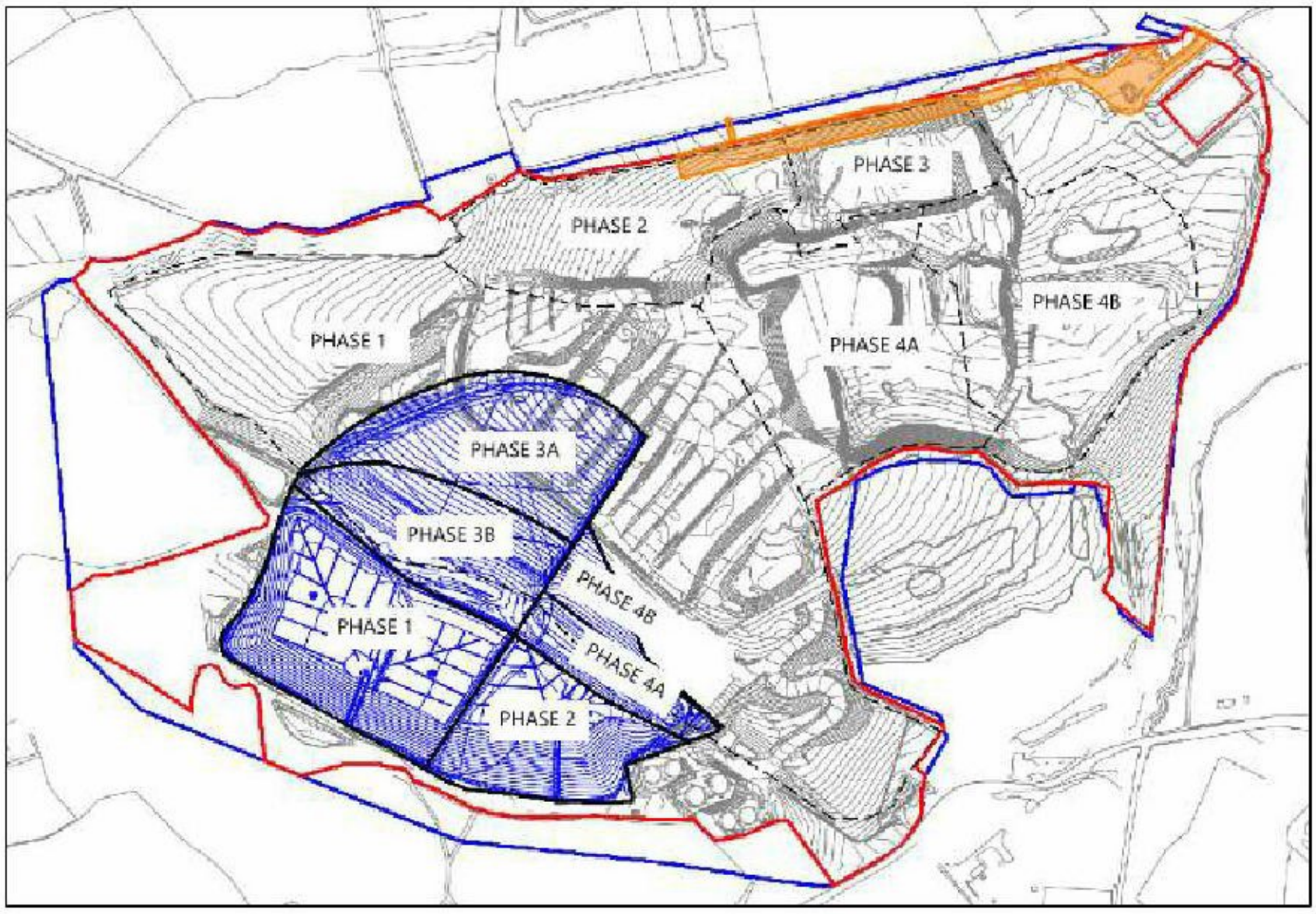


Figure 5-1 - Landfill cells / phases of landfilling within United Mines Landfill. Site shown by orange shaded area. Blue area shows "extension area".

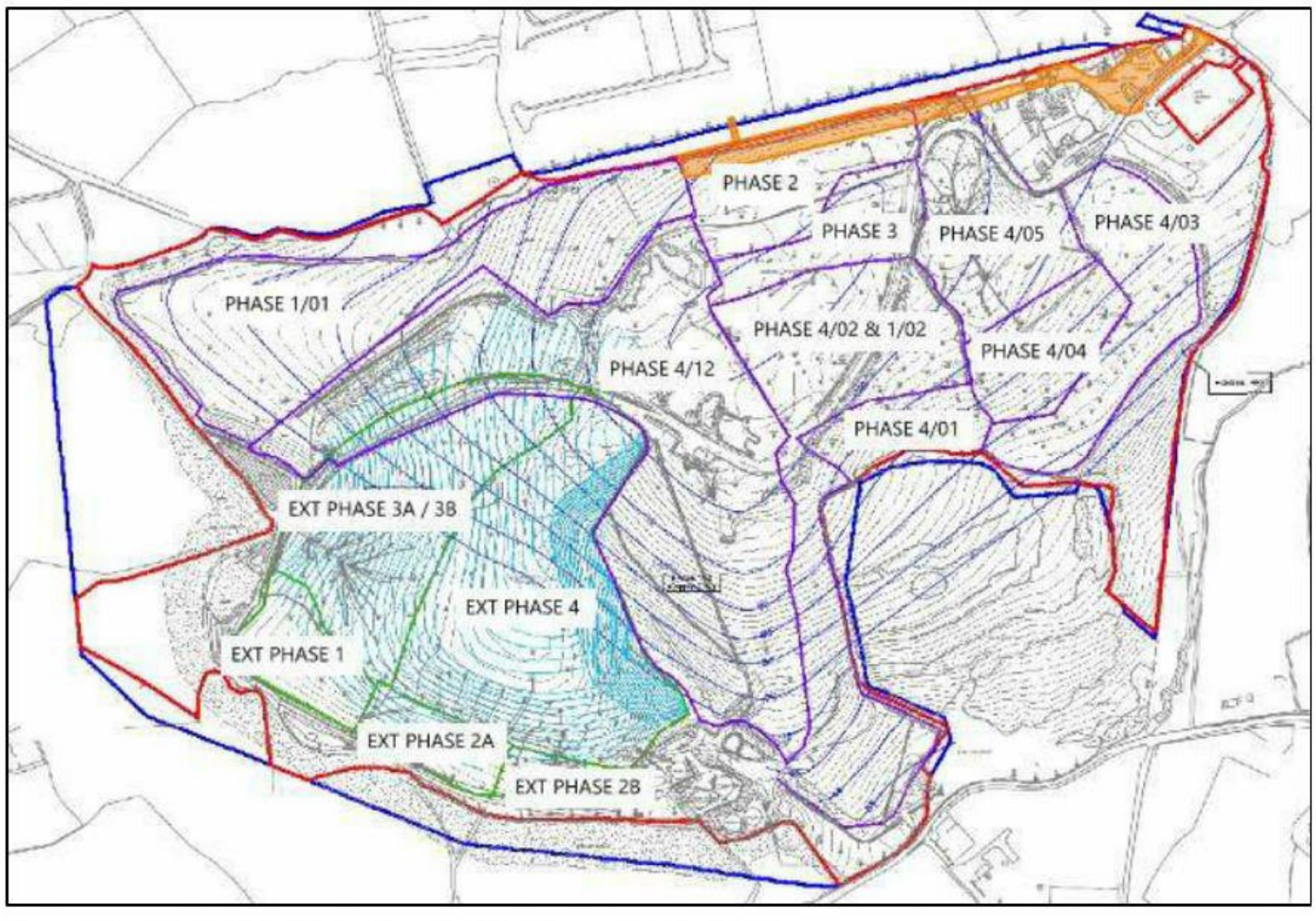


Figure 5-2 - Phases of landfill capping. Site shown by orange shaded area.

The layout of the Gas Extraction System for the United Mines Landfill Site is on Drawings included in Appendix A. Individual gas wells are generally connected to one of a number of manifold points around the landfill site, although there are a large number of gas wells shown which do not appear to be connected to the rest of the system. The manifolds are connected to a series of 180mm, 250mm and 315mm diameter buried gas pipes with dewatering points and valves.

The United Mines Landfill Site's gas utilisation compound is located in the north of the site and is located immediately to the south of the Site. The as-built gas infrastructure drawing suggests that the pipework enters the gas utilisation compound at two entry points, in the north and southeast of the compound.

Surface water management

The United Mines Landfill occupies three different "catchment areas" of site drainage, the function of which is to collect waters (from existing watercourses and rainfall) entering the landfill and discharge them into outgoing watercourses at an acceptable discharge rate and quality. The Site sits within two of these catchments, the Western Catchment and Eastern Catchment. The main elements of the water management system for these catchments is summarised below:

- Western Catchment – occupies the western part of the Site. Surface water runoff from the northeast of the landfill and from a drain along the western landfill boundary drain to the Sparry Lane pond, located in the far west of the United Mines Landfill. There is an additional drain to the north of the landfill haul road which also discharges to the Sparry lane Pond. From the Sparry Lane Pond, water is pumped via a rising main and discharges to an existing culvert, near to the existing leachate treatment plant in the southern reaches of the United Mines Landfill area. This in turn discharges to the existing lined ditch and eventually a tributary of the existing Hicks Mill Stream
- Eastern Catchment – occupies the eastern part of the Site. Blind contour drains have been installed on the eastern flank of the landfill to ensure there is no surface water runoff toward Horses Lane. An open channel has been installed adjacent to part of the west-east bridleway to the north of the landfill. This, together with a lined channel adjacent to part of the landfill haul road, discharges to a French drain and then to a pre-existing soakaway.

5.2 Liaison with environmental regulators

Initial contact has been made with Cornwall County Council (the Permit holder) and the Environment Agency with respect to the current proposals. This contact follows on from previous discussions of a related scheme. It is understood that the Environment Agency position is that the onus is on the proposer to demonstrate that the proposal will not cause environmental harm or reduced ability to comply with the permit obligations.

6 Preliminary Geoenvironmental Risk Assessment

6.1 General Approach

In the UK, the assessment of risk from contamination is based on consideration of the conceptual site model and follows the "source-pathway-receptor" approach. If one of these three elements (source, pathway or receptor) is absent, it is considered that there is no risk of harm. If, however, there is considered to be a linkage between any given source and any given receptor, then a risk-based approach is used to assess the significance or impact of the linkage. Risks are defined as the probability of an event occurring combined with the severity of the consequence of that event. Particularly, to assess the risks to site end users posed by any given source, the sensitivity of each receptor is considered. For example, the concentration of contamination acceptable at a site to be developed as a residential property with a garden used to grow vegetables and accessible to young children is set lower than that for a commercial site where soil is exposed only in minor areas of landscaping and the only long-term users of the site are adults. Similarly, a site overlying a Principal Aquifer supplying potable water will be considered more stringently than a site overlying an impermeable geology with only minor seepages of groundwater.

6.2 Conceptual site model

The potential risks posed to human health and the environment by ground contamination at this site have been evaluated by a generic quantitative risk assessment which incorporates the 'source-pathway-receptor' identification and assessment methodology in accordance with CLRM [3]. The risk assessment process therefore involves the identification of each source based on the information in this report, including any available existing ground investigation results together with the identification of relevant exposure pathway(s) and receptors. The potential risks to the receptors have been assessed by considering the potential effect of the source on the receptor as well as the likelihood of a pathway linking the two, i.e. a contaminant linkage as discussed above.

6.3 Sources

The potential contamination sources at the site have been identified from the review of regulatory data, historical maps and previous site investigations and are summarised in Table 6-1. The 'Contaminants of Concern' in this risk assessment are based primarily on information from this review of historical information and to R&D 66 [8].

Table 6-1 Summary of potential sources of contamination

Potential source	Location	Likely age	Potential contaminants of concern
United Mines Landfill	On-site and adjacent	Up to 50 years	Ground gas – methane, carbon dioxide, trace gases. Leachate – metals, petroleum hydrocarbons, oils, PAHs, nutrients (ammoniacal nitrogen) Waste materials, including - ammonia, metals, cyanide, acids, resins, lead/acid batteries, asbestos products, fuels, oils and greases, tar, bitumen and asphalts, and solid putrescible wastes.
Bedrock	On- and off-site	-	Ground gas – radon and mine gases
Reworked ground / mine waste associated with historical mining activities	On- and off-site	>100 years	Metals Ground gas – radon, methane, carbon dioxide

Potential source	Location	Likely age	Potential contaminants of concern
Current and historical commercial and industrial uses in the surrounding area including: Waste Recycling Centre, United Downs Industrial Park (scrap metal storage, steel fabricators), United Downs Raceway	Off-site – from adjacent	Approximately 50 years	Asbestos, metals, petroleum hydrocarbons, oils, PAHs, solvents

6.4 Pathways and receptors

The proposed development comprises a Sustainable Distillery Research Centre. This will include a series of buildings covering approximately 15% of the Site area and located on part of the United Mines Landfill. Approximately 70% of the area would be used as service roads and space for parking and vehicle turning. The remaining 15% of the Site will be soft landscaping. The presence of contamination (in soils, liquids or gases) has the potential to impact upon human and environmental receptors both in the short term (during construction) and in the long term (during use and occupation). Those receptors and the pathways that could link them to the sources identified in Table 6-1 are summarised below.

Table 6-2 Summary table of receptors and potential pathways

Receptor		Pathway
Human Health	Investigation and construction workers	Direct / dermal contact. Ingestion / inhalation of soils. Inhalation of gas / vapour.
	Future site users / visitors (workers)	Direct / dermal contact. Inhalation of contaminated dusts, gas and vapour.
	Offsite occupiers / visitors of neighbouring land	Inhalation of contaminated dusts, gas and vapour.
Controlled Waters	Secondary Aquifer (Maylor Slate Formation, Elvan Intrusion)	Migration via permeable strata and preferential pathways (e.g. via mine workings, soakaways)
	Surface waters (Carnon River, Restronguet Creek, Carrick Roads)	Migration via permeable strata and preferential pathways (e.g. via mine workings, adits with outfall to surface waters).
	Surface waters (Hick Mills stream)	Migration via permeable strata and preferential pathways (e.g. landfill surface water drainage)
Built environment	Buildings / structures	Gas migration via permeable strata with potential for accumulation to hazardous concentrations
	Buried concrete foundations.	Aggressive attack
	Potable water supply pipework	Direct contact
Ecology	Flora	Direct contact and root uptake

6.5 Assessment of risk

The assessment of the level of risk for each of the potential contaminant linkages identified above is summarised in Table 6-3. The table lists the potential sources identified above. For each source, an assessment is made, receptor by receptor as to the magnitude of the potential consequence (reflecting the potential severity of the hazard associated with that source and the sensitivity of the receptor).

Consideration has also been given to the level of uncertainty associated with each of these potential sources. For example, much of the information is based upon historical records which are likely to be partial and will not be complete, together with the limited nature of the existing site investigation data. Because of this uncertainty, the identification of the sources is based upon a conservative assessment of the potential location, nature and extent of the source. The probability or likelihood of the hazard being realised is then assessed by consideration of the directness / integrity of the exposure pathway that could link the receptor to the source. The assigned level of risk is determined by the terms of consequence and probability in accordance with C552 [9]. The final column describes all of the factors considered in the assessment and presents the justification for the assessed level of risk.

Table 6-3 - Preliminary Risk Assessment

Source		**Receptor**/ Pathway	**Risk assessment** (following CIRIA C552)			Comment on hazard realisation
Origin	Contaminants of concern		Consequence	Probability	Risk	
United Mines Landfill Reworked ground / mine waste Current and historical commercial and industrial uses in the surrounding area	Waste materials, including - ammonia, metals, cyanide, acids, resins, lead/acid batteries, asbestos products, fuels, oils and greases, tar, bitumen and asphalts, and solid putrescible wastes. Leachate – metals, petroleum hydrocarbons, oils, PAHs, nutrients (ammoniacal nitrogen)	**The Site and surrounding area have been subject to metalliferous mining since the early Bronze Age (over 2000 years BC). The earliest maps (dated 1880s) show ground workings on Site and numerous shafts in the surrounding area. Mining had largely ceased by the early 1900s. Extent of remediation to local mine shafts unknown. Site and surrounding area largely unchanged until United Downs Raceway was developed about 250m east by the 1970s. United Downs Landfill became operational in 1974. Part of the landfill (including the area beneath the Site) operated on a dilute and attenuate basis. This was followed by a period of landfilling within engineered cells that "piggy back" onto the dilute and attenuate area. Local authority records indicate the site accepted domestic, commercial, trade and special wastes. Specific contents / chemistry are unknown. Landfill accepted wastes until 2010 and has since been restored. The landfill is capped, with a gas management / extraction system, leachate management system (including treatment plant) and surface water management system. The specific details of the landfill cap (material composition / chemistry) and the performance of the management systems are unknown, however their layouts are well understood. The Waste Recycling Centre (adjacent to west) became operational in the 1990s and currently comprises a series of skips locate on hardstanding for sorting and recycling household wastes. United Down Industrial Estate has been present adjacent to the north since the 1990s. Current uses there include the United Down Deep Geothermal Power Project, car / metal scrap yards, a granite supplier, a wheel shop, a welding shop, steel fabricators, amongst others.**				
		Investigation and construction workers Direct / dermal contact. Ingestion / inhalation of soils. Inhalation of dusts, gas and vapour.	Severe	Low likelihood	**Moderate**	Potential for exposure during investigations / excavations. Buildings proposed on area of landfill. Development proposals will be designed to minimise disturbance to ground surface and need for excavation within landfill wastes. However, potential for excavations to extend through landfill cap to underlying waste materials remains. Standard health and safety precautions will be used. Mitigation of potential risks can be achieved by appropriate investigation, use of standard good construction practise and by maintaining watching brief during investigation / construction.
		Future site users / visitors (workers) Direct / dermal contact. Inhalation of contaminated dusts, gas and vapour.	Severe	Unlikely	**Moderate / low**	Most of Site anticipated to be covered by buildings / hardstanding with limited soft landscaping. Composition and chemistry of landfill cap and underlying waste materials unknown. Mitigation of potential risks can be achieved by appropriate investigation, appropriate design of buildings / structures that is sympathetic to the location on a former landfill, and appropriate restoration to the landfill surface / placement of clean capping layer as required.
		Offsite occupiers / visitors of neighbouring land Inhalation of contaminated dusts, gas and vapour.	Severe	Unlikely	**Moderate / low**	Potential for exposure during investigations / excavations. Development proposals will be designed to minimise disturbance to ground surface and need for excavation within landfill wastes. However, potential for excavations to extend through landfill cap to underlying waste materials remains. Nearest neighbours are maintenance staff on United Mines Landfill and workers at United Down Industrial Estate (i.e. adjacent to site). Mitigation of potential risks can be achieved by appropriate investigation, use of good construction practise and by maintaining watching brief during investigation / construction.
		Secondary Aquifer (Maylor Slate Formation, Elvan Intrusion) Migration via permeable strata and preferential pathways (e.g. via mine workings, soakaways)	Medium	Low likelihood	**Moderate/ low**	Potential for mobilisation of contamination contained within landfill wastes / mining wastes during excavation. Composition / chemistry of these material is unknown. Development proposals will be designed to minimise disturbance to ground surface and need for excavation within landfill wastes. Landfill cells beneath the Site operate on a dilute and attenuate basis. Part of Site drains via soakaway. Former mine workings may act as preferential pathway to contamination migration. Mitigation of potential risks can be achieved by appropriate investigation, appropriate design of buildings and site drainage system, use of good construction practise and by maintaining watching brief during investigation / construction.

Source		**Receptor**/ Pathway	**Risk assessment** (following CIRIA C552)			Comment on hazard realisation
Origin	Contaminants of concern		Consequence	Probability	Risk	
		Surface waters (Carnon River, Restronguet Creek, Carrick Roads) Migration via permeable strata and preferential pathways (e.g. via mine workings, adits with outfall to surface waters).	Medium	Low likelihood	**Moderate / low**	Potential for mobilisation of contamination contained within landfill wastes / mining wastes during excavation. Composition / chemistry of these material is unknown. Development proposals will be designed to minimise disturbance to ground surface and need for excavation within landfill wastes. Landfill cells beneath the Site operate on a dilute and attenuate basis. Part of Site drains via soakaway. Former mine workings may act as preferential pathway to contamination migration. Mining adits have outfall to surface waters. Mitigation of potential risks can be achieved by appropriate investigation, appropriate design of buildings and site drainage system, use of good construction practise and by maintaining watching brief during investigation / construction.
		Surface waters (Hick Mills stream) Migration via permeable strata and preferential pathways (e.g. landfill surface water drainage)	Medium	Unlikely	**Low**	Potential for mobilisation of contamination contained within landfill wastes / mining wastes during excavation. Composition / chemistry of these material is unknown. Development proposals will be designed to minimise disturbance to ground surface and need for excavation within landfill wastes. Part of site drains to tributary of Hick Mills stream. Main channel of Hick Mills stream is about 1km south of the Site. Mitigation of potential risks can be achieved by appropriate investigation, appropriate design of buildings and site drainage system, use of good construction practise and by maintaining watching brief during investigation / construction.
		Buried concrete foundations. Aggressive attack.	Mild	Low	**Low**	Proposed buildings may require new concrete foundations (not piled). Chemistry of Made Ground and natural soils / rock unknown. Potential for aggressive attack due to direct contact. Mitigation of potential risks can be achieved by appropriate investigation and concrete design.
		Potable water supply pipework Direct contact	Medium	Unlikely	**Low**	Potable water supply likely to be required as part of Proposed Development. Routing of water supply unknown but potential to be laid within landfill material (wastes or capping materials). Composition / chemistry of materials unknown. Potential for contamination to permeate pipework. Mitigation of potential risks can be achieved by appropriate investigation and selection of suitable materials.
		Flora Direct contact and root uptake	Minor	Low	**Very low**	Limited proportion of Site (approximately 15%) likely to be soft landscaping. Chemistry of near surface soils is unknown. Existing vegetation does not show any evidence of impeded growth / die back. Mitigation of potential risks can be achieved by appropriate investigation and by importing chemically and physically suitable subsoils and top soils as required.
United Mines Landfill Reworked ground / mine waste Bedrock	Ground gases – carbon dioxide, methane, radon, trace gases	**The Site and surrounding area have been subject to metalliferous mining since the early Bronze Age (over 2000 years BC). The earliest maps (dated 1880s) show ground workings on Site and numerous shafts in the surrounding area. Mining had largely ceased by the early 1900s. Extent of remediation to local mine shafts unknown. Site and surrounding area largely unchanged until United Downs Raceway was developed about 250m east by the 1970s. United Downs Landfill became operational in 1974. Part of the landfill (including the area beneath the Site) operated on a dilute and attenuate basis. This was followed by a period of landfilling within engineered cells that "piggy back" onto the dilute and attenuate area. Local authority records indicate the site accepted domestic, commercial, trade and special wastes. Specific contents / chemistry are unknown. Landfill accepted wastes until 2010 and has since been restored. The landfill is capped, with a gas management / extraction system, leachate management system (including treatment plant) and surface water management system. The specific details of the landfill cap (material composition / chemistry) and the performance of the management systems are unknown, however their layouts are well understood. The Waste Recycling Centre (adjacent to west) became operational in the 1990s and currently comprises a series of skips locate on hardstanding for sorting and recycling household wastes. United Down Industrial Estate has been present adjacent to the north since the 1990s. Current uses there include the United Down Deep Geothermal Power Project, car / metal scrap yards, a granite supplier, a wheel shop, a welding shop, steel fabricators, amongst others. Site is in a radon affected area. Potential for release of mine gas from former mine workings.**				

Source		**Receptor**/ Pathway	**Risk assessment** (following CIRIA C552)			Comment on hazard realisation
Origin	Contaminants of concern		Consequence	Probability	Risk	
		Investigation and construction workers Inhalation/ exposure to hazardous ground gases (methane and carbon dioxide) and vapours.	Severe	Low likelihood	**Moderate**	Exact development proposals unconfirmed. Potential for excavation in areas of former landfill / mine workings. Limited potential for accumulation of ground gases to hazardous concentrations during construction. Development proposals could disrupt current gas management system. Mitigation of potential risks can be achieved be appropriate investigation and assessment and by adopting good construction practice.
		Future site users / visitors (workers) Inhalation/ exposure to hazardous ground gases (radon, methane and carbon dioxide) and vapours.	Severe	Likely	**High**	Exact development proposals unconfirmed but likely to include some small structures located over former landfill with potential for confined spaces. Landfill is regulated by gas management system. Efficiency / effectiveness of this unconfirmed and potential for release of gas at the surface unknown. Site located over historical mine workings and is in a radon affected area. Development proposals could disrupt current gas management system. Mitigation of potential risks can be achieved be appropriate investigation, assessment and design of buildings / structures that is sympathetic to the location on a former landfill / historical mine workings and incorporating appropriate gas protection measures.
		Offsite occupiers / visitors of neighbouring land Inhalation/ exposure gas and vapour.	Severe	Unlikely	**Moderate/ low**	Exact development proposals unconfirmed but likely to include some small structures located over former landfill. Landfill is regulated by gas management system. Efficiency / effectiveness of this unconfirmed and potential for release of gas at the surface unknown. Development proposals could disrupt current gas management system, including venting / extraction adjacent to off-site receptors. Mitigation of potential risks can be achieved be appropriate investigation, assessment and design of buildings / structures that is sympathetic to the location on a former landfill / historical mine workings, by ensuring that existing gas infrastructure is well understood and incorporating appropriate gas protection measures to prevent off-site migration.
		Buildings / structures Gas migration via permeable strata with potential for accumulation to hazardous concentrations	Medium	Low likelihood	**Moderate/ low**	Exact development proposals unconfirmed but likely to include some small structures located over former landfill with potential for confined spaces. Landfill is regulated by gas management system. Efficiency / effectiveness of this unconfirmed and potential for release of gas at the surface unknown. Site located over historical mine workings and is in a radon affected area. Development proposals could disrupt current gas management system. Mitigation of potential risks can be achieved be appropriate investigation, assessment and design of buildings / structures that is sympathetic to the location on a former landfill / historical mine workings and incorporating appropriate gas protection measures.

7 Conclusions and Recommendations

7.1 Summary of contamination risks

An Initial Conceptual Site Model has been determined and a Preliminary Risk Assessment with respect to ground contamination has been carried out for the Site on the basis of desk-based data. At this preliminary stage of this project the main sources of potential contamination have been identified and the potential risks have been qualitatively assessed. The assessment is based upon the Site in its current condition, but it also includes consideration of the potential risks associated with any below ground works (e.g. site investigation or future foundation works etc.) and the potential future use. A summary of the potentially significant risks (i.e. greater than Low) is presented below.

All of these potential risks are capable of mitigation by appropriate ground investigation, assessment and design.

Table 7-1 Summary of potential risks

Receptor	Source	Potential risk
Investigation and construction workers	Waste materials (mining and landfill)	Moderate
	Hazardous ground gases (landfill)	Moderate
Future site users and visitors	Waste materials (mining and landfill)	Moderate
	Hazardous ground gases (radon and landfill)	High
Neighbours	Waste materials (mining and landfill)	Moderate / low
	Hazardous ground gases (landfill)	Moderate / low
Groundwater (Secondary Aquifer)	Waste materials (mining and landfill)	Moderate / low
Surface waters	Waste materials (mining and landfill)	Moderate / low
Buildings	Hazardous ground gases (landfill)	Moderate / low

7.2 Statutory Designation

In our opinion, it is unlikely that the Site would be determined as Contaminated Land (under the provisions of Part 2A of the Environmental Protection Act 1990) in its current status, or following the event of any redevelopment, provided the recommendations below are followed.

7.3 Recommendations

There are potentially significant risks associated with the Site and its proposed development due to its former uses (primarily its mining and landfilling history). However, by undertaking appropriate ground investigation and monitoring and by adopting a suitable building design and foundation solution, it is possible to mitigate the assessed risks and safely build the proposed development in this location without compromising the former landfill site. Such details can appropriately be left to a planning condition on the outline permission and the reserved matters design stage.

It is therefore recommended that all available documentation / archive reports related to the United Mines Landfill are obtained and reviewed, including but not limited to: up to date as-built drawings showing the landfill infrastructure (gas, leachate, surface water); recent annual monitoring reports; details of the applicable Environmental Permits; and leachate, gas and surface water management and maintenance plans. Detailed consideration should also be given to the mining risks and constraints at the Site and copies of any relevant mine plans obtained.

In addition to these environmental risks, the plans for the development will have to demonstrate that they will not cause environmental harm or reduced ability to comply with the permit obligations. Therefore, it is recommended that in addition to detailed consideration of the mining constraints specific to the Site described above, a ground investigation should be completed. The objectives, scope and methodology of the investigation should reflect the scale and nature of the proposed development, should combine geotechnical and geoenvironmental objectives and should be agreed in advance with both Cornwall County Council and the Environment Agency.

The objectives of the ground investigation will be to define:

- The presence, extent and nature of any Made Ground/ fill materials and depth to bedrock,
- The ground gas regime,
- The shallow groundwater regime.

The investigation should identify the potential pathways and allow assessment of risk to sensitive receptors. This data will also inform any remediation/ mitigation requirements associated with the proposed development. To meet the aims and objectives above, the scope of the site investigation should include the following:

- Boreholes of suitable frequency and depth. Boreholes should include in situ testing, sampling of soils / rock and monitoring installations to intercept ground gas and shallow groundwater,
- Trial pitting across the site with sampling of near surface soils,
- Chemical testing of representative soil and groundwater samples; and
- A hazardous ground gas monitoring programme.

The data obtained from this investigation would be collated, assessed and presented in a report suitable for submission under a planning condition. The report would include recommendations on the need for and scope of any remediation.

At this stage it is anticipated that the remedial design / actions will include;

- Design to ensure the development does not cause any environmental harm or reduces the ability of the current control / monitoring facilities to comply with the permit obligations
- Design to avoid / mitigate the potential risks associated with mining and landfill infrastructure
- Gas protection measures to mitigate the potential risks associated with both radon and the other hazardous ground gasses
- Design / actions to mitigate the potential risks associated with unstable / soft ground
- Design / actions to mitigate the potential risks to both construction workers, neighbours and future occupiers / visitors associated with any residual ground contamination.

The risks associated with UXO for the development have been assessed as Low and unless those development plans change significantly, no further action is required in that respect.

8 References

[1] Ministry of Housing, Communities and Local Goverment, "National Planning Policy Framework," Ministry of Housing, Communities and Local Government, 2019.

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[5] Environment Agency, "GPLC1 - Guiding principles for land contamination," Environment Agency, 2010.

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[8] NHBC, Environemant Agency and Chartered Institute of Environmental Health, Guidance for the safe development of housing on land affected by contamination. R&D 66:2008, 2008.

[9] CIRIA, "Contaminated Land Risk Assessment. A guide to good practice. C552," CIRIA, 2001.