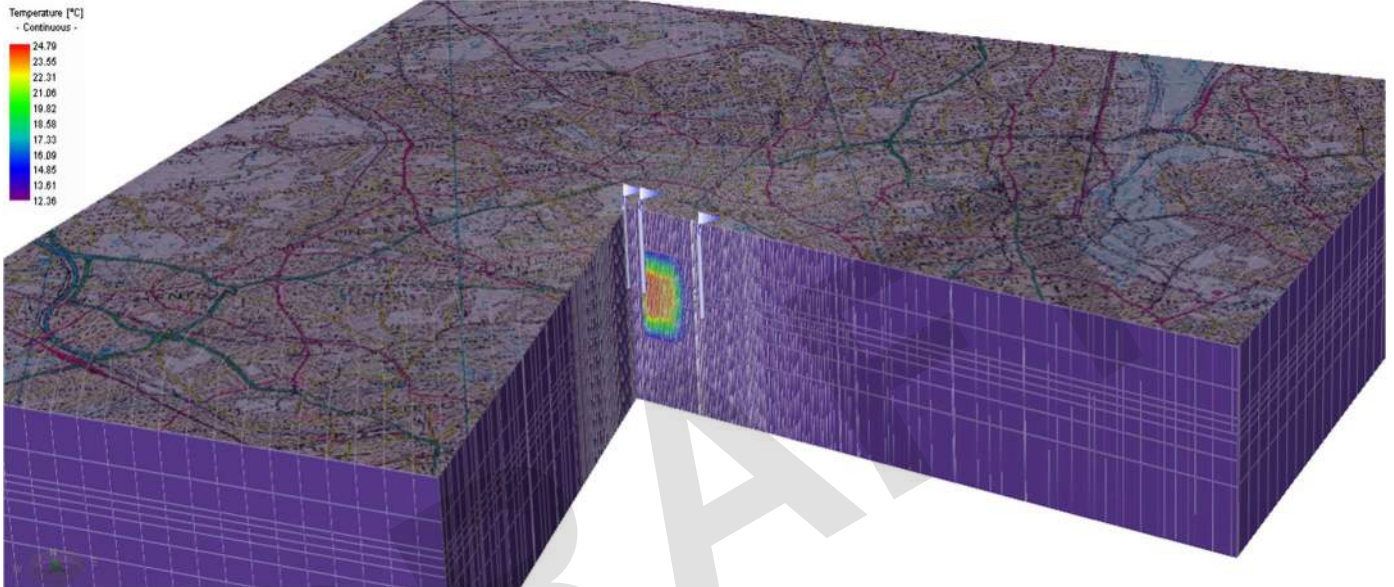


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REPORT

Report Title:

Tier 1: Groundwater Risk Assessment for a Proposed Expansion to an Existing Cemetery

Site Location:

Old Town Church, St Mary's, Isles of Scilly

Report prepared for:

Council of the Isles of Scilly

Report prepared by:

Huw Williams

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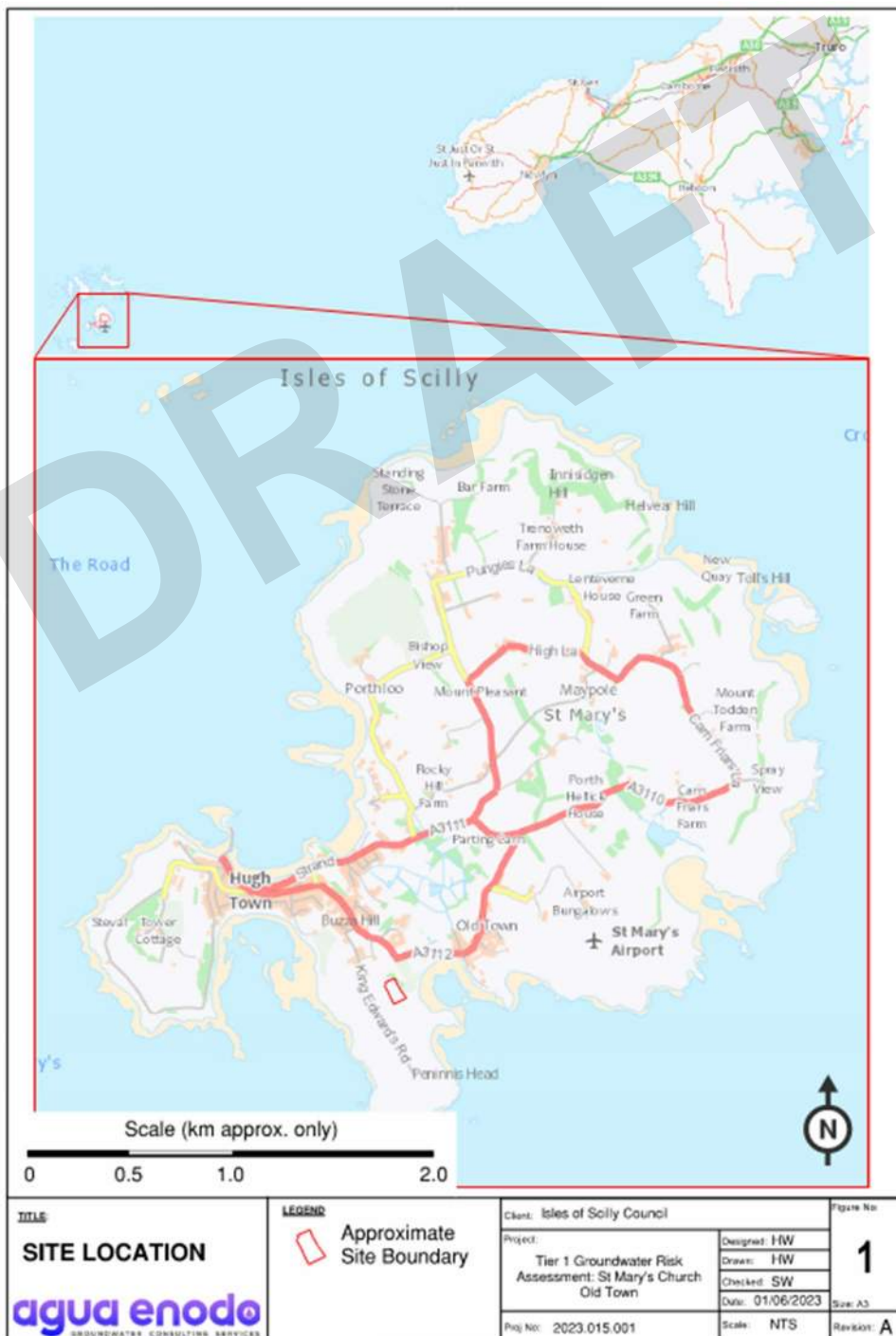
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1 Introduction and Project Background

The Isles of Scilly Council c/- Cornwall County Council have commissioned Agua Enodo to undertake a Groundwater Risk Assessment (GW-RA) for the proposed expansion of the existing cemetery at the Old Town Church, St Mary's, Isles of Scilly (IoS [herein referred to as the site. Refer Figure 1 for site location]).

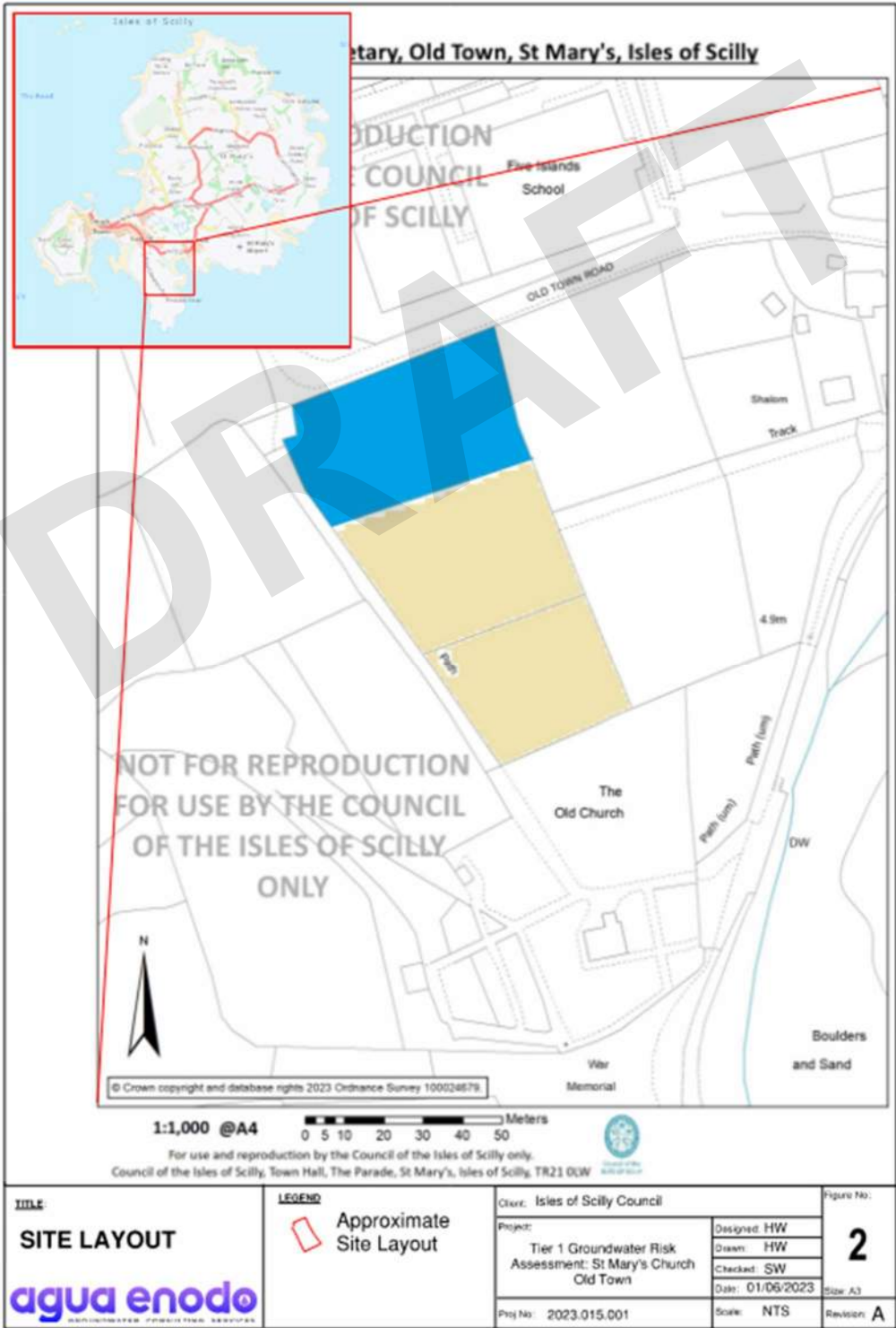
This report has been prepared in accordance with Environment Agency Guidance: Cemeteries and burials: Groundwater Risk Assessments (updated 1 April, 2022 on www.gov.uk). It follows the Source > Pathway > Receptor approach and justifies the Tier 1 Risk Assessment methodology selected.



1.1 Historical and Proposed Future Use

The burial register for the existing cemetery (highlighted cream-colour on Figure 2) dates from 1981 to the present day, totalling 385 recorded burials. This gives an average of 9 burials per year. This is corroborated with recent records which show 8 burials per year in the last three years (per. comm. Rebecca Williams, Head of Environment at Council of the IoS via email of 15/05/2023).

The proposed expansion area (highlighted blue Figure 2) is planned to have <10 burials per year, with an anticipated average 8 to 9 per year (per. comm. Rebecca Williams, 15/05/2023).



1.2 Scope of Services and Project Objectives

The scope and objectives of this GW-RA are to provide:

- A desktop study of the environmental site setting relevant to the existing and proposed cemetery within a 1 km area of the site, including but not limited to:
 - SOURCE: Assessment of the proposed cemetery expansion;
 - PATHWAY: Geology, hydrogeology, aquifer, groundwater and surface water characteristics; and
 - RECEPTOR: Environmentally sensitive receptors in the vicinity of the site.
- Justification of selecting a Tier 1 GW-RA; and
- The Tier 1 GW-RA, to assess reasonably foreseeable groundwater risks due to the proposed expansion of the cemetery.

No site walkover was conducted as part of this HIA.

All work has been carried out in accordance with the Environment Agency's Groundwater risk assessment for your environmental permit - How to carry out a groundwater risk assessment as part of an application for an environmental permit (www.gov.uk last updated 3 April 2018).

Analysis herein also complies with principals of:

- *The Environment Agency's approach to groundwater protection* dated February 2018 Version 1.2, in particular with reference to *Section L – Cemetery developments*; and
- *Guidance: Protecting groundwater from human burials*, Published 1 April 2022.

1.3 Disclaimer

This GW-RA has been undertaken based on currently available information at time of writing, provided by IoS Council, as well as readily available public information.

Documents and sources of information are referenced where appropriate in the text of this report and listed in References (Section 6).

Information provided to Agua Enodo was assumed to be reliable and no independent verification of information was undertaken.

Failure to manage and reduce any environmental risk to a minimum may result in action being taken under the Environmental Permitting (England and Wales) Regulations 2016, the Water Resources Act 1991 and the Anti-pollution Works Notice Regulations 1999.

2 Justification of the Selected Methodology

Historical records for burials at the site show:

- A long-term average of 9 burials per year for 41 years (from 1981);
- A recent three-year average of 8 burials per year (2019 to 2022); and
- Anticipated rate of 8 to 9 burials per year in the expanded cemetery area.

Based on census data reviewed for the purposes of this GW-RA (Office for National Statistics < www.ons.gov.uk/visualisations/censuspopulationchange/ > accessed 31/05/2023) the population of the IoS has fallen by 4.7% between 2011 and 202, and no significant population increase is anticipated.

For the purposes of this assessment, the following has been assumed:

1. Burials to be completed within the drift and heavily weathered granite (to a depth of <1.6 m is considered sufficient);
2. Burials to be evenly distributed across the site; and
3. Not more than 9 burials per year.

Based on these assumptions, a Tier 1 GW-RA has been undertaken and is presented herein.

Based on experience, it is reasonable to apply the following generic risk-based guidelines to controls and minimise pollution risk:

- At least 250 m from all groundwater supply boreholes and springs;
- At least 30 m from all surface watercourses or springs;
- At least 10 m from field drains and ditches (including perennial features); and
- Conduct no burials at or below the water table.

3 Conceptual Site Model: Environmental Site Setting

The expansion area is centred approximately on National Grid Reference SV 91059 10175 (Figure 3) off the southern side of Old Town Road on Peninnis Head, at the southern end of St Mary's.

Currently the site is covered by grassland (Figure 3) and surrounded by fields directly to the east and west. The existing cemetery lies to the south and The Five Islands Academy to the north.

The expansion area slopes gently towards the southeast, with the site elevation of c.8.0 mOD along the western side and c.6.0 mOD along the eastern side. The existing site layout and land-use is shown on Figure 3 and Figure 4 respectively.

Selected environmental site setting characteristics relevant to this GW-RA have been reviewed in the following sections.

3.1 Geological Setting

The shallow and deep geology of the site has been characterised using British Geological Survey (BGS):

- Soil data from the UK Soil Observatory online viewer (UKSO: www.mapapps2.bgs.ac.uk/ accessed 01/06/2023);
- Drift and solid geology from the 1:50,000 BGS geological map series: Sheet Number 357 & 360: loS Solid and Drift, published 1975 (as well as the BGS online viewer Onshore GeoIndex, accessed 01/06/2023); and
- Borehole Records (BGS Onshore GeoIndex, accessed 01/06/2023).

A representative geological profile for the site is summarised in Table 2 and summarised in the following sections. Published geological mapping is shown on Figure 3 along with a selected representative geological column for the site

3.1.1 Soil and Drift

The site is a mix of shallow and deep soil (thickness increasing down-slope) from c.0.5 m on the western side to >1.0 m deep on the eastern side (Figure 5).

The shallow soils are characterised as light to medium sandy loam to sandy soil, and medium/light to heavy clayey to silty soil on the deeper eastern side.

Head deposits are mapped as underlying soil on the eastern side of the site, corresponding to the change from shallow and deep soil profile. The Quaternary head deposits are generically described as poorly sorted and poorly stratified, angular rock debris and/or clayey hill-wash and soil creep, mantling a hillslope. This description and extent of the deposit corroborates the soil profile.

3.1.2 Solid Geology

Sy Mary's is composed of the loS Intrusion. This is described as being granitic of varying coarse to fine grain containing muscovite, biotite, orthoclase and quartz.

The depth of the granite is unproven, but is likely to form an outcrop of bedrock.

3.1.3 BGS Borehole Records

There are 46 Water Well Records and 74 Borehole Records located on St Mary's. They are fairly evenly distributed across the Island, with the exception of 28 Borehole Records associated with Mary's Airport, and drilled for geotechnical purposes along the runway alignment, generally to a depth of < 2 m.

14 No. borehole records were selected for review, based on their proximity to the site and are summarised in Table 1. Barney's well (underlined) has been identified as the sole Public Water Supply well on the site (refer Appendix A).

Table 1. Selected Borehole Records

BH Ref	Borehole Name / Location	Ground level (mOD)	Rest Water Depth (m)	Recorded Drift Material	Depth to Granite (m)	Distance (km) & Direction from Site
SV91SW20	Old Town	5.2	6.1	Sand and Clay	12.2	0.4 E
SV91SW21	Carn Gwaval Farm	-	-	-	-	0.2 N
SV91SW7	Rams Valley Well	-	-	Unconsolidated	2.7	0.6 NW
SV91SW35	Castle Well	-	-	-	-	0.4 NE
SV91SW45	Clemmie's Well	-	-	-	-	1.0 WNW
SV91SW30	New Well	-	-	-	-	0.4 NNW
SV91SW1	South of Moor Well	-	-	-	-	0.4 NNW
SV91SW8		-	-	-	-	
SV91SW9	Old Moor Well	-	-	-	-	0.5 NNW
SV91SW18	St Mary's	-	-	-	-	0.7 NNE
<u>SV91SW31</u>	<u>Barney's Well</u>	3.1	1.2	Fine clay & gravel (drift) over heavily weathered granite	3.9 (weathered granite) 5.1 (fresh granite)	0.7 NE
SV81SE1	Garrison Well	14.4	12.2	-	-	1.3 WNW
SV91SW38	Parking Carn	10.7	9.1	-	-	0.8 NE
SV91SW32	Parting Carn		-	-	-	0.75 NNE

Notable characteristics from each borehole log are highlighted in yellow (Appendix A).

Correspondence from Cornwall County Council and South West Water regarding the location of public water supply boreholes, is provided in Appendix B.

Table 2. Selected Representative Geological Profile at the Site

Unit	Geological Description	Thickness (m)	Depth to Base (mbgl)
Soil	Shallow (<1.0 m) to deep (>1.0 m) light sandy to heavy silty clayey TOPSOIL	1.0 (+/-0.5)	1.0 (+/-0.5)
Quaternary Head	Poorly sorted and poorly stratified, angular rock debris and/or clayey hill-wash and soil creep	0.0 to 2.7 (+/-0.5)	3.7 (+/-1.0)
Isles of Scilly Intrusion	Heavily weathered clayey granite	3.9 to 5.2 (+/-2.0)	7.8 (+/-4.0)
	Fresh Granite	unproven	unproven

Soil and Quaternary head of this nature are generally considered suitable for use as cemeteries. Pollutants from burials will be partly mitigated due to the high cation exchange capacity of the clayey soils and ability for adsorption.

Heavily weathered granite forming a clayey layer above fresh granite is also generally considered suitable for use as cemeteries. Pollutants from burials will be partly mitigated due to the high cation exchange capacity of the clayey soils and ability for adsorption.

There are no other relevant geological hazards associated with the geological profile presented in Table 2. This includes, but is not limited to, a low risk of shrink-swell, landslides, soluble rocks, compressible ground or running sands.

3.2 Hydrogeological Setting

3.2.1 Groundwater Flow and Occurrence

There is limited groundwater flow and occurrence data on St Mary's. Typically, groundwater on small islands is highest near the centre of the island, especially where this corresponds to higher ground, as it does on St Mary's. It then flows towards the coast.

As classified by the BGS: the granite is a low permeability aquifer, locally important in south-west England, yielding up to 1 L/s from near surface weathered zone and secondary fractures. Fracture flow is typically controlled by topography.

Based on groundwater elevations from reviewed borehole logs, and groundwater flow controlled by the topography, it is reasonable to assume groundwater flow beneath the site:

- Is in an easterly or south-easterly direction, towards the coast;
- Is at a depth of c.5.0 m (+/-2 m); and
- Is relatively slow, due to the gently sloping land, subdued topography of the area and low-lying elevation of the site relative to sea level.

This depth is corroborated by expected groundwater levels near the coast; as groundwater is typically a couple of metres above sea level in low-lying coastal areas.

3.2.2 Hydrostratigraphy

No hydraulic parameters for the strata encountered were obtained for the purposes of this assessment. However, it is reasonable to assume the Quaternary drift material has low permeability, due to the fine content noted in the long. The granite is a fractured aquifer, with permeability controlled by the number and connectivity of fractures.

3.2.3 Regulatory Designations

Based on a review of DEFRA's Magic Map, (<https://magic.defra.gov.uk/magicmap.aspx> accessed 01/06/2023) the following environmental receptors are present in the vicinity of the site (Figure 7 and Table 3).

Table 3. Summary of Local Designations

Designation	Type	Name	Description	Distance (km) & Direction from Site
Statutory	AONB	IoS	Maritime heathland and grassland, small pockets of woodland, arable fields, hedges and stone walls support a large variety of plants and animals.	Covers the site
	SSSI	Lower Moors	Lowland marsh and swamp.	0.31 km NE
		Peninnis Head	Lowland dwarf shrub heath.	0.36 km SSE
	SAC	IoS Complex	Sandbanks, mudflats and reefs partially or wholly covered by tidal waters supporting flora (Shore Dock) and Fauna (Grey Seal).	0.16 km SE
	Potential SPA	IoS	No description given. Extent of Potential SPA coincides with the existing SAC and extends seaward from the Mean High Water mark.	0.16 km SE
Non-Statutory	SPZ	SPZ 2	Outer Protection Zone	0.39 km NE
		SPZ 1	Inner Protection Zone	0.58 km NE
Other	Groundwater Vulnerability	High / Medium-High	High Vulnerability on the western side of the site (corresponding to the area of thin soil and no Quaternary Head cover) and Medium-High on the eastern half of the site (corresponding to the area of thicker soils and the presence of Quaternary Head deposits).	Covers the site
	Aquifer Designation	Secondary	Both the Quaternary Head deposits and Granite bedrock are classified as Secondary Aquifers.	Covers the site

Notes on Table 3:

- AONB: Area of Outstanding Natural Beauty
- SSSI: Site of Special Scientific Interest
- SAC: Special Area of Conservation
- Potential SPA: Potential Special Protection Area

- SPZ: Source Protection Zone

No other statutory or non-statutory environment designations were identified as part of this GW-RA including, but not limited to Coal Authority designations, Nitrate Vulnerability Zones, Drinking Water Safeguard Zones, National Forests or RSPB Reserves.

These features have been assessed in the RW-RA where relevant. Their locations within the conceptual model domain are presented in Figures 7 and 8.

3.3 Other Environmental Site Characteristics

Average rainfall for the IoS is 869.7 mm per year (1961 to 2020 MetOffice.gov.uk, accessed 01/06/2023)

Surface water ponding can occur at locations with low permeability soils. It is important to manage greywater in an appropriate manner.

No archaeological investigations have been undertaken as part of this GW-RA.

3.4 Characteristics Summary Conceptual Model

Extrapolated from selected representative local borehole logs and geological mapping:

- The site is located in an area where soil, Quaternary Head and heavily weathered granite is likely to be c.7.8 m (+/-4.0 m) thick, with fresh granite bedrock below; and
- Groundwater is likely to be at a depth of c.5.0 m (+/-2.0) and flow towards the coast, in a south-easterly direction.

Based on published maps:

- There are no known surface water or groundwater features in the vicinity of the site (Figure 7 and Appendix B); and
- There are no environmental receptors (statutory or non-statutory) in the vicinity of the site. Furthermore, due to the location of the cemetery near to the coast, there are no known environmental receptors down-hydraulic gradient from the site.

3.5 Pollutants of Concern

There will be c.9 burials per year. The main pollutants of concern will be:

- Ammoniacal nitrogen;
- Ammonium;
- Total Organic Compounds (TOC); and
- Pathogens.

Due to the low numbers of burials, the cumulative ammoniacal nitrogen and TOC concentrations are likely to be low.

Due to the clayey nature of the soil and gently sloping topography of the site, transport of pathogenic organisms are likely to be limited. Pathogens have short residency times at distance from source. As there is no near or down-hydraulic gradient receptor there is considered to be a low risk to groundwater pollution and potable well supply,

The thickness of clayey drift and decayed granite is considered to give sufficient mitigation of pollutants from burials due to the ability for adsorption via cation exchange in such clay dominated soils.

If significant fractures are encountered in the IoS Intrusive granite, then the risk is higher for the movement of burial contaminants and pathogens away from the source due to the faster movement of groundwater in the aquifer. However, as this is likely to discharge directly to the coast, this risk is considered low.

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4 Environmental Permit and Groundwater Risk Assessment

Local councils (or other cemetery operators) do not need to apply for an environmental permit for existing cemeteries if:

- they do not need to use active mitigation measures to prevent pollution
- they are not planning to expand a cemetery area after 1 April 2022 which needs new planning permission under section 57 of the Town and Country Planning Act 1990
- they are planning to expand a cemetery area after 1 April 2022 which needs new planning permission, but the risk assessment shows that the expansion is not high risk and the Environment Agency has agreed this

To assess the requirements of a permit, the good practice groundwater protection requirements (Section 4.1 of this report) and a Tier 1 GW-RA (Section 4.2 of this report) have been conducted

4.1 Minimum Good Practice Groundwater Requirements

Environment Agency Guidance for minimum good practice groundwater protection (from Protecting groundwater from human burials, Environment Agency, Published 1 April 2022) is assessed in Table 4.

Table 4. Assessment of the Minimum Good Practice Groundwater Protection Requirements

Requirement 1: No Human Burials within:	Criteria Met? Yes / No
A groundwater SPZ1	Yes. Nearest SPZ1 is c.580 m and is not located down-hydraulic gradient of the site (Figure 8 and Table 3).
10 m of the nearest land drain	Yes. No land drain mapped within 10 m of the site (Figure 9)
30 m from the nearest watercourse or any other surface water	Yes. No watercourse or perennial ditch mapped within 30 m of the site (Figure 6 and Figure 9)
50 m of any well, spring or borehole, irrespective of that water's current use	Yes. No boreholes or springs mapped within 50 m of the site (Figure 6 and Figure 9)
250 m of any well, spring or borehole used for human consumption or food production	Yes. No boreholes or springs mapped within 50 m of the site (Figure 6 and Figure 8)
Areas identified as having karstic groundwater flow characteristics.	Yes. In the Head drift, flow is not karstic. In the underlying granite, groundwater flow is recognised as being within the weathered upper zone of the granite, and potentially secondary flow in fractures. However, where shallow, these are likely to be clay filled, due to the weathering at the coast.
A groundwater SPZ1	Yes. Nearest SPZ1 is c.580 m and is not located down-hydraulic gradient of the site (Figure 8 and Table 3).
Requirement 2: No Human Burials on:	Criteria Met? Yes / No
Land which is liable to flooding	Yes. The location is not mapped as an area at risk from river or sea flooding (https://check-long-term-flood-risk.service.gov.uk/map accessed 02/06/2023)

Requirement 3:	Criteria Met? Yes / No
Base of each grave at least 1 m above the highest anticipated annual groundwater level	Yes. Groundwater level is anticipated to be 5 mbgl (+/-2 m). This means burial depths are likely to remain above the highest anticipated groundwater level.
Requirement 4:	Criteria Met? Yes / No
You should not dig graves in unaltered or unweathered bedrock	Yes. Unweathered granite is likely to be 7.8 mbgl (+/- 4.0 m). This means burial depths are likely to remain above the highest anticipated depth of fresh granite bedrock.

Based on our assessment of the minimum good practice groundwater protection, the proposed cemetery expansion meets all requirements.

The only item of potential non-compliance is the karstic nature of the bedrock aquifer. However, given the low-permeability cover and relative limited karstic behaviour of the granite, this is considered a less than minor failure to fully meet the requirements.

4.2 Tier 1 Groundwater Risk Assessment

Based on the Environment Agency's Guidance: Cemeteries and burials: groundwater risk assessments (updated April 2022), a Tier 1 GW-RA has been conducted.

The potential of a number of pollutant pathways and the degree of associated risk assessed numerically on a 0 to 10 score with 10 being the highest risk is shown in Table 5 (refer Appendix C for risk ranking).

From the resultant data, the final values are assessed against burial number and a determinant of risk calculated from EA flow charts and nomographs. The table below also contains risk scores in brackets based on the presence of fractures in the Granite.

Table 5. Summary of pollution risk associated with the site.

Table 5. Tier 1 Risk Assessment

Risk	Assessment	Comment / Mitigation	Resultant Risk
Burials per year	LOW	Anticipated to be <9 per year	-
Drift Type: Soil, Drift and heavily weathered granite	MODERATE	Low permeability and high absorption potential of clays mitigating transport of pollutants of concerns	1-2
Drift thickness: Thin soil, drift and heavily weathered granite	HIGH	Low-permeability cover thins towards the western side of the site. This may reduce the attenuation potential of pollutants of concerns.	3-4
Depth to Water Table	HIGH	The water table high is anticipated to be below the base of the grave cuts.	7-8
Fractured Granite (groundwater flow)	HIGH	If encountered at shallow depth, the rapid transport of pollutants in groundwater is possible.	3-6
Proximity to potable wells and springs	LOW	There are no water abstractions mapped within 500 m radius of the site	1-2
Aquifer Type / groundwater flow	LOW	The aquifer is a secondary aquifer, with no known down-hydraulic gradient sensitive receptors	5-6
Abstractions and SPZs	LOW	There are no SPZ within 350 m of the site and the nearest are up-hydraulic gradient of the site.	1-2
Proximity to water course/springs	LOW	No water courses or ditches were identified.	1-2
Proximity to land drains	LOW	No land drains were identified	1.2
Precipitation	MODERATE	Low annual rainfall	-

The total score being: 24 to 34. Based on the Groundwater Risk Nomograph, the risk is moderate.

4.3 Tier 2 Groundwater Risk Assessment

As detailed in the Tier 1 Risk Assessment, a moderate risk was identified for the site. Therefore, a Tier 2 GW-RA was deemed appropriate. Worst-case and conservative values were used where appropriate. The methodology is discussed in the following sections.

Based on the pollutants of concern, Ammonium was considered herein.

4.3.1 Infiltration Worksheet: Input Parameters

Table 6 provides the selected input parameters (with Infiltration Worksheet in Appendix D).

Table 6. Infiltration Worksheet Input Parameters

Parameter	Selected Value	Selected variance	Justification / Discussion
Input Conc. Ammonium	870,000 mg	-	A single 70 kg corpse in the first year of decomposition releases: 0.87kg NH4+ (Source: EA Guidance)
Infiltration rate	87 mm/year	+/-5%	Taken to be 10% of the average annual rainfall of 869.7 mm/year
Infiltration per burial	522 Litres/year	+/-25%	87 mm/yr x 6 m ² (burial plot) = 522 Litres/year
Infiltration per year (9 burials)	4,698 L/yr	+/-2 burials per year	522 L/yr (infiltration rate) x 9 (burials per year) = 4,698 Litres/year
Total Conc. Ammonium	1,667 mg/L	+/-2 burials per year	(9 x 870,000) / 4,698 = 1,667 mg/l
Discharge Rate	0.013 m ³ /day	+/-2 burials per year	87 mm/yr (infiltration rate) x 54 m ² (total area of the all plots) = 0.013
Thickness of drainage layer	1.9 m	+0.5 m	Minimum burial depth plus additional 0.5 m depth
Attenuation unsaturated zone thickness	3.2 m	+/- 1.0 m	5 mbgl (water table) – 1.8 m (the required basal depth of a single grave as stated within Environment Agency guidance) = 3.2 m (and varied for sensitivity analysis)
Water filled porosity	0.15	+/-0.05	Based on published values for sandy clay (and varied for sensitivity analysis)
Bulk density	1.073	+/-0.5	Based on literature values.
Degradation	Sorbed and dissolved	-	Sorbed and dissolved phases as ammonium attenuation within the unsaturated subsoil is likely to take place predominantly through cation exchange and nitrification, it was considered appropriate to select degradation as active.
Fraction of rapid flow through the unsaturated zone	10%	+/-5%	The unsaturated zone comprises sandy clay. Therefore, it was considered unlikely that a significant fraction of the discharge would pass through the unsaturated zone unretarded by the soil / rock matrix.
Dimensions of the drainage field	280 m ²	+/-50%	The conservative field size of cemetery expansion.
Saturated Aquifer Thickness	6 m	+/- 3	Conservatively assuming the base of the aquifer is sea level, the effective aquifer thickness is 6 m.
Hydraulic Conductivity	2 m/d	+/- 0.5	Matrix porosity is likely to be low, however fracture k may be higher, if present.
Hydraulic gradient	0.01	+/-25%	Taken to be height of water table above sea level to sea level (assumed water table elevation at the coast)

4.4 Initial Assessment Results

Table 7. Initial Assessment Results

Contaminant of Concern	Environmental Standard (DWS)	Concentration at Compliance Point
		Groundwater: 50 m from site
Ammonium (NH ₄ ⁺)	0.5 mg/L	<p>Sensitivity Low Values: 4.69 mg/L</p> <p>Worst Case: 0.43 mg/L</p> <p>Sensitivity High Values: 0.02 mg/L</p>

Initial assessment results show compliance for the worst case and favourable case scenarios relevant to Drinking Water Standards. Within the Initial Assessment, Input Parameters were generally selected to give a 'Conservative' or 'Worst Case' risk assessment; in particular with regard to the potential contaminant loading.

Based on our judgement, the most important factor controlling compliance was the area of the drainage field, with larger areas more readily meeting compliance.

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5 Conclusions and Recommendations from the HIA

Based on the findings of this RW-RA, we have drawn the following conclusions:

- 1) The site does not require an Environmental Discharge Permit, as it meets all criteria Minimum Good Practice Groundwater Protection (Section 4.1, Table 4); and
- 2) Based on the Tier 1 GW-RA:
 - a) A low to moderate risk was identified as part of the qualitative risk assessment (Section 4.1 Tier 1 Risk Assessment, Table 5); and
 - b) A quantitative GW-RA was undertaken using the Infiltration Worksheet. This demonstrated compliance for the worst case and favourable sensitivity analysis. The key assumption being the rate of burials.
- 3) A review of soil and groundwater chemical analysis suggested that Natural Attenuation processes would be anticipated; including Nitrification (the biological oxidation of ammonium). The process of nitrification would further reduce the ammonium concentration and thereby further lessen the potential impact of the development on groundwater quality;
- 4) It was concluded that the Sensitivity Assessment 'Realistic Case' Groundwater Risk Assessment demonstrates the proposed Burial Ground Development to represent a potential LOW RISK to controlled waters (groundwater); and
- 5) The risk assessment verifies that the spatial extent of the proposed Burial Strategy would be acceptable.

6 References

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- British Geological Survey (BGS) Drift and solid geology from the 1:50,000 BGS geological map series: Sheet Number 357 & 360: IoS Solid and Drift, published 1975 (as well as the BGS online viewer Onshore GeoIndex, accessed 01/06/2023
- EA, 2018. The Environment Agency's approach to groundwater protection. Dated February 2018, Version 1.2

7 Author's Statement

This Hydrogeological Risk Assessment was carried out by Huw Williams, director at Agua Enodo Ltd (registered address: Lowin House, Tregolls Road, Truro, Cornwall, TR1 2NA).

Huw holds a BSc in Geological Sciences and an MSc in Hydrogeology, both from University College London.

With over 20 years in industry, Huw is also a former employee of the Environment Agency, and has completed many Groundwater Risk Assessments, Environmental (Discharge) Permit and Groundwater Abstraction Licence applications.

Proof of relevant insurance can be provided on request.

Based on the above, we submit that Huw Williams is a competent industry professional in respect to undertaking the above assessment.

8 Limitations

It is important to understand the variability of the ground conditions in this area. No guarantee of flow rates or sustainable yield can be provided at this stage and it will be necessary to drill and test a borehole in-situ to better evaluate the performance of a new borehole at this site.

We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, their professional advisers and the relevant authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on hwilliams@aguaenodo.com if you require any further information.

Report prepared by

-UNSIGNED DRAFT-

Huw Williams
Hydrogeologist

Figures

DRAFT




TITLE:

EXISTING LANDUSE

GW-RA ONLY
NOT FOR CONSTRUCTION

LEGEND

 Approximate Site Boundary

Client: Isles of Scilly Council

Project:
Tier 1 Groundwater Risk
Assessment: St Mary's Church
Old Town

Proj No: 2023.015.001

Designed: HW
Drawn: HW
Checked: SW
Date: 01/06/2023

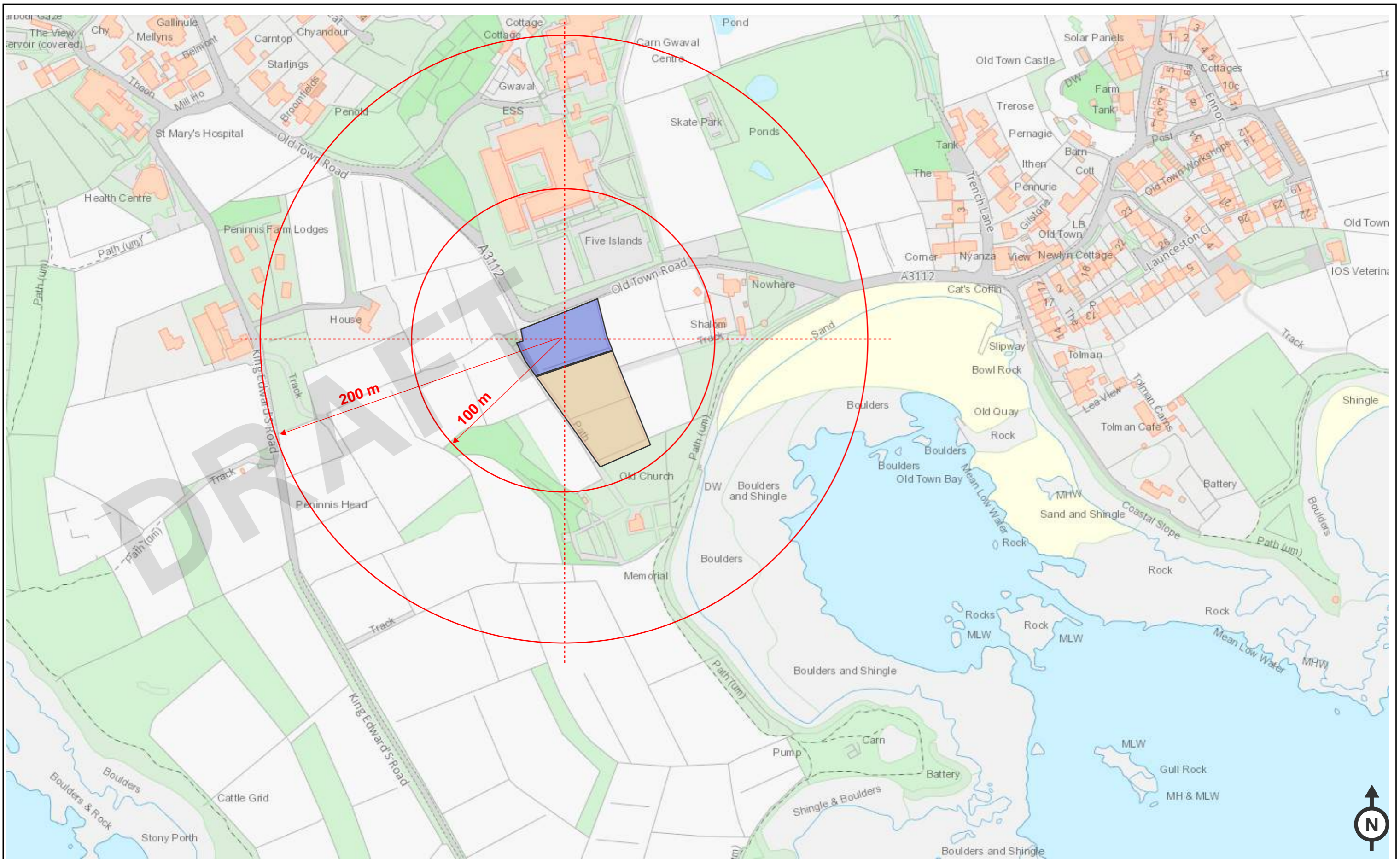
Scale: NTS

Figure No:

3

Size: A3

Revision: A




TITLE:

STUDY AREA

GW-RA ONLY
NOT FOR CONSTRUCTION

LEGEND

 Approximate Site Boundary

Client: Isles of Scilly Council

Project:
Tier 1 Groundwater Risk
Assessment: St Mary's Church
Old Town

Proj No: 2023.015.001

Designed: HW
Drawn: HW
Checked: SW
Date: 01/06/2023

Scale: NTS

Figure No:

4

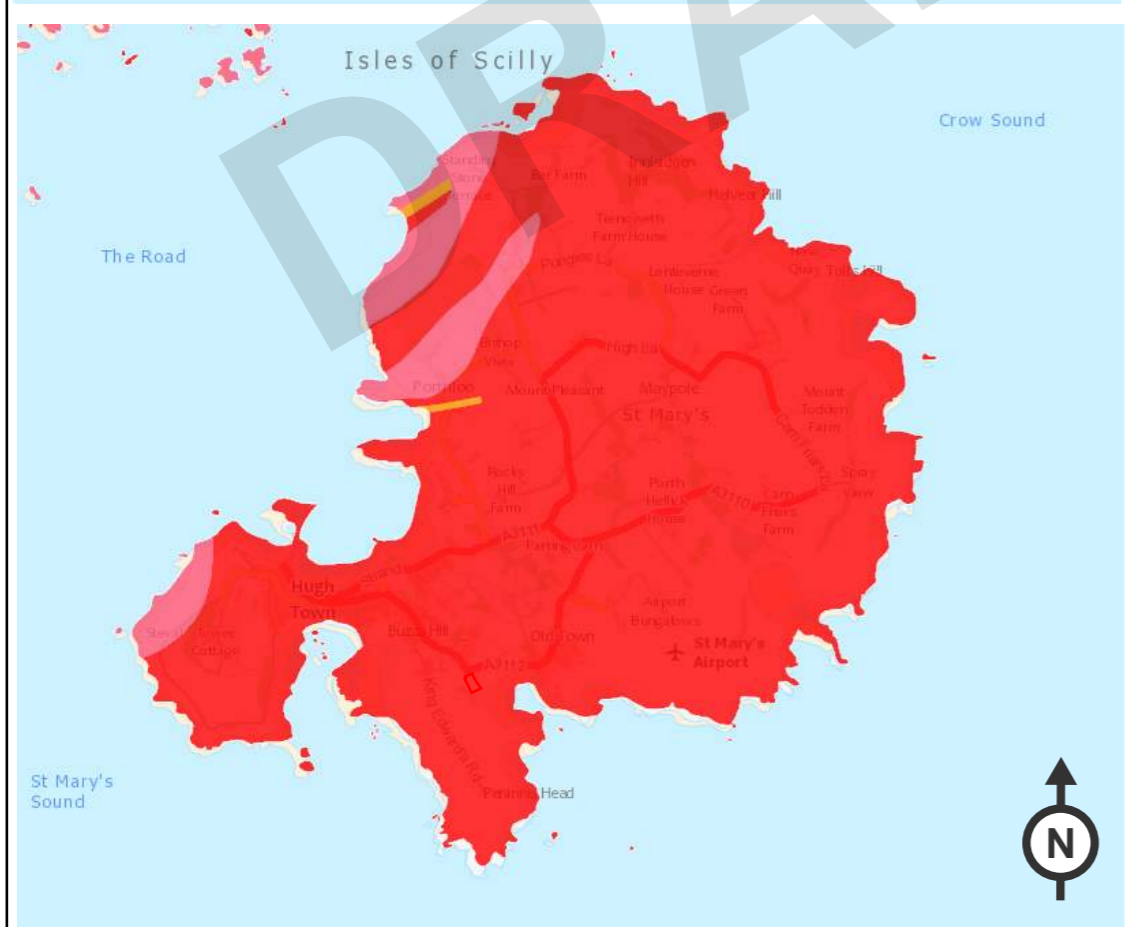
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Revision: A



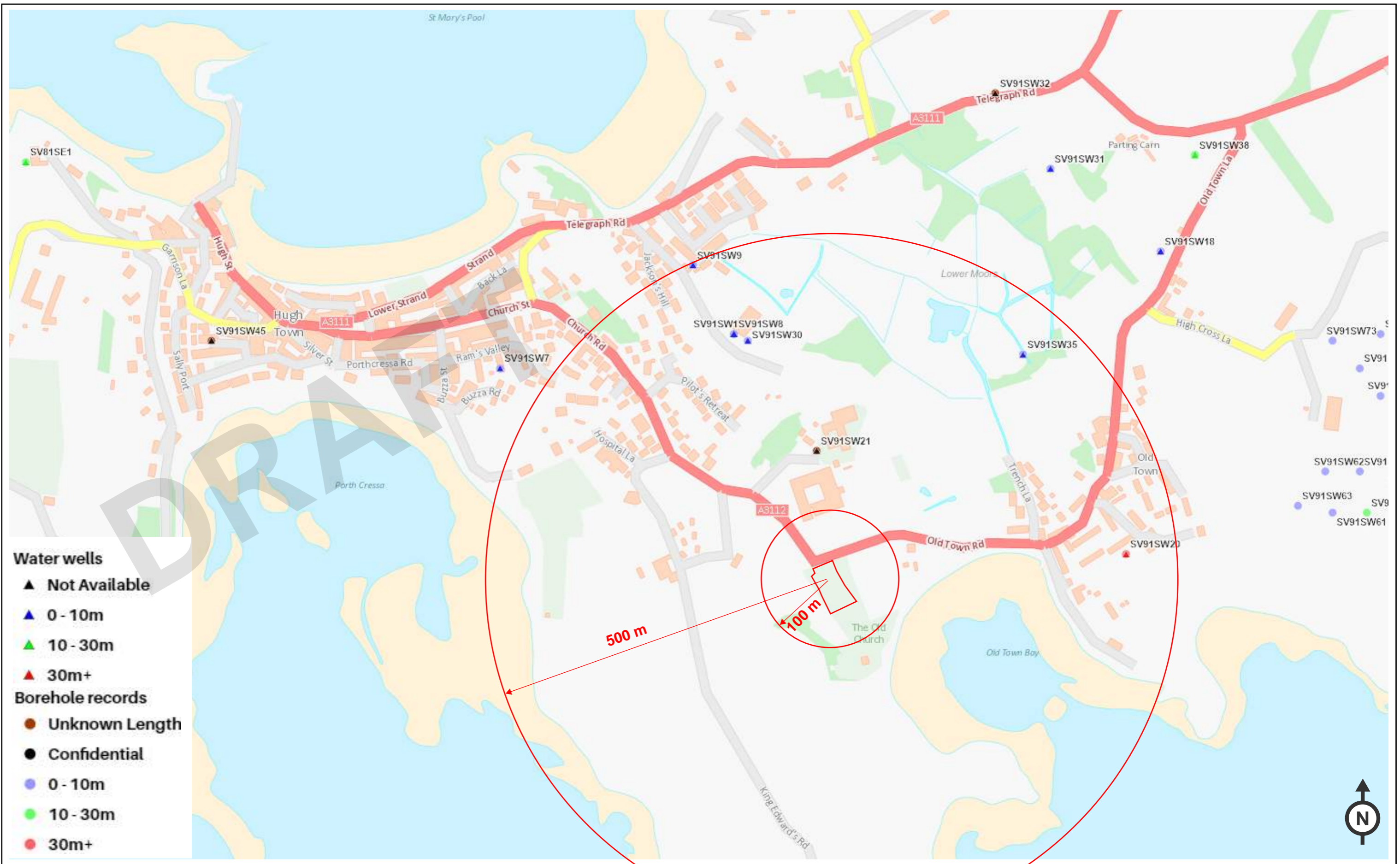
Superficial deposits 1:50,000 scale

- ALLUVIUM - CLAY, SILT, SAND AND GRAVEL
- BLOWN SAND - SAND
- HEAD - CLAY, SILT, SAND AND GRAVEL
- RAISED BEACH DEPOSITS - GRAVEL
- TIDAL FLAT DEPOSITS - GRAVEL, SAND AND SILT


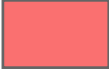





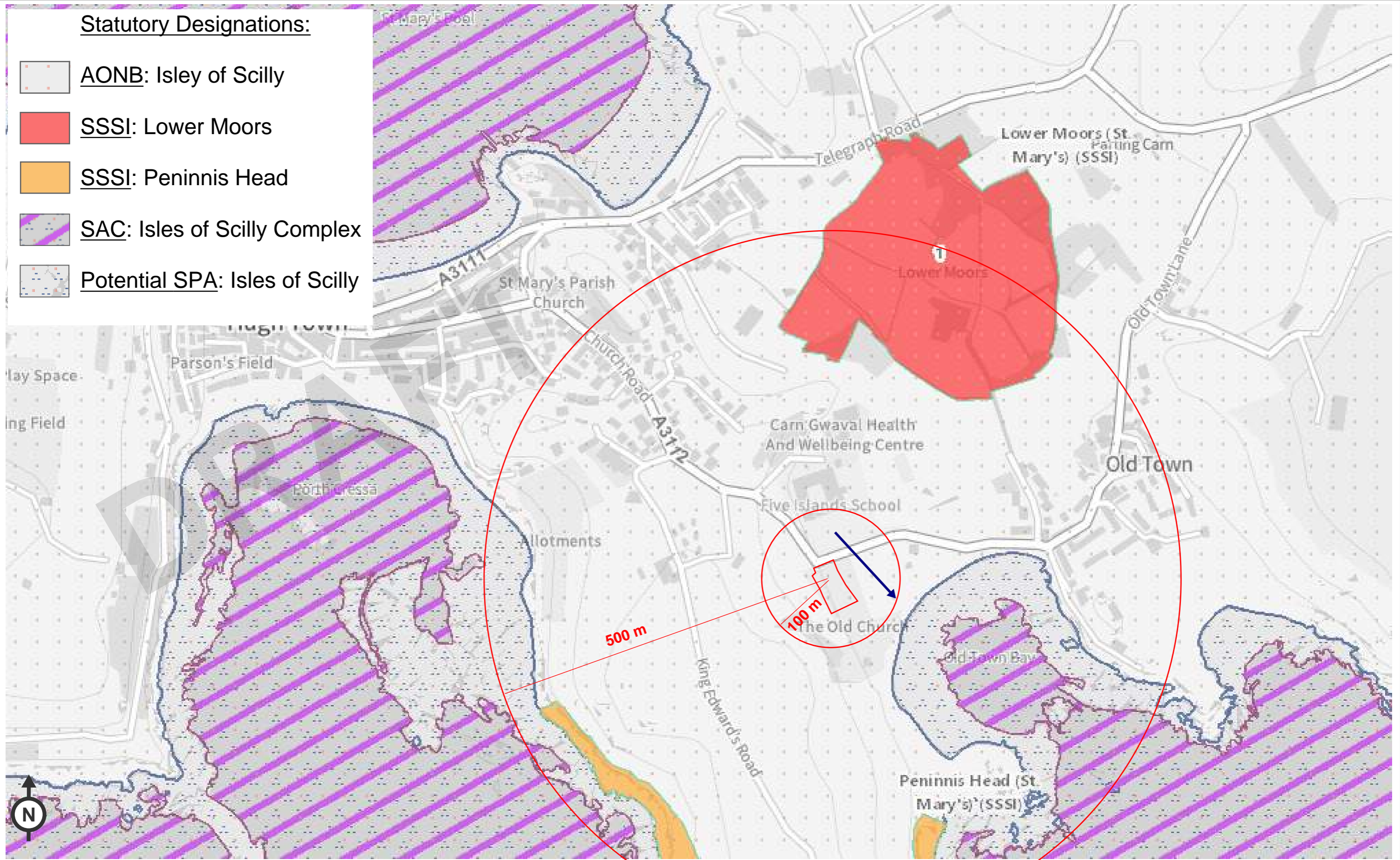
Bedrock geology 1:50,000 scale

- ISLES OF SCILLY INTRUSION - MICROGRANITE, APLITIC
- UNNAMED DYKE, PERMIAN - FELSITE
- ISLES OF SCILLY INTRUSION - GRANITE





Statutory Designations:

-  **AONB: Isley of Scilly**
-  **SSSI: Lower Moors**
-  **SSSI: Peninnis Head**
-  **SAC: Isles of Scilly Complex**
-  **Potential SPA: Isles of Scilly**



TITLE:
STATUTORY DESIGNATIONS

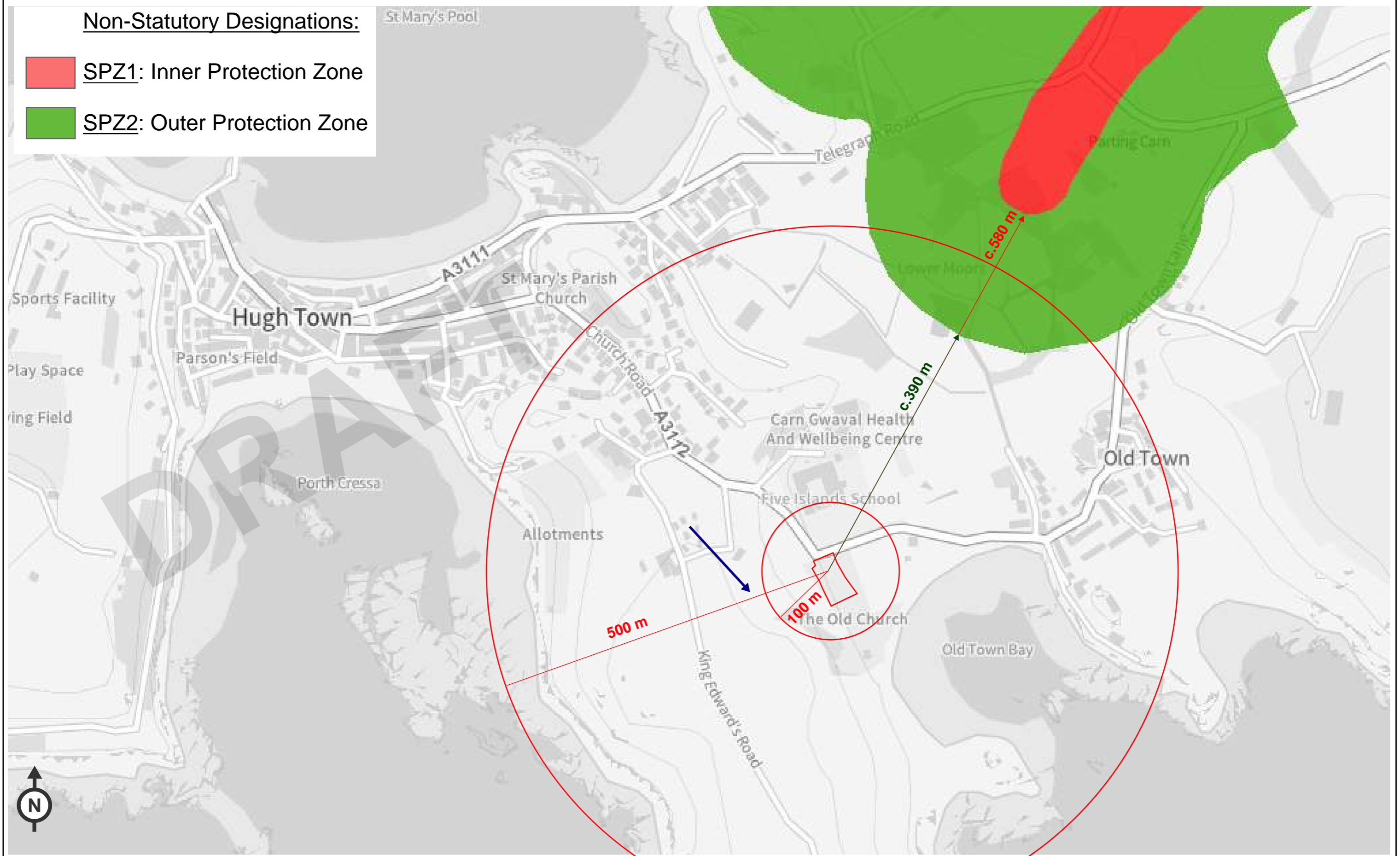
GW-RA ONLY
NOT FOR CONSTRUCTION

- LEGEND
-  Approx. Site Location
 -  Inferred Groundwater Flow Direction in the vicinity of the site

Client: Isles of Scilly Council		Figure No:
Project: Tier 1 Groundwater Risk Assessment: St Mary's Church Old Town		7
Designed: HW	Drawn: HW	Size: A3
Checked: SW	Date: 01/06/2023	Revision: A
Proj No: 2023.015.001	Scale: NTS	

Non-Statutory Designations:

- SPZ1: Inner Protection Zone**
- SPZ2: Outer Protection Zone**



LEGEND

- Approx. Site Location
- Inferred Groundwater Flow Direction in the vicinity of the site

Client: Isles of Scilly Council		Figure No:
Project: Tier 1 Groundwater Risk Assessment: St Mary's Church Old Town		8
Designed: HW	Drawn: HW	Size: A3
Checked: SW	Date: 01/06/2023	Revision: A
Proj No: 2023.015.001	Scale: NTS	

Appendix A

DRAFT



1

110 SV81/2
13

SV 8989 1077

13

Garrison Well. 6° Cornwall 87 SW/E
Depth approx. 70 ft. Deepest on island. Shaft 3' 6" square.
30 ft. of standing water.
Rest level .∴ 40 ft. below surface.
Never dry. Water brackish; not used much.

DRAFT

105/1-SV91/14-17
105/1-4

St. Mary's Island

Analyses below of water from Buzza Hill Reservoir is
mixed water from above wells. 105/1-4

Analyses (parts per 100,000)

Quality varies. Best at Parting Carn - water level 2 ft. above H.W.M.O.S. tides
Storage Reservoir. Buzza Hill. 18.5.44.
Appearance bright - few mineral particles. Turbidity - less than 5 parts per million.
Colour - Hazen v. ft. yellow. 15 (silica scale). Odour - nil.
Reaction pH. Acid 5.4. Free Carbonic Acid 6.6
Electric conductivity at 20° C. 3700. Total solids, dried at 180° C. 250.0.
Chlorine in Chlorides 116.0. Alkalinity as Calcium Carbonate 1.8.
Hardness - Total 94.0; Temp. nil; Perm. 94.0.

Nitrogen in Nitrates 0.64

Nitrogen in Nitrites less than 0.001

Free Ammonia 0.0008

Ammoniacal Nitrogen nil

Albuminoidal Ammonia 0.016

Albuminoidal Nitrogen nil

Oxygen absorbed in 4 hrs. at 27° C. 0.205

Metals: Iron 0.005
Manganese 0.055

Zinc 0.2
Other metals absent

Bacteriological Results;

No. of bacteria growing on Agar per cc. or ml. in	1 day at 37° C. - 1
" " " " " "	2 days " 37° C. - 13
" " " " " "	3 " " 20° C. - 300

Presumptive coliform Reaction:	Present 10 cc.:	Absent 1 cc.
Bacteria coli. Type 1.:	Present nil	" 100 cc.
Type 2.:	Present 10 cc.:	" 1 cc.
Cl. welchi Reaction	Present 100 cc.:	" 10 cc.

Water reasonably clear and bright in appearance, is acid in reaction, deficient in
Carbonate or temporary hardness, and will be plumbo-solvent and corrosive to metals.
Excessively hard in character - permanent, high content of salinity causing taste,
low standard of organic purity. Unsuitable for public supply.

and bacterial

10S SV91/16

A+B SV9092 1052

10S / 3

A+B
A
B

South of Moor well
St Mary's Island

A
B

2 wells.
Depth 18 ft. Diam. 5 ft.
Depth 16 ft. Diam. 5 ft.

Constructed ~ 1938. ? by Ward and Moyle
Both wells deepened in 1939 by J. F. Ellis

6" Cornwall 87. SE. W

Sited Aug 1946 H.E.F.

DRAFT

SV91/16A+B

3

South of Moor well. Two wells.
Depth 18 ft., diameter 5 ft. and depth 16 ft., diameter 5 ft.
Constructed in 1938. ? by Ward and Moyle.
Both wells deepened in 1939 by J.F. Ellis.

6" Cornwall 87 SE/W

COPY

10 SV91/14
APPENDIX "A"

RAM'S VALLEY WELL was sunk to a depth of about 25 feet, sixteen of which were cut through the solid rock. Water was first met at about sixteen feet from the surface, but only oozing in very slowly. The work was continued for about nine feet below where the water was first seen, the springs becoming stronger as the well descended.

.....

The mean length of the square at the bottom of the Well is 5½ feet, the mean width 3½ feet, and the depth of water 8½ ft. These measurements give a capacity of more than 1000 gallons; and it has been found when the well is perfectly dry, it requires four hours to refill to the 8½ feet level. This means that the well would yield, if required, 4000 gallons a day between the hours of 6 a.m. and 10 p.m. Estimating the population of Hugh Town at 800, this gives a supply of 10 gallons a day to one-half of the Town, or 5 gallons a day to the whole of the Town, or 3½ gallons to every man, woman and child on the whole Island; population 1200.

The well was opened on January 18th, 1897, and there was found to be 11½ feet of water in it.

February 6th, 1903,.. depth of water 11 feet, at 3 p.m.

? 1903.
H of H. file 657/9361

Rams Valley Well. Approx. 1904. 6" Cornwall 875E/W
Depth 18ft., diameter 2 ft. Yield 2,000 gallons per day. Public supply.

3.

108 SV91/14

Analysis - 1897 or 1901.

Ram's Valley

Total Solid Residue -----	38.64
Combined Chlorine -----	13.40
" " (exp. as NaCl) -----	22.08
Nitrogen as Nitrates -----	1.01
Nitrites -----	a heavy trace.
Saline Ammonia -----	0.0035
Albuminoid Ammonia -----	0.0105
Oxygen req. to oxidise the organic matter -----	0.1240
Hardness (in degrees) -----	10 ^o
Lead or Copper -----	absent

Observations. This is a water of doubtful purity & certainly should not be used if a better supply can be obtained.



COPY

THE CLINICAL RESEARCH ASSOCIATION, LIMITED.

108 SV91/14

Watergate House,
 York Buildings,
 Adelphi,
 London, W.C.2.

To Dr. Addison,
 St. Mary's,
 Isles of Scilly.

Ref: No. 26,362.

The sample of water marked Well - 26ft. (Ram's Valley Well) collected on 22.7.25. and received here on 24.7.25., has been chemically examined, and I have been instructed to forward the following report:-

ANALYSIS (B).

	<u>Parts per 100,000</u>	<u>Grains per Gallon.</u>
Total Solids (dried at 120°C.)	80.00	56.000
Combined Chlorine	28.30	19.81
equivalent to Na Cl.	46.70	32.69
Nitric nitrogen	1.52	1.06
Nitrous nitrogen	Nil.	Nil.
Ammoniacal nitrogen	0.0003	0.0002
Albuminoid nitrogen	0.0090	0.0063
Oxygen absorbed in 4 hours at 27°C.	0.071	0.050
Lead or copper	Nil.	Nil.
Temporary hardness (equivalent to Ca Co ₃)	2.2	1.6
Permanent hardness do.	21.5	15.0
Total hardness do.	23.7	16.6

Judged on chemical analysis alone, i.e., without bacteriological tests, this water cannot be regarded as fit for drinking unless previously boiled.

(sgd). W.J.CURRY

Secretary.

COPY

THE CLINICAL RESEARCH ASSOCIATION

108 SV91/14

Westgate House,
York Buildings,
Adelphi,
London, W.C.2.

To Dr. W.B. Addison,

St. Mary's,

Isles of Scilly.

3. 10. 25.

Ref. No. 34,199.

Bacteriological examination, by cultural and microscopical methods, of the sample of water marked, 26' Well. (Ram's Valley Well) collected on --- and received here on 29. 9. 25. has given the following results:-

(1) QUANTITATIVE.

The average number of organisms, producing visible colonies on gelatine plates incubated at 20°C. for 3 days, is found to be 458 per c.c.

The average number of organisms, producing visible colonies on agar plates incubated at 37.5°C. for 2 days, is found to be 16 per c.c.

(11) QUALITATIVE.

B. Coli. not found in 100 c.c.
Streptococci. present in 10 c.c.
B. Enteritidis Sporogenes not found in 100 c.c.

The temperature of the water on arrival was 15°C.

In the absence of other excremental organisms we cannot regard the presence of the Streptococci as indicative of sewage pollution, they are probably adventitious.

From a bacteriological point of view the water might be regarded as safe for drinking purposes.

(Sgd). W.K.CURRY.

Secretary.

F.M.

SV 9058 1047

IOS / 1

Report by J.H. Blight, Penzance. 1944

- 1 Rams Valley Well. 1904 approx.
2 ft. diam., 18 ft. deep. Yield 2,000 g.p. day.†
- 2 Old Moor Well. 1914-1918. (Used only in drought).
6 ft. diam., 17 ft. deep. Yield 10,000 g.p. day.†
- 4 New Well. 1942. (Adjoining two other wells 16 ft. and 18 ft. deep).
10 ft. square, 26 ft. deep. 27,000 g.p. day.† Minimum yield much less.
During drought, after standing for 3 hrs. pump empties well in 2 hrs. or less

SV91/14

Combined flow does not exceed 14,000 g.p. day at worst period.

At present public supply unpalatable. Water at Parting Carn, Pump Rd. shows vast improvement. This suggests Old Town Marshes for future development, being 50 acres in extent having a catchment area of about 500 acres. The granite is below sea-level and is covered with 12-20 ft. of sand, silt and a layer of clay into which water percolates and is stored. This is a large natural underground reservoir. Lowering water below high water mark causes entrance of sea-water. This has already occurred at Moor Well and New Well. Old Town Marshes are flooded in winter to a depth of a foot or so. Any well sunk here should be situated as far from the sea as is compatible with access to the site, to avoid lowering the water level near the sea. Minimum run-off in Scilly is .20 cu. secs. per 1,000 acres
 ∴ 54,000 gallons yielded from 500 acres in 24 hrs.

Water levels in three new wells varies as much as 10 ft., indicating that ground water finds difficulty in reaching New Well. This may be due to choked fissures and a heading would therefore increase supply at well bottom. (Water is decreasing annually). This may cause pollution, therefore, it is recommended to sink a well near Aunt Joanies on the opposite side of Old Town Marshes as suggested by the Geologist Dr. Hickling.

Proposed new well - Barneys Well

Depth 26 ft. Internal diameter 6 ft. Headings at bottom for 20 ft. Height 6 ft. Width 2 ft. 6 in., to provide storage capacity of 2,000 gallons at level of 20-26 ft. below the surface as a sump. Lining of broken rock up to 1 ft. 6 in. above ground level. Pumping carried out at Aunt Joanies Well. New well in reserve with heading

Analyses (parts per 100,000)

Quality varies. Best at Parting Carn - water level 2 ft. above H.W.M.O.S. tides *
 Storage Reservoir. Buzza Hill. 18.5.44.
 Appearance bright - few mineral particles. Turbidity - less than 5 parts per million.
 Colour - Hazen 4.5 ft. yellow. 15 (silica scale). Odour - nil.
 Reaction pH. Acid 5.4. Free Carbonic Acid 6.6
 Electric conductivity at 20° C. 3700. Total solids, dried at 180° C. 250.0.
 Chlorine in Chlorides 116.0. Alkalinity as Calcium Carbonate 1.8.
 Hardness - Total 94.0. Temp. nil; Perm. 94.0.
 Nitrogen in Nitrates 0.64 Nitrogen in Nitrites less than 0.001
 Free Ammonia 0.0008 Ammoniacal Nitrogen nil
 Albuminoidal Ammonia 0.016 Albuminoidal Nitrogen nil
 Oxygen absorbed in 4 hrs. at 27° C. 0.205
 Metals: Iron 0.005 Zinc 0.2
 Manganese 0.055 Other metals absent

Bacteriological Results:

No. of bacteria growing on Agar per cc. or ml. in 1 day at 37° C. - 1
 " " " " " " 2 days " 37° C. - 13
 " " " " " " 3 " " 20° C. - 300
 Presumptive coliform Reaction: Present 10 cc.: Absent 1 cc.
 Bacteria coli. Type 1.: Present nil " 100 cc.
 Type 2.: Present 10 cc.: " 1 cc.
 Cl. welchi Reaction Present 100 cc.: " 10 cc.

Water reasonably clear and bright in appearance, is acid in reaction, deficient in Carbonate or temporary hardness, and will be plumbo-solvent and corrosive to metals. Excessively hard in character - permanent, high content of salinity causing taste, low standard of organic/purity. Unsuitable for public supply.

hand bacterial

by Mr. Blight
 † alleged minimum yields said to be grossly overestimated



COPY

IOS SV91/14

The COUNTIES PUBLIC HEALTH LABORATORIES
 91, Queen Victoria Street, London, E.C.4.

RAMS VALLEY WELL.

Analysis of a sample of water received on 14. 5. 35, from Gerald Cox Esq., Dalmouth Corporation Waterworks. Labelled St. Mary's, Isles of Scilly Water Supply.

RAMS VALLEY WELL.

Taken by G. Cox. Witness A.Nance. Date---- 5.0 p.m.

Chemical results in parts per 100,000

Appearance.	Bright, few vegetable and mineral particles.
Colour.	Normal. Odour - None.
Reaction pH.	Faintly acid, 6.0 Free Barbonic Acid - 3.3
Electric Conductivity at 20°C.	1020
Total solids, 180°C.	71.5
Chlorine in chlorides :	24.0
Nitrogen in Nitrates	2.20 Nitrites - absent.
Hardness: permanent.	54.0 Calcium - 3.9
temporary.	0.0 Magnesium - 9.9
total	54.0
Metals.	Minute trace of Iron. 0.012
Free Ammonia	0.0052
Albuminoid ammonia	0.0108
Oxygen absorbed in 4 hrs. at 80°F.	0.0900

Bacteriological results.

No. of Bacteria per c.c.	
on Agar in 3 days at 20°C.	8600
on Agar in 1 day at 37°C.	420
The Bacillus Coli.	Present in --- absent in 100cc.
Bacillus welchii	
(B. Enteriditis Sporogenes)	Present in --- Absent in 100 cc.

This is a reasonable clear and bright and colourless water. It is acid in reaction exceedingly hard in character and devoid of Carbonate (Temporary) hardness and will be corrosive to metals and contact with Lead (a poisonous metal) should be avoided. The hardness is due to the presence of sulphate and Chlorides of Calcium and Magnesium and corrosive action on boilers, hot water pipes etc., would be marked. The amount of common salt is not excessive and metals are absent, apart from a minute and negligible trace of iron.

The water is of low grade of organic purity and is highly nitrated suggesting an origin from a manurially polluted soil. The bacterial content is also high but bacteria indicating recent and dangerous pollution were not found. The water, in view of its chemical characters, is an objectionable one for the purposes of a Public Supply, but cannot on this sample be considered seriously polluted or unwholesome necessitating sterilisation, though the latter is probably desirable as a safeguard.

(Signed)-----

for Drs. Beale and Suckling.

Copy.

108 SV91/14

THE COUNTIES PUBLIC HEALTH LABORATORIES
91, Queen Victoria Street, London, E. C. 4.

(Ram's Valley)

Ref. J. 164.

Analysis of a sample of water received on 14.5.35, from
Gerald Cox, Esq., Falmouth Corporation Works;
Labelled St. Mary's Isles of Scilly Water Supply.

Ram's Valley Well.

Taken by G. ^{Cox} ~~Yas.~~ Witness A. Nance. Date --- 5.0, p.m.

Chemical results in parts per 100,000.

Appearance.	Bright, few vegetable and mineral particles.		
Colour.	Normal.	Odour.	None.
Reaction pH.	Faintly acid 6.0.	Free Carbonic Acid	- 3.3.
Electric Conductivity at 20°C.	1020.		
Total solids, 180°C.	71.5.		
Chlorine in Chlorides.	24.0		
Nitrogen in Nitrates.	2.20	Nitrites	- absent.
Hardness; permanent.	54.0.	Calcium	- 3.9
		Magnesium	- 9.9
temporary	0.0		
total.	54.0		
Metals.	Minute trace of Iron.	0.012	
Free ammonia.	0.0052		
Albuminoid ammonia	0.0108		
Oxygen absorbed in 4 hrs at 80°F.	0.0900		

Bacteriological results.

No. of Bacteria per c.c.	
on Agar in 3 days at 20° C.	2,600
on Agar in 1 day at 37°C.	420
The Bacillus Coli.	Present in --- Absent in 100cc.
Bacillus Welchii (Enteritidis Sporogenes).	Present in -- Absent in 100 cc.

This is a reasonably clear and bright and colourless water.

It is acid in reaction exceedingly hard in character and devoid of Carbonate (Temporary) hardness and will be corrosive to metals and contact with Lead (a poisonous metal) should be avoided.

The hardness is due to the presence of Sulphate and Chlorides of Calcium and Magnesium and corrosive action on boilers, hot water pipes, etc., would be marked. The amount of common salt is not excessive and metals are absent, apart from a minute and negligible trace of iron.

The water is of low grade of organic purity and is highly nitrated suggesting an origin from a manurally polluted soil. The bacterial content is also high but bacteria indicating recent and dangerous pollution were not found. The water, in view of its chemical characters, is an objectionable one for the purposes of a Public Supply, but cannot on this sample be considered seriously polluted or unwholesome necessitating sterilisation, though the latter is probably desirable as a safeguard.

(Signed) -----
for Drs., Beale and Suckling.



Copy

-5-

108SV91/14

The Counties Public Health Laboratories
 91, Queen Victoria Street,
 London, E.C.4.

Analysis of a sample of Water received on 4.2.39 from
 Messrs. D.Balfour & Sons, for St. Mary's, Isles of Scilly.

Labelled Ram's Valley Well.

Sgd. and Taken by T. Flower. Witness E.B.Guy. Date 2.2.39. 1.15 p.m.

Appearance Bright: slight brown film-deposit of iron oxides.
 Turbidity: 4.5 p.p.m. (Silica Scale)
 Colour Yellow: A.P.H.A. 23.
 Odour Nil. Total Alkalinity as CaCO₃; 3.0

Free Carbonic Acid 2.8 Reaction, pH. Faint acid: 6.4

Results expressed in parts per 100,000.

Ca	Mg.	Na.	K.	CO ₃	SO ₄	Cl.	NO ₃	SiO ₂	Probable Combinations.
2.2	3.5			1.8	11.4	23.2	4.45	1.20	
1.2				1.8					Calcium carbonate 3.00
1.0					2.4				Calcium sulphate 3.40
	2.29				9.0				Magnesium sulphate 11.29
	1.21					3.52			Magnesium chloride 4.73
		12.79				19.68			Sodium chloride 32.47
		1.65					4.45		Sodium nitrate 6.10
									SILICA 1.20
									Difference 1.31.

Total solid constituents dried at 180°									63.50.

Hardness - Permanent 20.0 Temporary 1.0 Total 21.0
 Ammonical Nitrogen 0.0030 Free Ammonia 0.0036
 Albuminoid Nitrogen 0.0132 Albuminoid Ammonia 0.0160
 Oxygen absorbed in 4 hours at 80°F. 0.190
 Nitrites Absent
 Metals - Iron: 0.035 in solution. 0.007 Other metals: Absent.
 Note - To convert the above parts per 100,000 into grains per gallon multiply by .7

BACTERIOLOGICAL RESULTS.

No. of Colonies per cc. or ml.
 On Agar in 3 days at 20°C. 280
 On Agar at 37°C. in: 1 day 13
 2 days 23
 Bacillus Coli Present in - Absent in 100 c.c.
 Bacillus Welchii Present in - Absent in 100 c.c.
 (B. Enteritidis Sporogenes)
 Coliform organisms present in 10 c.c. but no typical B.Coli was found.

10 S SV91/15

SV 9086 1062 106 / 2

2

old moor well
St Mary's Island

Constructed between 1914-18. Used only in drought.
Purchased from Admiralty for public supply.
Depth 17 ft. Diameter 6 ft.
Yield 10,000 g.p.d.

6" Cornwall 87 SE.W

Sited Aug. 1946. M.E.F.

DRAFT



SV91/15

2 . Old Moor Well. Constructed between 1914-18. Used only in drought.
Purchased from Admiralty for public supply.
Depth ~~is~~ 17 ft. Diameter 6 ft. Yield 10,000 gallons per day. 6" Annual 87/SE/W

DRAFT

2

IOS SV91/15

Analysis - 1897 or 1901.

Moor Well

2

Total Solid Residue	53.48
Combined Chlorine	20.30
" " (exp. as NaCl)	33.45
Nitrogen as Nitrates	0.075
Nitrates	absent
Saline Ammonia	0.0028
Albuminoid Ammonia	0.0230
Oxygen req. to oxidise the organic matter	0.3600
Hardness (in degrees)	10.5°
Lead or Copper	absent.

Observations. A water which is too impure to be used for drinking purposes.

3

Copy

108, SU91/15

THE CLINICAL RESEARCH ASSOCIATION, LIMITED

2
Watergate House,
York Buildings,
Adelphi,
London, W.C.

To Dr. Addison,

St. Mary's,

Isles of Scilly.

28. 7. 25.

Ref. No. 26.363.

The sample of water marked Well - 20 ft. (Moor Well) collected on 22.7.25 and received here on 24.7.25., has been chemically examined, and I have been instructed to forward the following report:-

ANALYSIS (B).

	<u>Parts per 100,000.</u>	<u>Grains per Gallon.</u>
Total solids (dried at 120°C.)	92.00	64.40
Combined chlorine	33.70	23.59
equivalent to Na Cl.	55.60	38.92
Nitric Nitrogen	0.90	0.63
Nitrous nitrogen	Nil	Nil
Ammoniacal nitrogen	0.0008	0.0006
Albumenoid nitrogen	0.0216	0.0151
Oxygen absorbed in 4 hours at 27°C.	0.229	0.160
Lead or copper	Nil.	Nil.
Temporary hardness (equivalent to Ca CO ₃)	2.0	1.4
Permanent hardness do.	20.0	14.0
Total hardness. do.	22.0	15.4

The figures representing organic matter are very high and much of it is probably of vegetable origin but is, nevertheless, objectionable.

The water - judged without bacteriological examination - cannot be considered as fit for drinking, but if it must be used it should be boiled.

(Sgd) W.J. CURRY

Secretary.

THE COUNTIES PUBLIC HEALTH LABORATORIES
91, Queen Victoria Street, London, E.C.4.

108 SV91/15

Ref. J. 163.

2

MOOR WELL.

Analysis of a sample of water received on 14.5.35, from Gerald Cox Esq. Falmouth Corporation Waterworks. Labelled St. Mary's, Isles of Scilly. Water Supply.

MOOR WELL. Witness A. Nance. Date 11.5.35. 5.0 p.m.

Chemical results in parts per 100,000.

Appearance.	Clear and Bright.	
Colour.	Faint yellow.	Odour - none.
Reaction pH.	Acid 5.6	Free Carbonic Acid 4.8
Electric Conductivity at 20°C.		1035
Total Solids, 180 C.		73.5
Chlorine and chlorides		24.8
Nitrogen in Nitrates		2.40 Nitrites - absent
Hardness: permanent		62.0 Calcium - 3.5
temporary		0.0 Magnesium - 12.1
total.		62.0
Metals.	Minute trace of Iron	0.003
Free ammonia		0.0052
Albuminoid ammonia		0.0250
Oxygen absorbed in 4 hrs. at 80°F.		0.2700

Bacteriological results.

No. of Bacteria per c.c.		
on Agar in 3 days at 20°C.		7800
on Agar in 1 day at 37°C.		72
The Bacillus Coli.	Present in ----	Absent in 100 cc.
Bacillus Welchii		
(B. Enteritidis Sporogenes)	Present in ---	Absent in 100 cc.

This is a clear and bright water with faint yellow colour, It is acid in reaction, devoid of Carbonial hardness and will be corrosive to metals and contact with Lead should be avoided. The water is excessively hard and the hardness being due to Sulphate and Chlorides of Calcium and Magnesium, is permanent in character. No excess of Sodium Chloride (Common Salt) is preseny and metals are absent, apart from a minute and negligible trace of Iron. The water contains an excess of organic matter and is highly nitrated. The bacterial content is also high but bacteria of objectionable type and origin were not found. The water is impure, but judged by this sample, is not polluted to a degree to be unwholesome. On account of its hardness and chemical characters the water is an objectionable one for the purposes of a Public Supply and Chlorination would probably be a desirable precautionary measure.

(Sgd). -----

for Drs. Beale and Suckling.

COPY

108 SV91/15

4 THE CLINICAL RESEARCH ASSOCIATION, LIMITED

Dr. W.B. Addison,
St. Mary's,
Isles of Scilly.

Watergate House,
York Buildings,
Adelphi,
London, W.C.2.

3. 10. 25.

Ref. No. 34, 200.

Bacteriological examination, by cultural and microscopical methods, of the sample of water marked 20' Well. (Moor Well). collected on ----- and received here on 29. 9.25. has given the following results:-

(I) QUANTITATIVE.

The average number of organisms, producing visible colonies on gelatine plates incubated at 20°C. for 3 days, is found to be 641 per c.c.

The average number of organisms, producing visible colonies on agar plates incubated at 37°C. for 2 days is found to be 20 per cc.

(II) QUALITATIVE.

B. coli.	Not found in 100 c.c.
Streptococci.	present in 1 c.c.
B. Enteritidis Sporogenes	not found in 100 c.c.

The temperature of the water on arrival was 15.5°C.

The Streptococci present are probably derived from some extraneous source rather than sewage pollution; this in view of the fact that other excremental organisms are entirely absent. Even the presumptive tests for B.Coli giving definite negative findings.

We note that animals can come quite close up to the well but presume that the surface structures exclude possibility of contamination.

Taking the result of the examination as a whole the water might be considered safe for drinking purposes from a bacteriological point of view.

(Sgd.) W.J.CURRY,
Secretary.



For Survey use only Licence No.

N. 11940

RECORD OF WELL

At Old Town, St Marys,
Isles of Scilly.

Town or Village Old Town, St. Marys.
County Isles of Scilly.

IOS/43
SV91/35

EXACT SITE OF WELL

Six-inch sheet 87SE/W. Six-inch National Grid sheet SV9149 1020

For The Land Steward, Duchy of Cornwall. State whether owner, tenant, builder, contractor, consultant, etc.:-

Address (if different from above) The Land Steward, Duchy of Cornwall, Isles of Scilly.

Level of ground surface above sea level (O.D.).....ft. If well top is not at ground level, state how far above: *Scilly. below;.....ft.

DELETE WHICHEVER IS INAPPLICABLE

SHAFT.....ft.; diameter.....ft.; HEADINGS (please attach details—dimensions and directions)

BORE 120.....ft.; diameter of bore: at top.....5.....in.; at bottom.....in.

Full details of permanent lining tubes (position, length, diameter, plain, slotted etc.).....
Forty feet of 4 inch Galvanised pipe.

Water struck at depths of.....110.....ft. below well top.

TEST CONDITIONS

Rest level of water.....20.....ft. above well top. Suction at.....ft. Yield on.....hours' test days' test

pumping at.....240.....galls. per hour with depression to.....ft. below well top.

Recovery to rest level in.....mins.* Capacity of pump.....g.p.h. Date of measurements.....

NORMAL CONDITIONS

DESCRIPTION OF PERMANENT PUMPING EQUIPMENT:

Make and/or type.....Motive power.....

Capacity.....galls. per hour. Suction at.....ft. below well top.

Amount pumped.....galls. per day. Estimated consumption.....galls. per week.

Well made by W. Visick & Sons Ltd. Date of sinking 8/1/65

Information from As above.

ADDITIONAL NOTES ANALYSIS (please attach copy if available)

For Survey use only

Date Received 2.2.65

Section 6

Pumping test

Observ. well

Recorder

E.R. log

Site marked on

1" map 0

6" map 0.2.2.65 (use symbol)

Record forwarded

to

date

GEOLOGICAL SURVEY, WATER DIVISION, SOUTH KENSINGTON, LONDON, S.W.7.

23/11/59 G5970 W154188-P.S.47 10M 1/60 M.P.L.D. G.722

10S SV91/17

SV 9094 1051

10S / 4 4

New well
St Mary's Island

Depth 26 ft. Diam 7 ft or 10 ft sq.
Yield 27,000 g.p.d. Minimum yield
much less. During drought, after standing for
3 hours, pump empties well in 2 hrs. or less.

1942

6" Cornwall 87 SE-W

Sited Aug 1946 H.E.M.



4

New Well: Depth 26 ft., diameter 7 ft. or 10 ft. square. Yield 27,000 gallons per day. Minimum yield much less. During drought, after standing for three hours, pump empties well in two hours or less. 1942.

Above wells sited Aug. 1946. H.R.F. 6" Cornwall B7SE/W

SV91/17

DRAFT

108 SV91/17
The County Public Health
Laboratories,
91, Queen Victoria Street,
London, E.C.4

Ref. S/RW/11.

14th January, 1944.

ANALYSIS OF A SAMPLE OF WATER received on: 6th January, 1944.
from Council of the Isles of Scilly, Town Hall, St. Mary's.
labelled: New Well, St. Mary's. Date: 4.1.44. 10.20 a.m.

Taken by: T. Bodilly. Witness: - Signed: W. Hopwood.

Chemical results in Parts per 100,000.

Appearance: Bright - very few particles of mineral debris.
Turbidity: Less than 5 parts per million, Silica scale.
Colour: Hazen: 51, yellow-brown 10. Odour: Nil.
Reaction pH: Faint Acid: 6.5 Free Carbonic Acid: 1.5
Electric Conductivity Total Solids, dried at 180°C: 90.0
at 20°C: 1350
Chlorine in Chlorides: 34.5 Alkalinity as Calcium Carbonate: 3.0
Hardness: Total 31.0 Temporary: 1.0 Permanent: 30.0
Nitrogen in Nitrates: 1.2 Nitrogen in Nitrites: absent
Free Ammonia: 0.0024 Ammoniacal Nitrogen: -
Albuminoid Ammonia: 0.0048 Albuminoid Nitrogen: -
Oxygen Absorbed in 4 hrs. at 27°C. 0.095
Metals: Iron: 0.003 Other metals absent.

Bacteriological Results.

Number of "Bacteria" growing -) on Agar per cc. or ml. in)	1 day at 37°C. 2 days at 37°C. 3 days at 20°C.		
	17	30	250
Presumptive Coliform Reaction.	*Present: 50 c.c.	Absent: 10 c.c.	
Bact. coli.	Present: -	Absent: 100 c.c.	
Cl. welchii Reaction.	Present: -	Absent: 100 c.c.	

■ Due to coliform bacteria of intermediate types.

These results are consistent with a wholesome water suitable for drinking and domestic purposes.

In view of the slight acidity and deficiency in bicarbonate or temporary hardness, the water will be plumbo-solvent and corrosive to metals and lead should not be used in connection therewith.

This sample is reasonably clear and bright in appearance, faintly acid in reaction and free from metals apart from an insignificant trace of iron. The water is hard in character although not to an excessive degree and has a high but not excessive content of salinity. It is of satisfactory organic and bacterial purity although not of the highest standard.

IOS SV91/17
 4

Report by J.H. Blight, Penzance. 1944

- 1 Rams Valley Well. 1904 approx.
 2 ft. diam., 18 ft. deep. Yield 2,000 g.p. day. †
 - 2 Old Moor Well. 1914-1918. (Used only in drought).
 6 ft. diam., 17 ft. deep. Yield 10,000 g.p. day. †
 - 3 New Well. 1942. (Adjoining two other wells 16 ft. and 18 ft. deep).
 10 ft. square, 26 ft. deep. 27,000 g.p. day. † Minimum yield much less.
 During drought, after standing for 3 hrs. pump empties well in 2 hrs. or less
- Combined flow does not exceed 14,000 g.p. day at worst period.

At present public supply unpalatable. Water at Parting Carn, Pump Rd. shows vast improvement. This suggests Old Town Marshes for future development, being 50 acres in extent having a catchment area of about 500 acres. The granite is below sea-level and is covered with 12-20 ft. of sand, silt and a layer of clay into which water percolates and is stored. This is a large natural underground reservoir. Lowering water below high water mark causes entrance of sea-water. This has already occurred at Moor Well and New Well. Old Town Marshes are flooded in winter to a depth of a foot or so. Any well sunk here should be situated as far from the sea as is compatible with access to the site, to avoid lowering the water level near the sea. Minimum run-off in Scilly is .20 cu. secs. per 1,000 acres
 ∴ 54,000 gallons yielded from 500 acres in 24 hrs.

Water levels in three new wells varies as much as 10 ft., indicating that ground water finds difficulty in reaching New Well. This may be due to choked fissures and a heading would therefore increase supply at well bottom. (Water is decreasing annually). This may cause pollution, therefore, it is recommended to sink a well near Aunt Joanies on the opposite side of Old Town Marshes as suggested by the Geologist Dr. Hickling.

Proposed new well - Barneys Well

Depth 26 ft. Internal diameter 6 ft. Headings at bottom for 20 ft. Height 6 ft. Width 2 ft. 6 in., to provide storage capacity of 2,000 gallons at level of 20-26 ft. below the surface as a sump. Lining of broken rock up to 1 ft. 6 in. above ground level. Pumping carried out at Aunt Joanies Well. New well in reserve with heading.

Analyses (parts per 100,000)

Quality varies. Best at Parting Carn - water level 2 ft. above H.W.M.O.S. tides *
 Storage Reservoir. Buzza Hill. 18.5.44.
 Appearance bright - few mineral particles. Turbidity - less than 5 parts per million.
 Colour - Hazen v. ft. yellow. 15 (silica scale). Odour - nil.
 Reaction pH. Acid 5.4. Free Carbonic Acid 6.6
 Electric conductivity at 20° C. 3700. Total solids, dried at 180° C. 250.0.
 Chlorine in Chlorides 116.0. Alkalinity as Calcium Carbonate 1.8.
 Hardness - Total 94.0: Temp. nil: Perm. 94.0.
 Nitrogen in Nitrates 0.64 Nitrogen in Nitrites less than 0.001
 Free Ammonia 0.0008 Ammoniacal Nitrogen nil
 Albuminoidal Ammonia 0.016 Albuminoidal Nitrogen nil
 Oxygen absorbed in 4 hrs. at 27° C. 0.205
 Metals: Iron 0.005 Zinc 0.2
 Manganese 0.055 Other metals absent

Bacteriological Results:
 No. of bacteria growing on Agar per cc. or ml. in 1 day at 37° C. - 1
 " " " " " 2 days " 37° C. - 13
 " " " " " 3 " " 20° C. - 300

Presumptive coliform Reaction: Present 10 cc.: Absent 1 cc.
 Bacteria coli. Type 1.: Present nil " 100 cc.
 Type 2.: Present 10 cc.: " 1 cc.
 Cl. welchi Reaction Present 100 cc.: " 10 cc.

Water reasonably clear and bright in appearance, is acid in reaction, deficient in Carbonate or temporary hardness, and will be plumbo-solvent and corrosive to metals. Excessively hard in character - permanent, high content of salinity causing taste, low standard of organic purity. Unsuitable for public supply.

hand bacterial

by m. Blight

+ alleged minimum yields said to be grossly overestimated



From M/H File 657/9819

108 / SV 91/18
 5

To be furnished in Triplicate

"Barney's Well"

WELLS AND BOREHOLES

20 ft. east of well named as
 "Aunt Joaney's well" on 6"
 Cornwall 87 SE/W

Information to be supplied to the Ministry of Health

SV 9138 1076

Name of District
 If the District is a Rural District, name of Contributory Place concerned
 Level of surface of ground above Ordnance Datum
 Depth and diameter of shaft or boring, or of each
 Depth or depths at which water was found
 Estimated Quantity of Water required in Gallons per day
 Yield of water in gallons per diem, as ascertained by continuous pumping during days or otherwise
 Level of water above Ordnance Datum at commencement of pumping
 Level of water above Ordnance Datum at cessation of pumping
 Time taken for water to return to original rest level after pumping ceased
 A tabulated Statement should be sent showing the quantity of water pumped in each 24 hours during the duration of the test together with the level of the water above Ordnance Datum at the end of each day. If there should be any stoppage, the reason and duration should be stated.
 Limit of deviation from vertical as specified in inches per 100 feet.
 Deviation as ascertained by measurement.
 Distances of the well or borehole from any other known wells or boreholes in the neighbourhood
 Quality. (Copies of chemical and bacteriological analyses should be annexed. Information as to the mineral constituents of the water is desirable)
 A 6" to the mile Ordnance map showing (in red) the precise situation of the well or borehole
 Date of Completion of well or borehole
 Well or borehole sunk by

St. Mary's Isles of Scilly.

10.0 O.D.

6'0" internal diam.

at 6.80 O.D.

Present about 15,000 G.P. 24 hours.

Ultimately - estimated 40,000 gals. per day.

6.80 O.D.

- 0.50 O.D.

Pumping continued to feed town (see tabulated statement).

Note: Test pumping took place after about 700,000 gals. had been pumped to waste during well sinking.

Nil.

Nil.

120 yds.

attached.

See plan note at top hereof.

8/9/1944

St. Just Engineering Co.

Signed

J. M. Light

Date

23 Dec. 1944

Normally the pumping test should be continuous over a period of 14 days. This form should be signed by the Engineer for the proposed works.

2

A description of the Strata pierced should be given as follows:-

	Thickness of each Stratum		Total depths from the surface	
	Feet	Inches	Feet	Inches
Meat Earth		6		6
Mixed China Clay	1	6	2	0
Fine China Clay and gravel.	8	0	10	0
Coarse Gravel	3	6	13	6
Mixed Coarse Gravel and decomposed granite	2 1	6 6	16 17	0 6
Hard fissured granite.		6	18	0

A Section to scale showing the size of the well or boring, strata pierced, rest level of water, and other particulars, should also be forwarded to the Ministry.

D 91839-1 500 D/d 8024 3/44 R P W

3.

^{105/5}
105/5 SV 91/18
5

1944. Barneys Well. Engineer J.H. Blight, Penzance Corporation, Municipal Buildings, Penzance. Water deficient in carbonate and corrosive to metals.

Depth 20 ft. No headings. Concrete tubes 6 ft. in diameter. Yield 15,000-20,000 g.p. day during well sinking operations. Test gauging indicated that the incoming water at a level 19 ft. below the surface was 4,000 g.p.h. Steady pumping 1,500-1,800 g.p.h. failed to lower the water below 9 ft. from the top. Immediately pumping ceased the well commenced to fill and rose 12 ft. to a point 1 ft. below normal rest-level in one hour, i.e. an average rate of over 2,000 g.p.h. The last 2 ft. rise took longer than the first 2 ft. 40,000 g.p. day expected in spite of extremely dry year.

(St. Just Engineering Co., Mancherrō Hill, St. Just, Cornwall.)

Present figures 14.8.46. (J.H. Blight).

Ground level 10' O.D. (Liverpool)

Standing water level 6.8' O.D.

Pumping water level 3.8' O.D.

Consumption 12,000-14,000 g.p. day, pumped in 6-7 hrs. supplied from granite fissures at depth - 10 O.D.

Low pH value 6.2.

6" Cornwall 87SE/W

DRAFT

4

Analysis - 1897 or 1901.

10S SV91/18
Aunt Joanes
5

Total Solid Residue -----	41.30
Combined Chlorine -----	15.90
" " (exp. as NaCl) -----	26.20
Nitrogen as Nitrates -----	0.75
Nitrites -----	absent
Saline Ammonia -----	0.009
Albuminoid Ammonia -----	0.047
Oxygen req. to oxidise the organic matter -----	0.476
Hardness (in degrees) -----	7.5°
Lead or Copper -----	absent

Observations. This water is too highly charged with organic impurities to be now safe for drinking purposes.



5
Authority Council of the Isles of Scilly **109** **SV91/18**
Date from M/H file 657/9819

Site of Well or Bore St. Mary's Island of Scilly

"Barney's well" adjoining "Aunt Joan's well" named on
Date of analysis 27. Sept. 1948. (Compton's Public Health Laboratories)

Physical Characters (appearance, etc.)

Bright: few particles of mineral & organic debris.
Colour - normal.

CHEMICAL ANALYSIS Parts per 100,000

Reaction pH	<u>Acid</u>	<u>Acid 5.5.</u>
Total Solids	<u>dried at 180°C.</u>	<u>53.5.</u>
Chlorides/Chlorine		<u>18.6.</u>
Nitrogen as Nitrates		<u>1.4.</u>
Nitrogen as Nitrites		<u>absent.</u>
Saline and free Ammonia (Amm. Nitrogen)		<u>absent.</u>
Organic Ammonia (Album. Nitrogen)		<u>absent.</u>
Oxygen absorbed in	<u>4</u> hrs. @ 27°C	<u>0.70</u>
Poisonous Metals		<u>absent.</u>
Iron		<u>0.00</u>
Temporary hardness		<u>—</u>
Permanent hardness		<u>12.5</u>
Total hardness		<u>12.5.</u>

ANALYST'S REMARKS Acid in reaction; deficient in carbonate or temp. hardness will be corrosive to metals & lead shd. be avoided. No excess of salinity; insignificant trace of iron. Satisfactory organic & bac. purity. Neutralisation of acidity could be affected by aeration & small dose of lime.

BACTERIOLOGICAL ANALYSIS

Total Colonies at 37°C in	{ 1 day	<u>12</u>	per c.c.
	{ 2 days	<u>21.</u>	
	{ 3 days	<u>90.</u>	
No. of B.Coli	<u>Absent</u> per <u>100</u> c.c.		

REMARKS
/



CSVA/IR
 5

Council of the Isles of Scilly.

Well now named Barney's Well.

AUNT JOANEY'S WELL - TEST PUMPING.

(adjoining "Aunt Joaneys Well").
 info file 657/9819.

Level of Water (O.D.)

Date	Commencement of Pumping.	Completion.	Time Started.	Time Stopped.	Total Hours.	Average quantity of gallons per hour pumped.	Total amount pumped.	Remarks.
8/9/44	6.80	0.25	4.0p.m.	-	16	1800	28,800 gals.	Water fell to 2.50 O.D. first hour and to 1.25 O.D. in 2 hours.
9/9/44	1.25	1.25	8.0a.m.	-	24	1800	43,200 "	1 hour removing Ex. Valve
10/9/44	0.25	1.25	8.0a.m.	-	24	1800	43,200 "	
11/9/44	1.25	1.25	8.0a.m.	-	24	1800	43,200 "	
12/9/44	1.25	1.25	8.0p.m.	-	24	1800	43,200 "	Engine Valve trouble.
13/9/44	1.25	1.25	8.0p.m.	5.0a.m.	21	1800	37,800 "	
14/9/44	6.70	1.00	4.0p.m.	-	16	1800	28,800 "	Overhauled valve etc.
15/9/44	1.00	0.50	8.0a.m.	-	24	1800	43,200 "	Pumping to Reservoir.
16/9/44	0.50	0.25	8.0a.m.	-	24	1800	43,200 "	4 hours per day pumped to Reservoir.
17/9/44	0.25	0.00	8.0a.m.	-	24	1800	43,200 "	
18/9/44	0.00	0.00	8.0a.m.	-	24	1800	43,200 "	
19/9/44	0.00	0.00	8.0a.m.	-	20	1800	36,000 "	Repaired rising Main.
20/9/44	0.00	0.25	8.0a.m.	-	24	2500	60,000 "	6 hours to Reservoir.
21/9/44	0.25	0.50	8.0a.m.	-	24	2500	60,000 "	
22/9/44	0.50	0.50	8.0a.m.	4.0p.m.	8	2500	20,000 "	

Note: The test pumping took place at the end of the driest summer on record. At the end of the test pumping it was necessary to pump at 4,000 gallons per hour to keep the well in fork.

19/12/1944.

J. H. Light
 Dec. 1944

SV 9130 1087

108 SV91/19
/6

St. Mary's

Pump read, Parting Garn - Hand pump.
Dates from 1896. Used for cattle watering.
Ran dry when Barney's new well was sunk 175 yds. away.
Analysis below. 26.5.44

Appearance - very faint opalescence. Slight flocculent deposit of mineral debris and amorphous silica.
Turbidity - less than 5 parts per million, silica scale.
Colour - Hazen, very faint yellow; 15. Odour - nil
Reaction pH acid 5.4. Free Carbonic Acid 4.8.
Electric conductivity at 20° C. 810. Total solids dried at 180° C. 54.0.
Chlorine in Chlorides 19.2 Alkalinity as Calcium Carbonate 0.9.
Total Hardness 13.5. Temp. 0; Perm. 13.5.
Nitrogen in Nitrates 1.2. Nitrogen in Nitrites 0.001 approx.
Free Ammonia 0.0060 Ammoniacal Nitrogen nil.
Albuminoid Ammonia 0.0052 Albuminoid Nitrogen nil.
Oxygen absorbed in 4 hrs. at 27° C. 0.095
Metals: Iron 0.010 Zinc 0.2
Others absent

Bacteriological Results:

No. of bacteria growing on Agar. per cc. or ml. in 1 day at 37° C.	2	
" " " " " " " 2 days " " "	10	
" " " " " " " 3 days " 20° C.	450	
Presumptive Coliform Reaction: Present 10 cc.;	Absent 1 cc.	
Bacteria coli. Type 1.:	" 100 cc.;	" 50 cc.
Type 2.:	" 10 cc.;	" 1 cc.
Cl. welchi reaction.	" 100 cc.	" 10 cc.

This sample is not quite clear and bright but is not unduly turbid.
Water is acid in reaction, deficient in carbonate or temporary hardness and will therefore be plumbo-solvent and corrosive to metals. Water has moderate hardness, contains no excessive salinity or metals and is of passable organic quality.
Bact. riologically it is unsatisfactory showing evidence of contamination. If used for domestic purposes it should be chlorinated.

Sited Aug. 1946. MEF.

6" Cornwall 87SE/W



1063 Wt. 22438/0384 10m 7/45 (51) F.&S.

(For Survey use only) N. 3428

RECORD OF WELL (SHAFT OR BORE)

1-inch Map Registered No.

At ISLES OF SCILLY (Parking Carn)

Town or Village St Mary's

County Isles of Scilly 6-inch quarter sheet 87 SE/W

For Mr. C NATTS

10S SV91/24
/22

Exact site of well

SV9159 1078

Attach a tracing from a map, or a sketch-map, if possible.

Level of ground surface above sea level (O.D.) ft. If well-top is not at ground level, state how far above; below; ft.

SHAFT ft.; diameter ft. Details of headings

BORE 42 ft.; diameter of bore: at top 8 ins.; at bottom 8 ins. Lengths, diameters, perforations, etc., of lining tubes 8ft bins

Water struck at depths below well top, of (feet) 60 ft

Rest-level of water 30 ft. above well-top. Suction at 70 ft. Yield on 100 gal. per h with depression to 40 ft. below well-top. Capacity of pump 150 g.p.h. Recovery to rest level in 1.10 mins. Date of measurements 28.4.50 Date of well 28.4.50

Quality of water (attach copy of analysis if available)

Well made by W. Visick & Sons, Ltd.

Information from

Additional notes in space overleaf.

(For Survey use only) GEOLOGICAL CLASSIFICATION	NATURE OF STRATA	THICKNESS		DEPTH	
		Feet	Ins.	Feet	Ins.
	If measurements start below ground surface, e.g., from bottom of an existing shaft, state how far				
	Soil	2	6		
	Brown loam	4	-		
	granite from 10ft bins to	72	-		

Continued over leaf

GEOLOGICAL SURVEY AND MUSEUM, SOUTH KENSINGTON, LONDON. S.W.7.	Date received 5.6.50	Correspondence File No.	1" N.S. Map No. 357/360	1" O.S. Map No.	Site marked (use symbol): on 1" Map on 6" Map
--	-------------------------	-------------------------	----------------------------	-----------------	---



SV 9016 1051

108

23

SV 91/25

Analysis - 1897 or 1901.

Clemmie's Well

Total Solid Residue	-----	40.95
Combined Chlorine	-----	15.50
" " (exp. as NaCl)	-----	25.54
Nitrogen as Nitrates	-----	1.03
Nitrites	-----	a faint trace
Saline Ammonia	-----	traces only
Albuminoid Ammonia	-----	0.0182
Oxygen req. to oxidise the organic matter))))))	0.1900
Hardness (in degrees)	-----	8°
Lead or Copper	-----	abs.

Observations. This water contains too much organic matter, to be desirable or safe for drinking purposes.

COPY

108 SV91/25

THE CLINICAL RESEARCH ASSOCIATION, LIMITED

23
Watergate House,
York Buildings,
Adelphi,
London, W.C.

To Dr. W.B. Addison,
St. Mary's
Isles of Scilly.

12. 8. 25.

Ref. No. 28,184.

The sample of water marked Well. (Clemmie's Well) collected on 5.8.25. and received here on 8.8.25. has been chemically examined, and I have been instructed to forward the following report:-

ANALYSIS (B).

	<u>Parts per 100,000</u>	<u>Grains per Gallon.</u>
Total solids (dried at 120°C.)	79.40	55.58
Combined chlorine	26.8.	18.7
equivalent to Na Cl.	44.2	31.0
Nitric nitrogen	0.90	0.63
Nitrous nitrogen		Faint trace.
Ammoniacal nitrogen	0.0070	0.0049
Albumenoid nitrogen	0.0336	0.0235
Oxygen absorbed in 4 hours at 27°C.	0.43	0.30
Lead or copper	Nil.	Nil.
Temporary hardness (equivalent to Ca. Co ₃)	4.3	3.0
Permanent hardness do.	16.0	11.2
Total hardness do.	20.3	14.2

The amount of organic matter in the water is very considerable, and although it is probably mainly of vegetable origin, is nevertheless objectionable and renders the water in its present state unfit for drinking purposes, unless previously purified, e.g. by boiling.

(Sgd). W.J.CURRY

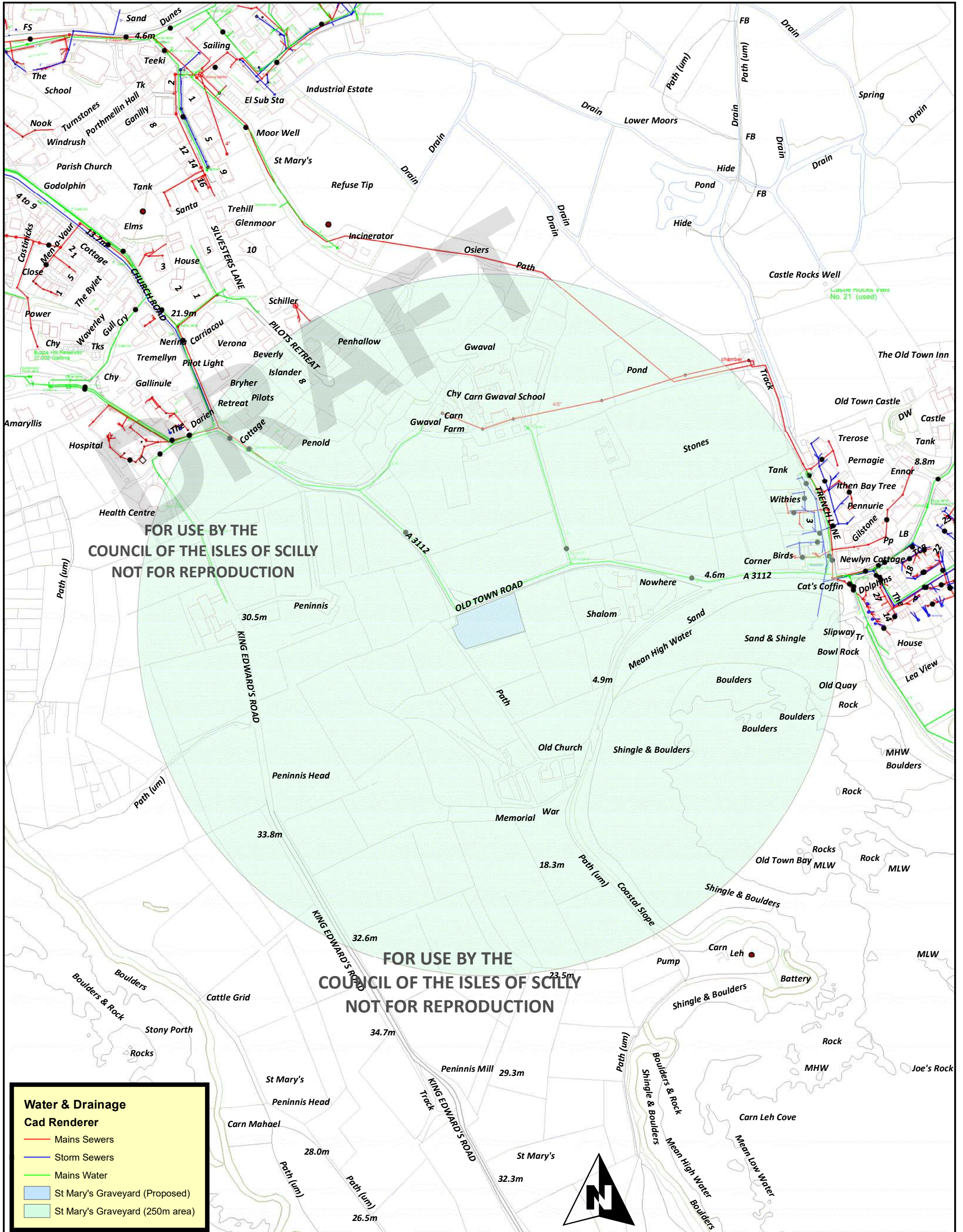
Secretary.

Appendix B

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Water & Sewerage Plan

Land on North Side of St Mary's Graveyard, St Mary's, Isles of Scilly



Appendix C

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Appendix C – Groundwater Risk Ranking

Ranking	Very Low 1-2	Low 3-4	Moderate 5-6	High 7-8	Very High 9-10
Drift Type	<u>Clay</u>	<u>Silt</u>	Silty sand	Sand/Gravel	Absent
Drift Thickness	>5 m	<u>3-5 m</u>	3 m	0-3 m	Absent
Depth to Water Table	>25 m	11-25 m	10 m	<u>5-9 m</u>	<5 m
Flow Mechanism	Intergranular	-	-	-	Fissure
Proximity to Wells	<u>>250 m</u>	-	-	-	< 250 m
Aquifer Type	Non-Aquifer	-	<u>Secondary Aquifer</u>	-	Principal Aquifer
Abstractions and SPZs	<u>None</u>	Within SPZ 3	Close to SPZ 2	Within SPZ 2	Within SPZ 1
Water courses and springs	<u>>100 m</u>	70-100 m	50-70 m	30-50 m	<30 m
Drains	<u>>100 m</u>	40-100 m	30-40 m	10-30 m	<10 m

Risk ranking for the site are underlined.

Appendix D

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Groundwater risk assessment for treated effluent discharges to infiltration systems

Infiltration Worksheet , Release v3.0


Date of Workbook Issue: March 2022

This worksheet has been produced in combination with the document: H1 Annex J5 User Manual version 2.0 (Environment Agency, 2014).

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IMPORTANT: To enable MS Excel worksheet, click the Microsoft Office Button  Excel Options, click Add-Ins. In the Manage box, select Excel Add-ins. Click Go. Select **Analysis ToolPak** and **Analysis ToolPak-VBA** (to calculate error functions)

Details to be completed for each assessment

Site Name:	St Mary's		
Site Address:	Old Town Road		
Completed by:	HW	Version:	x.xx
Date:	05-Jun-23		
Substance	Ammonium		
Environmental Standard (C _T)	0.5 mg/l	Origin of C _T :	Specify basis for standard (e.g. MRV, EQS, DWS)

This spreadsheet has been developed as a tool to assist groundwater risk assessment for effluent discharges to infiltration systems. The following worksheets are available:

- [Infiltration System](#)
- [Attenuation unsatzone](#)
- [Dilution](#)
- [Attenuation satzone](#)
- [Summary](#)
- [Simple calcs](#)

Site details entered on this page are automatically copied to each worksheet.

The worksheet uses the following colour coding:

- Worksheet option with pull down menu
- Data entry
- Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
- Data carried forward from an earlier worksheet
- Calculation

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

Infiltration Worksheet

Infiltration System



This sheet allows user to enter effluent concentration and details of infiltration system

Substance	Ammonium	From introduction sheet
Compliance value or environmental standard	C_T	From introduction sheet
	5.00E-01 mg/l	

Input Parameters

Variable	Value	Unit	Source of parameter value
----------	-------	------	---------------------------

<i>Standard entry</i>			
Concentration of substance in discharge (entering infiltration system)	C _e	1.67E+03 mg/l	
Type of treatment plant	Other		

Water use and percolation rate (for use only with septic tanks and package treatment plants)

Number of persons	p			Not valid for this treatment plant option
Water use		1.80E+02 litres/person/day		Not valid for this treatment plant option
Percolation rate	V _p		s/mm	Not valid for this treatment plant option

Specify discharge (Q1) or calculate based on use (Q2)

		Specified discharge Q1		
Discharge rate	Q1	1.30E-02	m ³ /d	
Calculated discharge	Q2	0.00E+00	m ³ /d	Value specified by user and not calculated

Area of drainage field and hydraulic loading

Specify area of drainage field or calculate based on percolation rate		Specify		
Enter area of drainage field	A	2.80E+02	m ²	
Calculated area of drainage field	A	0.00E+00	m ²	Value specified by user and not calculated
Calculated infiltration rate	Inf	4.64E-05	m/d	

Site being assessed:	St Mary's
Completed by:	HW
Date:	05-Jun-23
Version:	x.xx

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Infiltration Worksheet

Attenuation unsaturated zone



This sheet calculates attenuation factor for the unsaturated zone, concentration at base of unsaturated zone and discharge consent limit

Contaminant	Ammonium			From introduction sheet
Compliance value or environmental standard	C_T	5.00E-01	mg/l	From introduction sheet
Concentration of substance in discharge (entering infiltration system)	C_o	1.67E+03	mg/l	From infiltration sheet

Input Parameters
 Variable Value Unit Source of parameter value

Drainage Layer

Infiltration rate	Inf	4.64E-05	m/d	From infiltration sheet
Thickness of drainage layer	S_1	1.90E+00	m	
Water filled porosity	θ_1	1.50E-01	fraction	
Bulk density	ρ_1	1.07E+00	g/cm ³	
Calculated dispersivity	D_1	1.90E-01	m	calculated

Option to select degradation
 Degradation occurs - sorbed and dissolved phases
 Half life for degradation of substance $t_{1/2}$ 2.19E+03 days
 Calculated decay rate λ_1 3.17E-04 days⁻¹ calculated (very low value set if no degradation) *Calculated from half life (above)*

Enter method of defining partition co-efficient (using pull down list) **User specified value for partition coefficient**

Entry if specify partition coefficient (option)
 Soil water partition coefficient K_d1 1.50E-02 l/kg

Entry for organic chemicals (option)
 Fraction of organic carbon in soil f_{oc} 1.00E-02 fraction *Not valid - User specified value used*
 Organic carbon partition coefficient K_{oc} 1.00E+01 l/kg *Not valid - User specified value used*

Soil water partition coefficient used in assessment K_d1 1.50E-02 l/kg Specified value

Retardation factor	Rf_{u1}	1.11E+00	
Unretarded travel time (no dispersion)	t_{u1}	6.14E+03	d
Unretarded travel time (with dispersion)	t_{d1}	5.52E+03	d
Retarded travel time (with dispersion)	t_{r1}	6.12E+03	d
Attenuation factor	AF_{u1}	6.17E+00	

Unsaturated Zone

Thickness of unsaturated zone below drainage field	S_2	3.20E+00	m	
Water filled porosity	θ_2	1.50E-01	fraction	
Bulk density of unsaturated zone	ρ_2	1.07E+00	g/cm ³	
Calculated dispersivity	D_2	3.20E-01	m	calculated

Option to select degradation
 Degradation occurs - sorbed and dissolved phases
 Half life for degradation of substance $t_{1/2}$ 2.19E+03 days
 Calculated decay rate λ_2 3.17E-04 days⁻¹ calculated (very low value set if no degradation) *Default value of 1/10¹⁹⁹ used*
 Fraction of rapid flow through unsaturated zone B 1.00E-01

Enter method of defining partition co-efficient (using pull down list) **User specified value for partition coefficient**

Entry if specify partition coefficient (option)
 Soil water partition coefficient K_d2 1.50E-02 l/kg

Entry for organic chemicals (option)
 Fraction of organic carbon in soil f_{oc} 1.00E-02 fraction *Not valid - User specified value used*
 Organic carbon partition coefficient K_{oc} 1.00E+01 l/kg *Not valid - User specified value used*

Soil water partition coefficient used in assessment K_d2 1.50E-02 l/kg Specified value

Retardation factor	Rf_{u2}	1.11E+00	
Unretarded travel time (no dispersion)	t_{u2}	1.03E+04	d
Unretarded travel time (with dispersion)	t_{d2}	9.30E+03	d
Retarded travel time (with dispersion)	t_{r2}	1.03E+04	d
Attenuation factor	AF_{u2}	1.69E+01	
Total unretarded travel time	$t_{u1} + t_{u2}$	1.65E+04	d
Total retarded travel time	$t_{r1} + t_{r2}$	1.82E+04	d

Attenuation factor and discharge consent limit

Drainage layer attenuation factor	AF_{u1}	6.17E+00	
Unsaturated zone attenuation factor	AF_{u2}	1.69E+01	
Concentration at base of drainage layer	C_{db}	2.70E+02	mg/l
Concentration at base of unsaturated zone	C_{wt}	4.14E+01	mg/l
and			

Site being assessed:	St Mary's
Completed by:	HW
Date:	05-Jun-23
Version:	x.xx

Infiltration Worksheet



Dilution

Substance	Ammonium		
Compliance value or environmental standard	C _T	5.00E-01	mg/l
Source concentration	C _e	1.67E+03	mg/l
Concentration at base of drainage layer	C _{wt}	4.14E+01	mg/l

This sheet calculates the dilution factor for groundwater dilution below the drainage field. Substance concentration in groundwater and discharge consent limit

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	4.64E-05	m/d	From infiltration sheet
Area of drainage field	A	2.80E+02	m ²	From infiltration sheet

Entry for groundwater flow below site

Length of drainage field in direction of groundwater flow	L	3.50E+01	m	
Saturated aquifer thickness	da	6.00E+00	m	
Hydraulic Conductivity of aquifer in which dilution occurs	K	2.00E+00	m/d	
Hydraulic gradient of water table	i	1.00E-02	fraction	
Width of drainage field perpendicular to groundwater flow	w	8.00E+00	m	
Background concentration of substance in groundwater up-gradient of site	C _u	6.00E-03	mg/l	
		Calculate		
Enter mixing zone thickness	Mz	5.00E+00	m	Not valid - Value calculated
Calculated mixing zone thickness	Mz	3.78E+00	m	
Groundwater flow (mixing zone) below drainage field	Gw	0.61	m ³ /d	

Dilution factor and discharge consent limit

Dilution Factor	DF	47.58158991	
Headroom Factor	HF	47.02261083	
Unsaturated zone attenuation factor	AF _u	1.69E+01	From infiltration sheet
Concentration in groundwater below drainage field	C _{gw}	8.76E-01	mg/l
		or	
Environmental Permit limit value	EPL ₂	946.1909933	mg/l

Site being assessed:	St Mary's
Completed by:	HW
Date:	05-Jun-23
Version:	x.xx

Concentration immediately downgradient of drainage field exceeds target concentration

Infiltration Worksheet

Attenuation in saturated zone

Input Parameters	Variable	Value	Unit	Source
Substance				
Compliance value or environmental standard	C _t	Ammonium 5.00E-01	mg/l	From introduction sheet
Source concentration	C ₀	1.67E+03	mg/l	From introduction sheet
Dilution Factor	DF	4.76E+01		From dilution sheet
Unsaturated zone attenuation factor	AF _u	1.69E+01		From atten_unsatzone sheet
Concentration in groundwater below drainage field				
	C _{gw}	8.76E-01	mg/l	from dilution sheet
Option to select degradation				
Degradation occurs - sorbed and dissolved phases				
Half life for degradation of substance	t _{1/2}	2.19E+03	days	
Calculated decay rate	λ	3.17E-04	days ⁻¹	calculated (very low value set if no degradation)
Width of drainage field	W	8.00E+00	m	from dilution sheet
Mixing zone thickness	Mz	3.78E+00	m	from dilution sheet
Bulk density of aquifer materials	ρ	2.50E+00	g/cm ³	
Effective porosity of aquifer	n	1.00E-01	fraction	
Hydraulic gradient	i _{corr}	1.02E-02	fraction	from dilution sheet (adjusted)
Hydraulic conductivity of saturated aquifer	K	2.00E+00	m/d	from dilution sheet
Distance to compliance point	x	5.00E+01	m	
Option to select time				
Use steady state (recommended)				
Time since pollutant entered groundwater	t	1.00E+02	days	time variant optional only
Parameters values determined from options				
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	2.98E+00	m	see options
Transverse dispersivity	az	2.98E-01	m	see options
Vertical dispersivity	ay	2.98E-02	m	see options
Calculated Parameters				
Groundwater flow velocity	v	2.04E-01	m/d	
Retardation factor	Rf	1.00E+00	fraction	
Decay rate used	λ	3.17E-04	d ⁻¹	
Hydraulic gradient used in aquifer flow down-gradient	i _{corr}	1.02E-02	fraction	
Rate of contaminant flow due to retardation	u	2.04E-01	m/d	
Attenuation factor	AFs	2.07E+00	fraction	

This sheet calculates attenuation factor for the saturated zone; substance concentration at downgradient compliance point and discharge consent limit

Enter method of defining partition co-efficient (using pull down list)
User specified value for partition coefficient

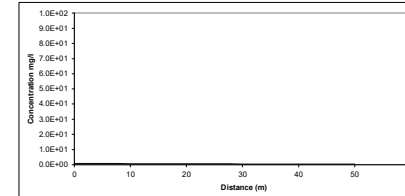
Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for organic chemicals (option)			
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Soil water partition coefficient	Kd	0.00E+00	l/kg

Define dispersivity (click brown cell and use pull down list)
Dispersivity based on Xu & Eckstein (1995)

Longitudinal dispersivity (m)	ax	Enter value	Calc value	Xu & Eckstein
Transverse dispersivity (m)	az	1.98E-12	5.99E-01	2.98E-01
Vertical dispersivity (m)	ay	1.98E-12	5.99E-02	2.98E-02

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{0.114}$; $az = ax/10$, $ay = ax/100$ are assumed
For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$



Calculated concentrations for distance-concentration graph

From calculation sheet	
Distance m	Concentration mg/l
0	8.8E-01
2.5	8.72E-01
5.0	8.52E-01
7.5	8.16E-01
10.0	7.76E-01
12.5	7.38E-01
15.0	7.02E-01
17.5	6.70E-01
20.0	6.41E-01
22.5	6.15E-01
25.0	5.91E-01
27.5	5.69E-01
30.0	5.48E-01
32.5	5.29E-01
35.0	5.12E-01
37.5	4.95E-01
40.0	4.80E-01
42.5	4.65E-01
45.0	4.51E-01
47.5	4.38E-01
50.0	4.26E-01

Site being assessed:	St Mary's
Completed by:	0
Date:	00-Jan-00
Version:	0

Attenuation and Dilution factors and discharge consent limit

Dilution Factor	DF	4.76E+01	
Unsaturated zone attenuation factor	AF _u	1.69E+01	
Saturated zone attenuation factor	AF _s	2.07E+00	
Concentration in groundwater at compliance point	C _{gw}	0.425649272	mg/l
Environmental Permit limit value	EPL ₃	1.96E+03	mg/l
Distance to compliance point		50	m

below compliance value

Discharge limit for discussion with Environment Agency

Concentration at compliance point below target concentration

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Infiltration Worksheet

Summary of calculations for concentration of substance in groundwater

No input required, values taken from previous worksheets

Summary of compliance data, attenuation and dilution factors

Substance		Ammonium	
Effluent concentration	C_e	1.67E+03	mg/l
Compliance value or environmental standard	C_T	0.50	mg/l
Distance to compliance point		50.00	m
Attenuation factor - unsat zone	AFu	1.69E+01	
Dilution Factor	DF	4.76E+01	
Attenuation factor- sat zone	AFs	2.07E+00	

Predicted concentrations at compliance point based on proposed effluent concentration

Concentration at base of unsaturated zone	C_{wt}	4.14E+01	mg/l	Attenuation in unsaturated zone only
Concentration in groundwater below drainage field	C_{gw}	8.76E-01	mg/l	Dilution taken into account
Concentration in groundwater at compliance point	C_{dcp}	4.26E-01	mg/l	Attenuation in saturated zone taken into account

Provisional Environmental Permit limit values

Based on attenuation in unsaturated zone	EPL ₁	2.01E+01	mg/l	
Based on attenuation in unsaturated zone and dilution	EPL ₂	9.46E+02	mg/l	
Based on dilution and attenuation in unsaturated and saturated zone	EPL ₃	1.96E+03	mg/l	Discharge limit for discussion with Environment Agency

