REPORT

Trawsfynydd Site

Hydrogeological Impact Appraisal for Dewatering External to, and South of, Reactor Safestore 1

Submitted to:

Pete Longley
Trawsfynydd Site
Blaenau Ffestiniog
Gwynedd
LL41 4DT

Submitted by:

Golder Associates (UK) Ltd
Attenborough House, Browns Lane Business Park, Stanton-on-the-Wolds,
Nottingham, NG12 5BL, UK

+44 [0] 115 937 1111

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APPOINTED IC REVIEW RECORD FORM		Sheet 1 of 1
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Document Title: Trawsfynydd Site: Hydrogeological Impact Appraisal for Dewatering External to, and South of, Reactor Safestore 1

Originating Organisation: Golder Associates (UK) Limited

Description: A Hydrogeological Impact Appraisal completed to support a licence application for the continued dewatering from the south side of Reactor 1 Safestore..

Document Author / Organisation / Position:	Document Verifier / Organisation / Position:
D Drury / Golder / Hydrogeologist	R Lansley/ Golder / Hydrogeologist

Scope of Appointed IC Review:

The scope of the review was the whole document.

Assessment Methodology:

Previous version B.0 were reviewed and a small number of minor comments were returned to Golder.

Appointed IC Findings:

Comments on version B.0 have been satisfactorily addressed in version A.0.

Endorsement Statement

I confirm that the work does meet the requirements of the work package and that:

1. **the technical specification and relevant safety requirements (where appropriate) have been appropriately addressed;**
2. **procedures used in undertaking the work are appropriate and have been implemented in accordance with the appropriate QA arrangements.**

Appointed IC Signature:	Date:
Name: P Longley, Appointed IC for Contaminated Land Management, IC33	27th January 2022

This form should be used to record assessment of specific items or as a record of IC activities in support of projects.

Distribution List

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1.0 INTRODUCTION

1.1 Terms of Reference

This report has been prepared by Golder Associates (UK) Limited (Golder) to support an application by Magnox Limited for a licence to abstract groundwater external to, and south of, Reactor 1 Safestore at its Trawsfynydd Site for the purpose of localised dewatering.

1.2 Background

The two reactor buildings at Trawsfynydd Site were designed with French drains on the outside of, and surrounding, their basements with the purpose of passively draining groundwater levels below the level of the basements.

Prior to March 2020 approximately 5 to 6 m^3 of water ingressed the Reactor 1 Safestore basement each week and the situation was unacceptable in terms of generation of aqueous waste. It is apparent that the drain on the south side of Reactor 1 Safestore is ineffective. Magnox therefore installed five boreholes approximately evenly spaced along the south side of, and external to, Reactor 1 Safestore to control groundwater levels. At the time, the borehole pumping scheme was envisaged to be temporary until a permanent scheme involving replacement of the French drain was designed and implemented. After some test pumping in 2020, continuous pumping started in January 2021. Whilst short-term pumping of groundwater without an abstraction licence is acceptable, Natural Resources Wales (NRW) has indicated that Magnox should now apply for an abstraction licence for the permanent abstraction of groundwater by the pumping scheme. Since the abstracted water is discharged into the surface water drainage system into which it would have flowed had the abstraction not occurred, and there is no intervening use of the water, the licence will be a transfer licence[1].

1.3 Purpose of this Report

The purpose of this report is to present a hydrogeological impact appraisal (HIA) in accordance with regulatory guidance (Environment Agency, 2007) to support a groundwater abstraction licence application.

1.4 Structure of this Report

Environment Agency (2007) explains the HIA "*methodology depends heavily on the development of a good conceptual model of the dewatering operation and the surrounding aquifer*." Section 2.0 of this report follows this introduction and presents a summary of the site-scale hydrogeological conceptual model. A conceptual model of the sub-surface south of Reactor 1 Safestore is presented in Section 5.0.

The dewatering scheme that is the subject of this HIA is described in Section 3.0. The scheme has been operating for approximately one year and the monitored effects of the dewatering are described in Section 4.0.

Section 6.0 presents the HIA in accordance with regulatory guidance.

Conclusions of the study are drawn in Section 7.0 and Section 8.0 lists documents that have been referred to.

1.5 Report Notation

The Site is the Nuclear Licensed Site and this is shown in Drawing 620/2 in Appendix A.

The site has two alternative north references; true north and 'Site' north. True north is in the direction to the geographical north on the site, and 'Site' north is made based on the 'Site Grid' orientation, where north to south is taken as the centre line through the Reactor/Safestore buildings. 'Site' north is 43° to the west of true north. Unless stated, geographical references in this report are relative to 'Site' north.

[1] As confirmed in an email dated 13 August 2021 from Charlotte Lillywhite, NRW to Sion Richards, Magnox.

2.0 SUMMARY OF THE SITE-SCALE HYDROGEOLOGICAL CONCEPTUAL SITE MODEL

The hydrogeology of the Site is well characterized following several campaigns of drilling over almost twenty-five years and routine quarterly monitoring of groundwater level and quality since late 2016. This section does not seek to reiterate the hydrogeological interpretation of the Trawsfynydd site and instead the reader is referred to Golder (2019a). What follows is an integrated conceptual model of the hydrology (including hydrogeology) of the Trawsfynydd Site illustrated with selected drawings (numbered Drawing 620/1 to 620/12 excluding Drawing 620/4 and Drawing 620/6) from Golder (2019a) reproduced in Appendix A. Drawing 620/3 is a site plan showing features relevant to groundwater including the boreholes drilled during the historical campaigns of investigation.

Rainfall at the Site is high compared with much of the UK. This, combined with the Site's proximity to Llyn Trawsfynydd (Drawing 620/1 and Drawing 620/2) which is at a higher elevation than the ground surface of the Site, means recharge to the sub-surface can be expected to be relatively high.

The sub-surface is comprised reworked Drift and made ground (Rock Fill) overlying bedrock. The Rock Fill predominates on the Site and is observed to be comprised of a range of material from large boulders to clay. The bedrock typically has low hydraulic conductivity and allows groundwater flow only where fractures are present, which typically are closer to the bedrock surface. Drawing 620/10 to Drawing 620/12 are sections through the sub-surface illustrating the bedrock, Rock Fill and main structures.

The shallow groundwater flow system can be thought of as occurring in two domains – a domain to the south of the Site where groundwater is recharged by leakage from Llyn Trawsfynydd to near surface bedrock (Drawing 620/5) and where flow can be expected to be relatively slow compared with flow in the second domain comprising the Power Station (Drawing 620/8). In the latter domain, water beneath the ground is not conventional groundwater – water flowing in the interstitial porosity of natural and made ground – but is mainly water that flows quickly across the Site through groundwater drains and surface water drains as well as through linking zones of transmissive Rock Fill above rock-head and through any transmissive features in the near-surface bedrock (Drawing 620/9).

The main flow route for groundwater across the developed Power Station part of the Site is from the area around the Cooling Ponds through an infilled trough in rock-head beneath Reactor 1 Safestore to the porous groundwater drainage pipe leading east into Manhole 6 (Figure 1 and Drawing 620/7). The intercepted water flows in a solid pipe from Manhole 6 and discharges the Site via the Diversion Culvert system (Drawing 620/7).

Water also recharges the ground south of Reactor 1 Safestore probably from leaking surface water drainage. This groundwater flows around to the east side of Reactor 1 Safestore, guided by the concrete structure of the Cooling Water Culverts and eastern Goliath Track wall towards the porous pipe leading east to Manhole 6.

The Diversion Culvert does not capture all water and some water flows north beneath the former Turbine Hall (Figure 1). Here it discharges to the pipe that runs alongside and then beneath the Cooling Water Culverts. Beyond the Cooling Water Culverts, water flows north and east. A proportion of it discharges to the ground surface on Roadway 5 where it is captured by road drains and discharged via the Northern Outlet Pipe, and some can be expected to flow in the ground to discharge in the “Gwylan” stream.

Water recharging the ground surface east of Manhole 6 flows east in Rock Fill and a proportion of it discharges to the ground surface at the break in slope east of the Main Drains Oil Interceptor and is subsequently captured by the Pwmp Dail, with the remainder expected to flow east in the ground to discharge in the Afon Tafarn-helyg (Drawing 620/2).

Groundwater levels are shown on Figure 2. Groundwater level in the near surface bedrock near Llyn Trawsfynydd is determined by the lake level, except downstream of the dams where the dams are almost completely successful in preventing the level being transmitted to the ground. Near drains that are below the water table (such as that leading to Manhole 6) and in drained Rock Fill (e.g., below Reactor 1 Safestore) groundwater levels are nearly constant. Variations in groundwater level are likewise prevented close to the springs on Roadway 5. Elsewhere groundwater levels respond clearly and quickly to rainfall. South of Reactor 1 Safestore the response appears to be accentuated by leakage from surface water drains.

The main flows of water into ground on the Site are infiltration into unpaved ground and near surface flow (in drift) from Craig Gyfynys. Of secondary importance is the upward flow from deep bedrock (of water that has recharged on Craig Gyfynys) and leakage from surface water drains. Most groundwater discharges into drains although the magnitude of this flow is uncertain since the estimate is based on a short campaign of measurement in 1997. Of secondary importance is the discharge to ground at, and flow in the ground across, the eastern Site boundary.

Groundwater is typically fresh (it has a potable level of salinity). Its major ion chemistry is naturally calcium–bicarbonate type water but winter application of de-icing salt means a trend to sodium-chloride type water develops and takes approximately three months to be washed from the ground. The groundwater is oxygenated across the Site and the percentage saturation tends to be higher where groundwater is recharged. Here the oxidation-reduction potential is also high. The pH of the groundwater is naturally slightly below neutral but rises above neutral probably because of leaching of concrete-based demolition arisings used to fill the Turbine Hall void and in areas where there have been leaks of liquid effluents to ground.

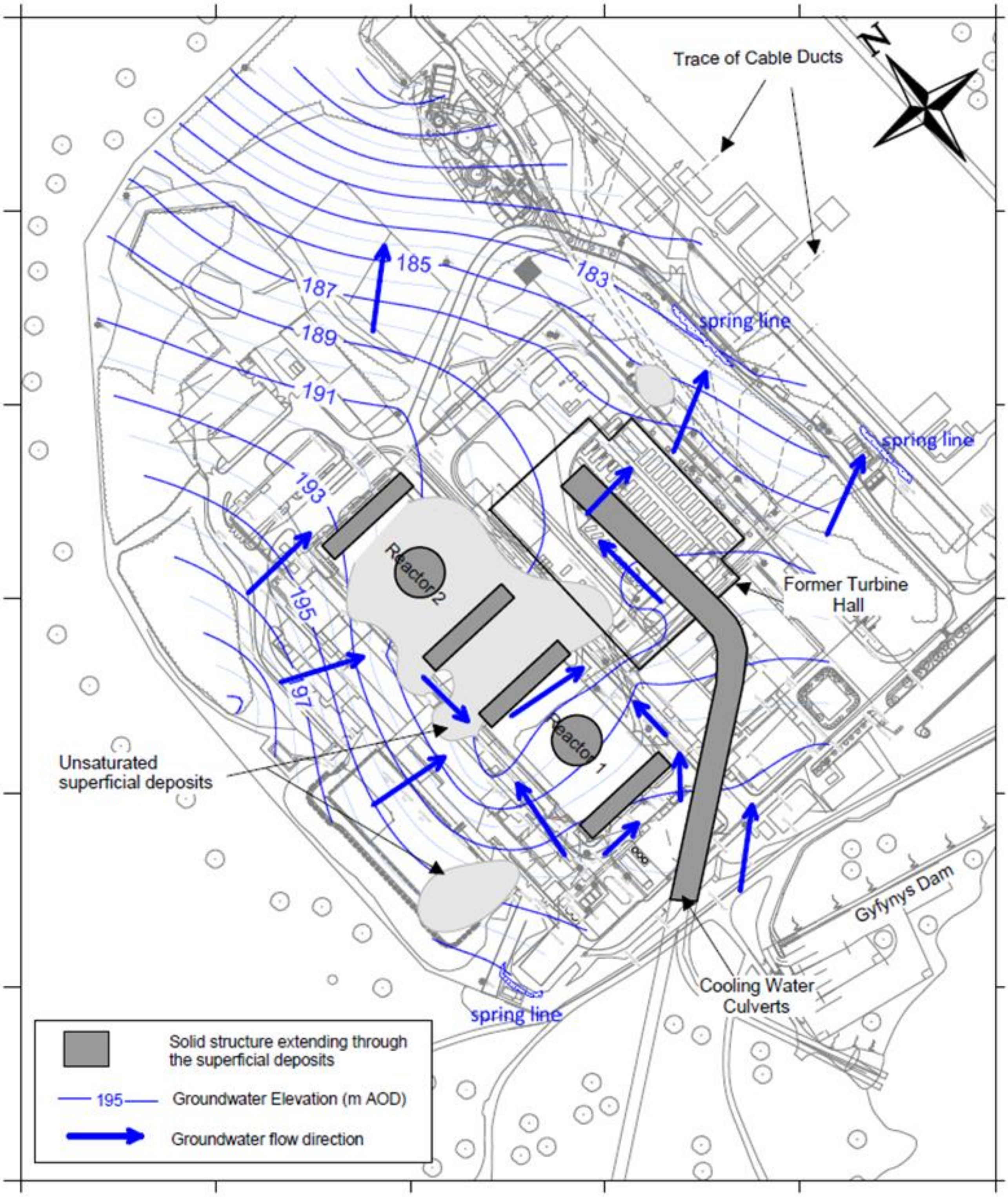


Figure 1: Main Flow of Water in Made Ground across the Site (reproduced from Figure 620/6 of Golder, 2019a)

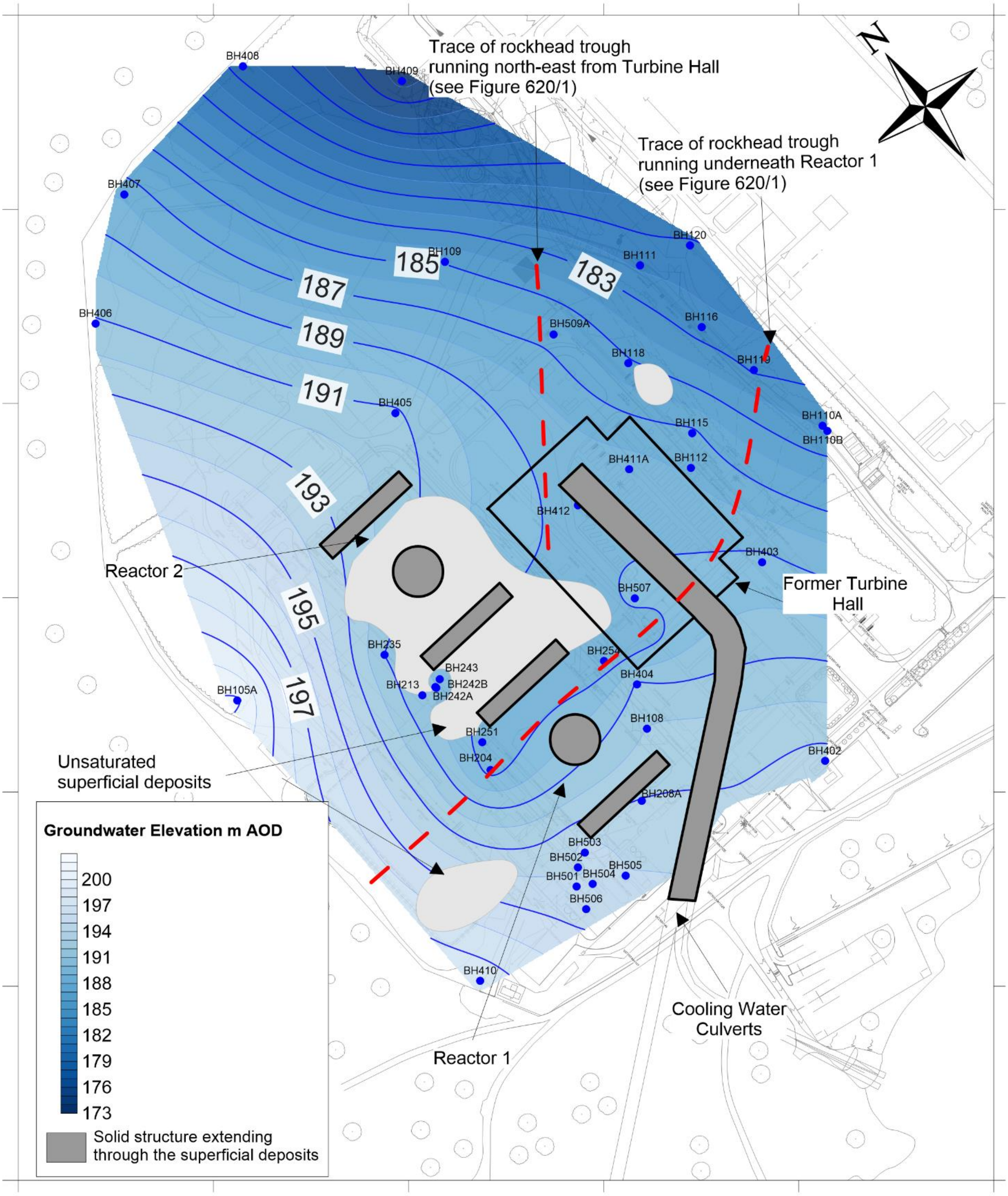


Figure 2: Groundwater Elevation Contour Plot for Superficial Deposits using November 2017 Data Supplemented with Data from November 2016 (from Golder, 2019a)

3.0 DESCRIPTION OF THE DEWATERING SCHEME

To control groundwater levels, five boreholes have been constructed approximately evenly spaced along the south side of Reactor 1 Safestore and each located approximately 1.7 m south of the external wall of the reactor. Photographs of the configuration of the boreholes, pipework and tanks are shown in Figure 3.

Figure 3: Photographs of the Dewatering Boreholes and Water Tanks

Borehole details are summarised in Table 1.

Table 1: Summary of Pumping Boreholes

Note a	BH1	BH2	BH3	BH4	BH5
Distance from the south wall of Reactor 1 Safestore to the centre of the borehole (mm)	1640	1900	1680	1750	1570
Top of gravel pack (m bgl)	3.0	3.0	3.0	3.0	2.5
Top of screen (m bgl)	3.0	3.0	3.0	4.0	3.0
Top of fractured rock (m bgl)	5.5	5.0	Not identified	Not identified	5.5
Top of competent rock (m bgl)	6.0	6.0	6.0	5.0	Not identified[b]
Pump intake (m bgl)[c]	6.2	6.2	6.2	6.2	6.2
Base of screen and borehole (m bgl)	7.5	7.5	7.5	7.5	6.2

a) *Boreholes are ordered numerically. Borehole BH1 is the most westerly and BH5 is the most easterly.*

b) *An obstruction identified at 6.2 m bgl may be the top of the very hard competent rock*

c) *The pumps draw the water level down to their injector heads. These were all initially at 6.2 m bgl (approximately 189.4 m AOD) but were lowered by 500 mm (i.e., to approximately 188.9 m AOD) on 29 June 2021.*

It is understood that when the boreholes were drilled there was no visual or olfactory evidence of contamination of the drilling arisings or the drilling flush. Asbestos was encountered in the near surface and low activity concentrations of Cs-137 (0.17 Bq/g, 0.0099 Bq/g and 0.0067 Bq/g[2]) have been detected in three of the fourteen samples of drilling flush.

During commissioning of the scheme in early 2020 groundwater was pumped to 10 m^3 above ground storage vessels before being sampled and then discharged to drains. Results of analysis of the contents of the storage tanks on six occasions between 22 January 2020 and 12 March 2020 found tritium at, or around, the limit of detection (10 Bq/l) except on one occasion when the concentration was 110 Bq/l[3]. 'Other' radionuclides detected by liquid scintillation were all at, or around, the limit of detection (10 Bq/l). There was no visual or olfactory evidence for contamination of the water.

The pumping scheme is now fully commissioned. Water pumped from each of the five boreholes is discharged to a holding tank and then flows through a plated interceptor. The plated interceptor discharges through a settlement tank and then under gravity to surface water manhole MH142 (shown in Figure 16). Once in the surface water drainage it is conveyed to MH103 and then to Llyn Trawsfynydd via an oil interceptor and the Diversion Culvert (see Drawing 620/3 in Appendix A).

[2] A benchmark for significance of these results is that material containing only radioactive caesium and with a concentration of 1 Bq/g or more is subject to radioactive substances regulation.

[3] A benchmark for significance of these results is the concentration of tritium in drinking water of 100 Bq/l when investigation of the presence of artificial radionuclides is required as set out in The Water Supply (Water Quality) Regulations 2018.

4.0 MONITORED EFFECTS OF DEWATERING TO DATE

This section summarises the results of monitoring of the dewatering that has taken place so far. Section 4.1 summarises the volume of water that has been pumped, and section 4.2 presents the pumping rate. Groundwater levels were measured outside and inside Reactor 1 Safestore before dewatering commenced and these are set out in section 4.3. The effect of dewatering on groundwater levels outside Reactor 1 Safestore are summarised in section 4.4 and the effect on the rate of inflow of water to Reactor 1 Safestore in section 4.5. Section 4.6 summarises the monitored quality of abstracted water.

4.1 Volume Abstracted

The volume of water that has been abstracted is monitored using an analogue flow meter on the piped connection between the holding tank and the plated interceptor.

Figure 4 is a plot of the cumulative volume of water abstracted. The gradient of the cumulative plot is steeper in the winter compared to the summer indicating a higher rate of abstraction over the winter.

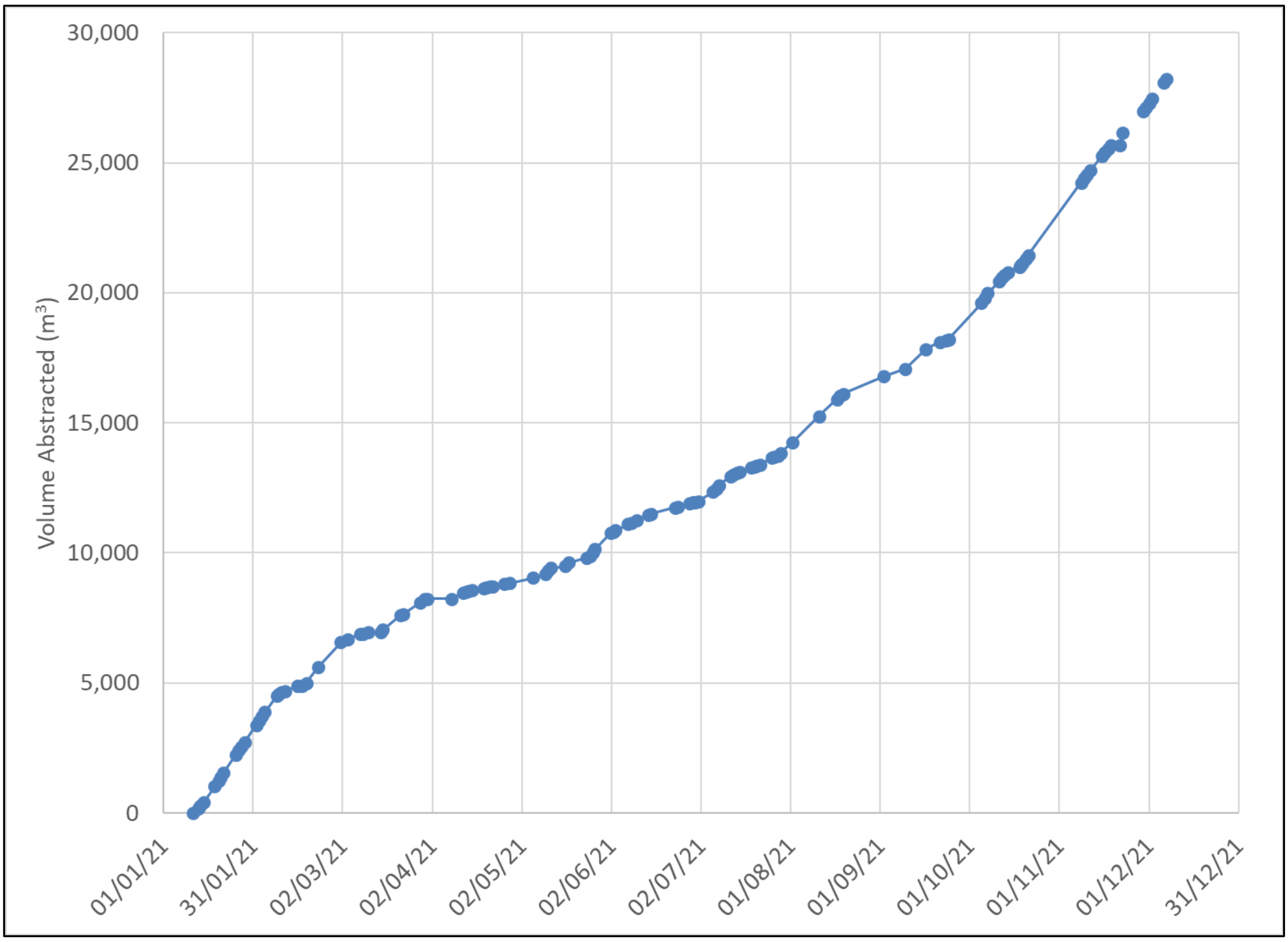


Figure 4: Cumulative Volume of Abstracted Water

4.2 Pumping Rate

From the records of volume of water abstracted, the flow rate has been calculated as the rate of change in volume since the previous reading. The flow rate is plotted in Figure 5 (with the blue line and markers).

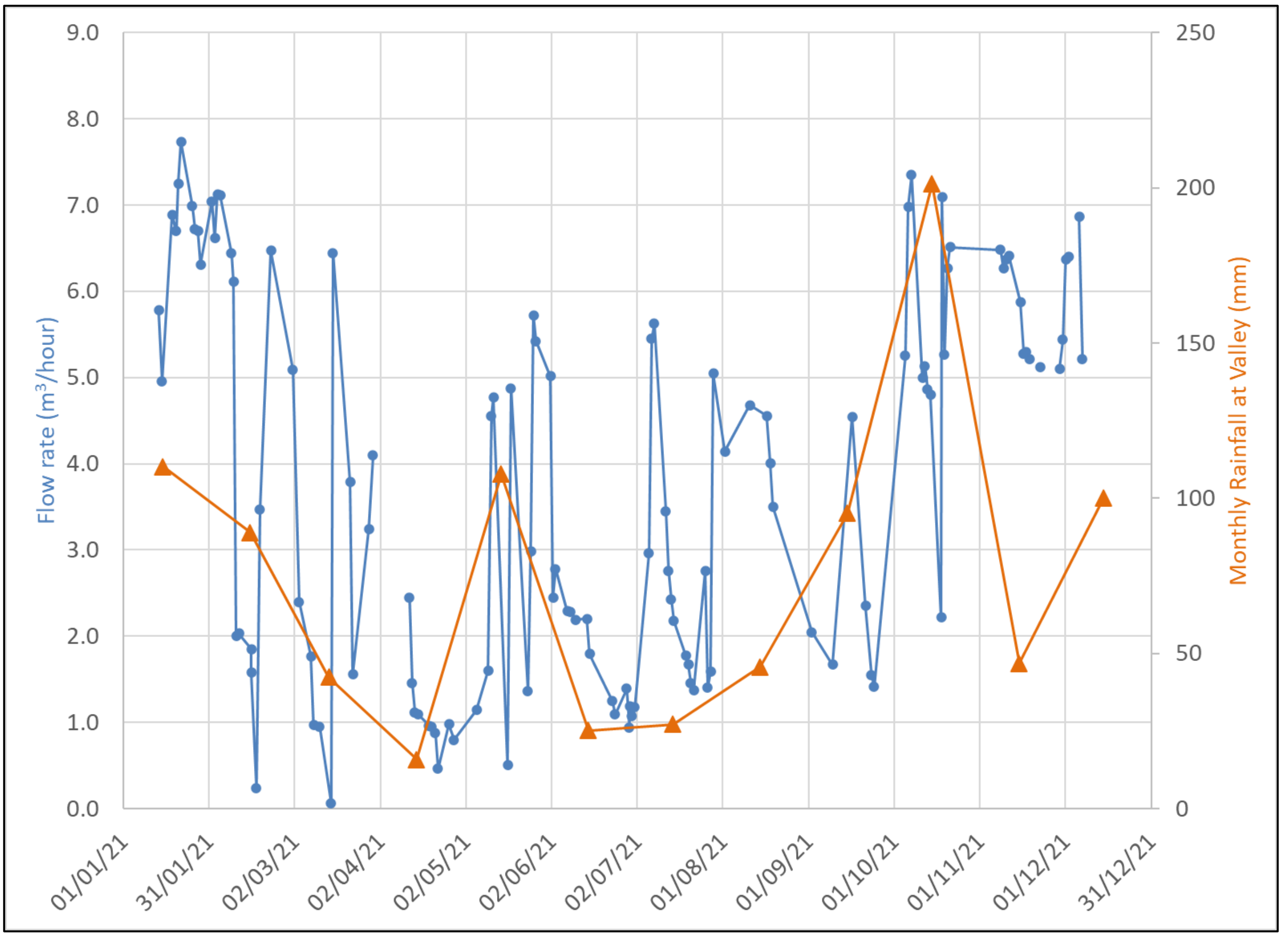


Figure 5: Flow Rate

Figure 5 shows the flow rate was highest between January and March and October and December. The flow rate fell towards the middle of the year. Also plotted on Figure 5 (with orange line and markers) is the monthly rainfall at Valley on Anglesey[4]. It is apparent from comparison of the flow rate and rainfall that the flow rate correlates with rainfall.

4.3 Baseline (Pre-pumping) Water Levels

4.3.1 Outside Reactor 1 Safestore

Groundwater levels were monitored on five occasions in the days before pumping commenced on 11 January 2021 in boreholes close to the south side of Reactor 1 Safestore. The boreholes are shown in Figure 6 and the water levels are shown in Table 2.

[4] Data obtained from https://www.metoffice.gov.uk/pub/data/weather/uk/climate/stationdata/valleydata.txt

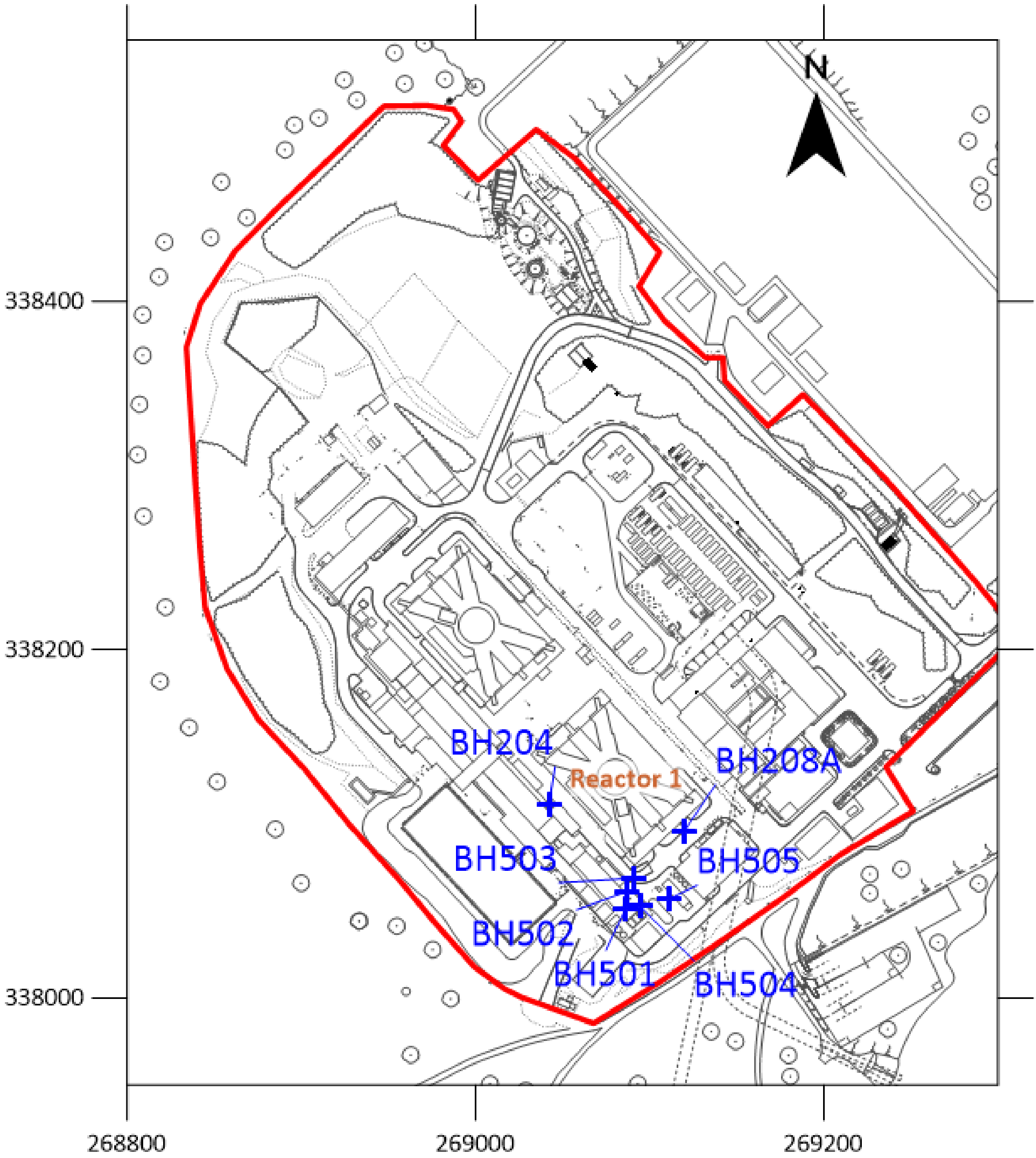


Figure 6: Locations of Groundwater Monitoring Boreholes

Table 2: Monitoring of Water Levels before Dewatering Commenced

Date	BH501		BH502		BH503		BH504		BH505		BH204		BH208A	
	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD
Datum[b]		195.49		195.60		195.68		195.63		195.57		195.62		195.49
22/12/20	- [a]	- [a]	1.55	194.05	1.13	194.55	1.08	194.55	1.56	194.01	- [a]	- [a]	2.44	193.05
04/01/21	1.32	194.17	1.90	193.70	1.19	194.49	1.52	194.11	1.58	193.99	- [a]	- [a]	2.60	192.89
05/01/21	1.32	194.17	1.90	193.70	1.20	194.48	1.54	194.09	1.58	193.99	7.08	188.54	2.65	192.84
06/01/21	1.32	194.17	1.89	193.71	1.23	194.45	1.55	194.08	1.60	193.97	7.07	188.55	2.60	192.89
07/01/21	1.29	194.20	1.92	193.68	1.24	194.44	1.56	194.07	1.58	193.99	7.05	188.57	2.63	192.86

Note a) No measurement was made.

Note b) Datums taken from Magnox (2021).

4.3.2 Inside Reactor 1 Safestore

There are seven approximately evenly spaced gullies 3 to 5 m from the inside of the south wall of Reactor 1 Safestore. Magnox (2014a) explains that alterations were made to gully No. 5 in the basement of the southeast part of Reactor 1 Safestore "*some time ago*" and a section of pipe was installed "*presumably to remove water from the ground during the works. This section of pipe remained and flow from it has been removed by pumping thereafter.*" On 31 July 2014 this basement land drain was temporarily sealed, and a standpipe installed to monitor the level of the water in the ground at this point. The results of the subsequent monitoring were documented by the Magnox Active Drains Project (Magnox, 2014b) and are reproduced in Table 3.

Table 3: Records of Water Level Monitoring Inside Reactor 1 Safestore

Date	Height of Water above Basement Floor (m)	Water Elevation (m AOD)[d]	Water Elevation (ft AOD)[d]
4 August 2014	1.400[a]	>191.71	>629.01
5 August 2014	1.400 [a]	>191.71	>629.01
6 August 2014	1.810	192.12	630.36
7 August 2014	1.800	192.11	630.32
11 August 2014	1.825	192.14	630.40
19 August 2014	1.810	192.12	630.36
1 September 2014	1.850	192.16	630.49
2 September 2014	1.830	192.14	630.42
24 September 2014	1.790	192.10	630.29
1 October 2014	1.845	192.16	630.47
6 October 2014[b]	1.955	192.27	630.83
5 November 2014[c]	1.985	192.30	630.93

Note a) Water was flowing out of the standpipe and therefore the true height of the water was greater than recorded. The standpipe was extended on 6 August 2014.
Note b) The average daily rainfall was 11.25 mm since 1 October 2014.
Note c) The measurement followed heavy rain over the previous week.
Note d) The basement floor was constructed at an elevation of 17'9" below the 642' level (i.e., 642'3" or 190.26 m AOD). It has subsequently been covered with a screed. It has here been assumed that the screed is 2" thick and the basement floor is 17'7" below the 642' level.

The data in Table 3 show that groundwater levels in the standpipe stabilized at around 192.16 m AOD (630' 6") but rose slightly higher following intense rainfall.

Magnox (2014b) explains that around the time of the water level monitoring, water was observed seeping through the floor screed and entering gullies number 1, 3 and 5 at a rate sufficient to fill the gullies over a period of a few weeks. Water was observed 'dribbling' into what is referred to as "west sump" from pipework connections.

4.4 Groundwater Levels outside Reactor 1 Safestore during Dewatering

The average groundwater levels in the monitoring boreholes before dewatering commenced has been calculated from the data in Table 2. The drawdown in groundwater level from the date that dewatering commenced has been calculated as the difference between the monitored groundwater level and the average groundwater level prior to commencement of dewatering. The drawdown in each monitoring borehole is plotted in Figure 7 along with the flow (pumping) rate (section 4.2). The graph in Figure 7 has been scaled to obscure negative drawdown values (i.e., where following commencement of dewatering groundwater levels are higher than they were before dewatering commenced).

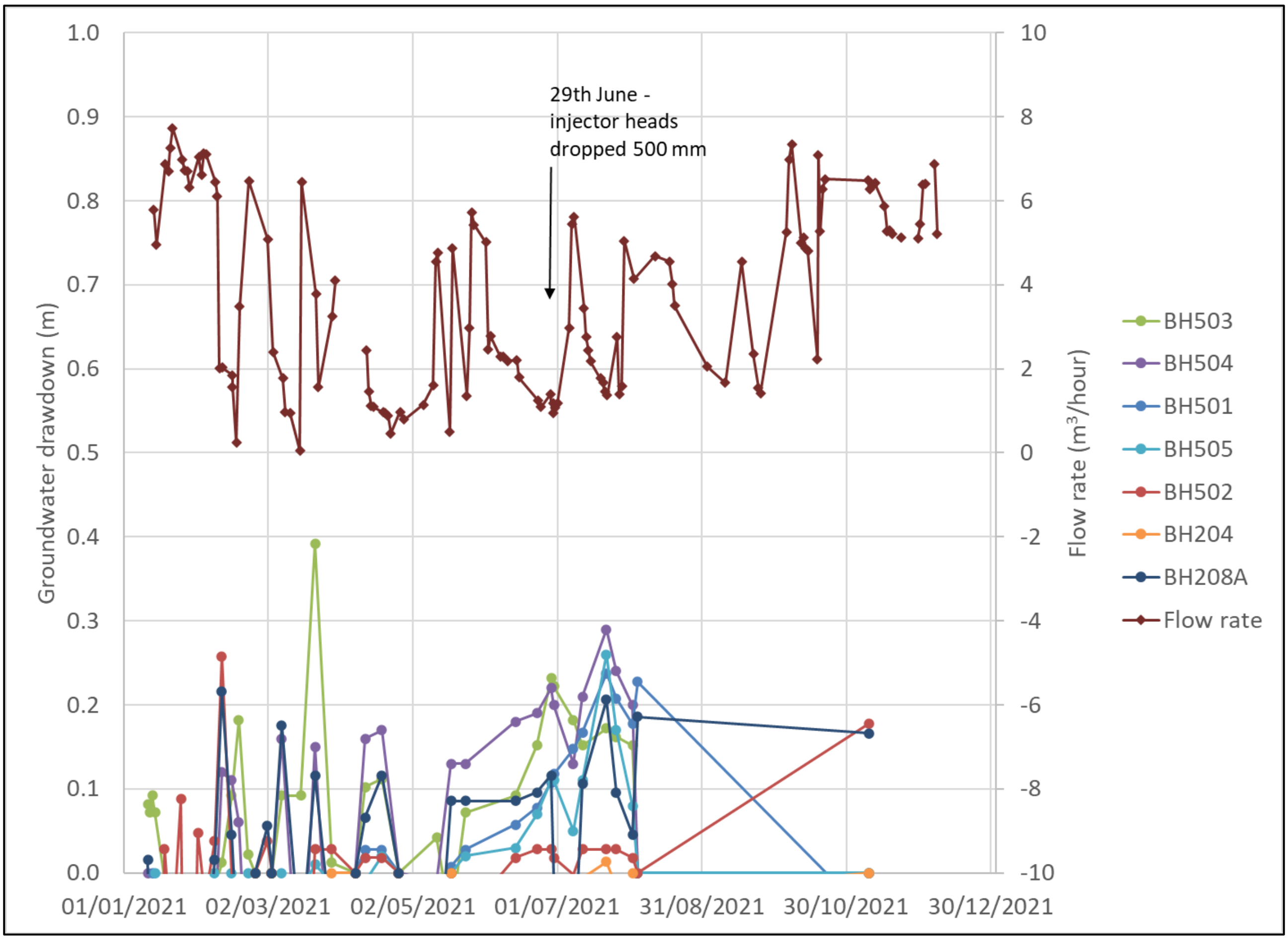


Figure 7: Dewatering Flow Rate and Groundwater Drawdown in Monitoring Boreholes

The monitored water level can be expected to be up to a few 10s of centimeter lower than the pre-pumping average water level calculated during winter due to the expected natural fall in level, particularly during the summer months. On this basis Figure 7 shows that there has been no, or negligible, drawdown in groundwater levels in the monitoring boreholes that can be attributed to the dewatering.

The monitored elevation of groundwater in BH208A, located within a few metres of the south side of Reactor 1 Safestore, is important for the development of an understanding of groundwater occurrence on the south side of Reactor 1 Safestore. The monitored groundwater elevations are plotted in Figure 8.

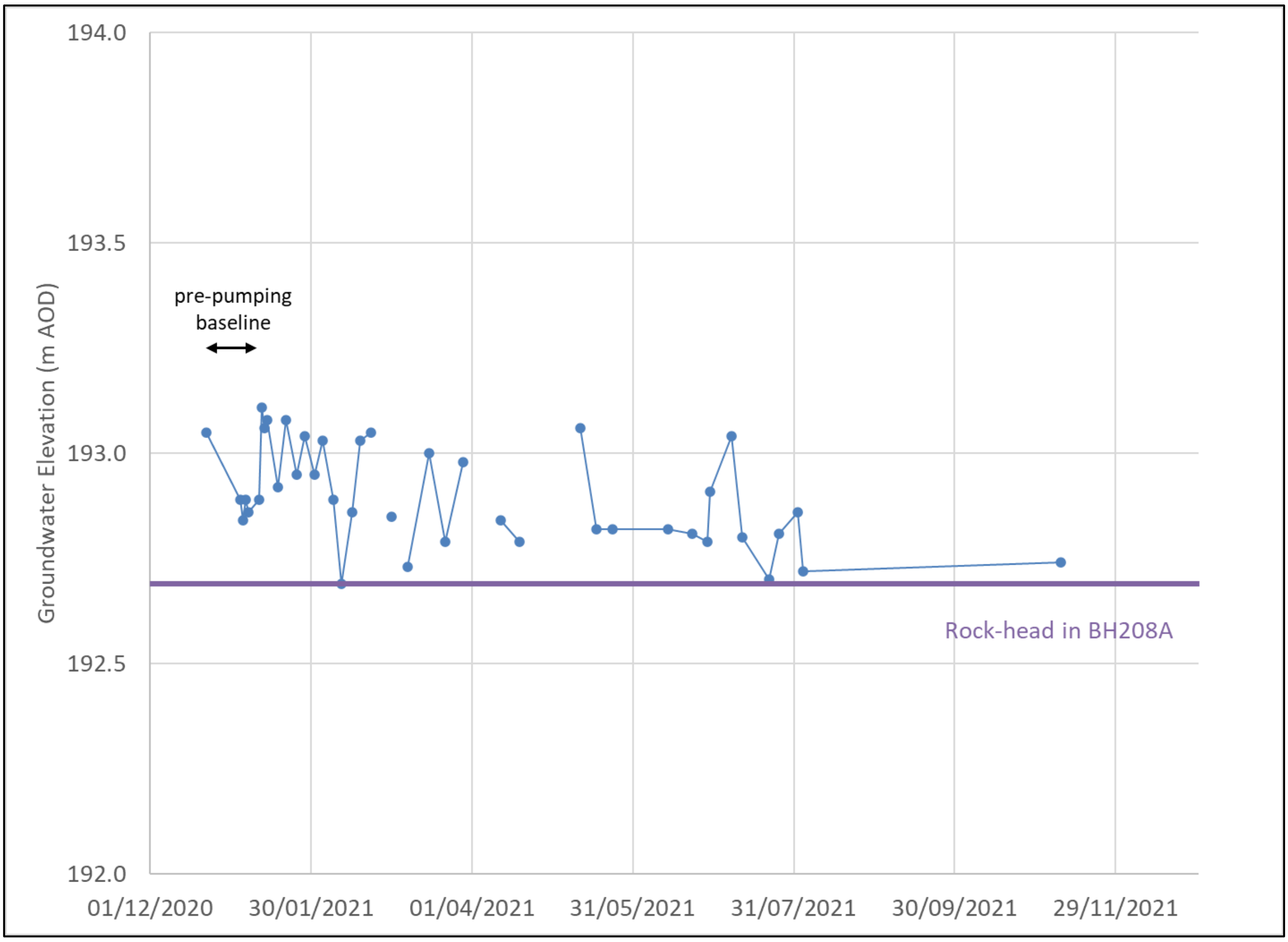


Figure 8: Monitored Groundwater Elevations in BH208A

Figure 8 shows the groundwater elevation in BH208A has remained up to a few tens of centimeters above the rock-head penetrated by BH208A before and throughout the period of pumping. There is no clear effect of the dewatering on groundwater level.

4.5 Inflow to Reactor 1 Safestore Basement

Water that enters the gullies in the basement of Reactor 1 Safestore is pumped to an Intermediate Bulk Container (IBC). The volume of water in the IBC has been monitored and the occasions when the IBC has been pumped dry have been recorded. It is therefore possible to calculate the change in volume of water in the IBC which equates to the inflow to the Reactor 1 Safestore basement. The weekly inflow to the Reactor 1 Safestore basement is plotted in Figure 9. Measurements have not been made daily throughout 2021 and the frequency of measurement introduces a degree of variability to the calculated weekly inflow volumes shown in Figure 9.

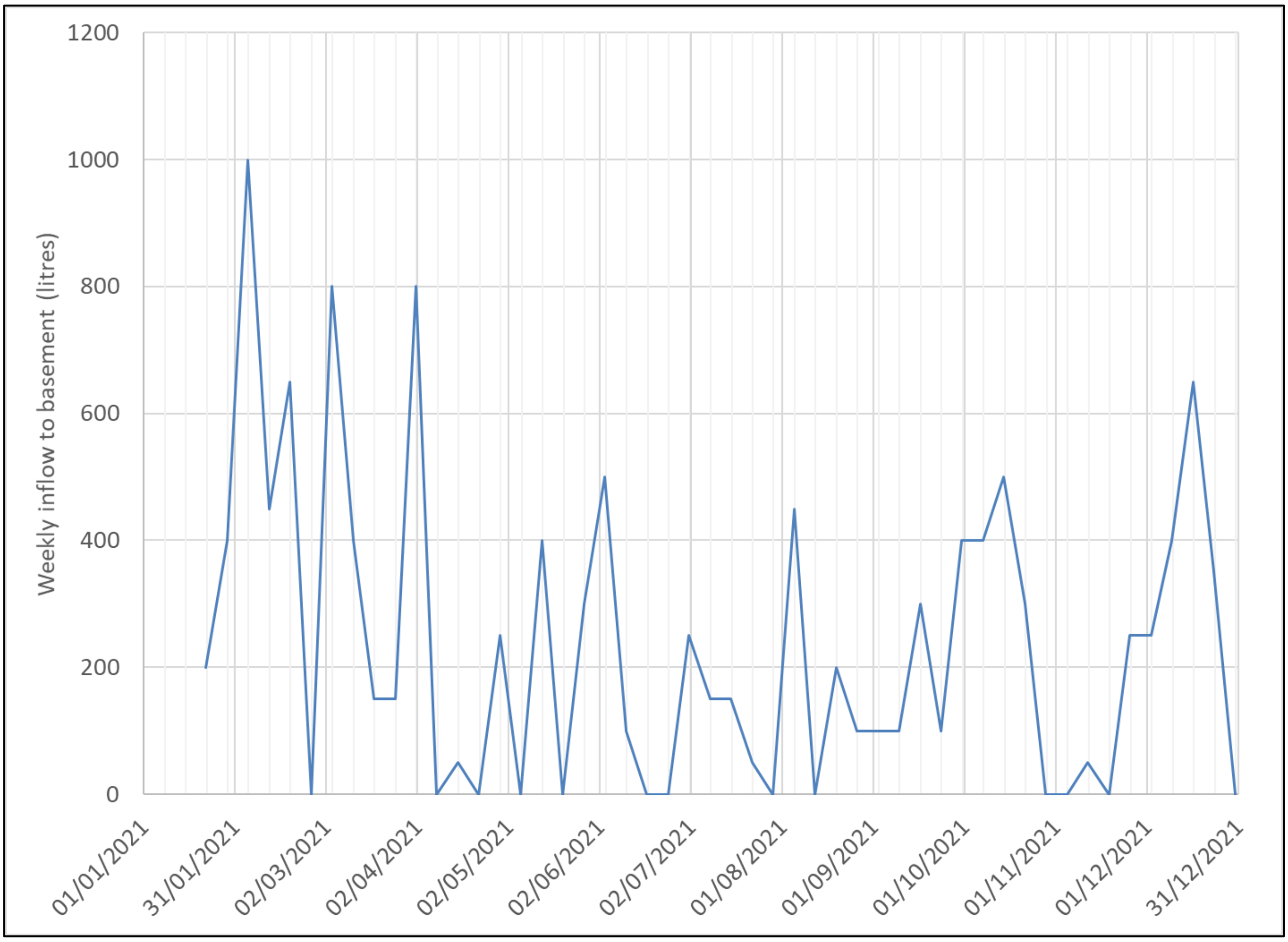


Figure 9: Inflow to Reactor 1 Safestore Basement

The general trend is of a reduction in inflow to the Reactor 1 Safestore during the first three months of pumping. Thereafter the inflow has remained lower with a weak correlation with seasonal rainfall (see Figure 5) with the December 2021 inflow slightly higher than the preceding months.

4.6 Quality of Abstracted Water

The quality of abstracted water has been monitored by measurements on site and by off-site analysis. The results on on-site measurements of turbidity, pH and radioactivity as determined by liquid scintillation counting, and observations of odour and oil sheen are set out in Table 4.

Table 4: Results of On-site Measurements of Abstracted Water Quality

Date	Turbidity (mg/l)	pH	Odour[b]	Oil Sheen[c]	Activity by Liquid Scintillation Counting (Bq/ml)[e]
11/01/2021	2.55	6.71	n/a	clear	-0.01
12/01/2021	2.58	7.07	n/a	clear	0.01
13/01/2021	2.41	6.83	n/a	clear	-0.01
14/01/2021	5.21	7.19	n/a	clear	-0.01
18/01/2021	2.60	7.44	n/a	clear	0.02
25/01/2021	1.20	7.66	n/a	clear	0.02

Date	Turbidity (mg/l)	pH	Odour[b]	Oil Sheen[c]	Activity by Liquid Scintillation Counting (Bq/ml)[e]
01/02/2021	2.35	7.23	n/a	clear	0.01
08/02/2021	3.71	7.41	n/a	clear	0.02
15/02/2021	10.38	6.98	n/a	clear	0.02
22/02/2021	5.90	6.97	n/a	clear	0.02
02/03/2021	3.10	7.40	n/a	clear	0.02
08/03/2021	1.71	6.77	n/a	clear	0.01
16/03/2021	1.89	7.06	n/a	clear	0.01
22/03/2021	2.66	7.09	n/a	clear	0.01
29/03/2021	4.46	7.19	n/a	clear	1.39[d]
08/04/2021	1.50	8.47	n/a	clear	0.00
12/04/2021	2.80	7.17	n/a	clear	0.01
19/04/2021	3.78	6.83	n/a	clear	0.01
26/04/2021	2.37	8.05	n/a	clear	0.01
12/05/2021	-[a]	-[a]	n/a	clear	-[a]
18/05/2021	2.39	8.08	n/a	clear	0.02
24/05/2021	2.94	7.21	n/a	clear	0.01
14/06/2021	3.32	6.96	n/a	clear	0.00
23/06/2021	3.08	7.02	n/a	clear	0.00
29/06/2021	12.82	7.18	n/a	clear	0.00
30/06/2021	1.92	6.87	n/a	clear	0.00
08/07/2021	1.55	6.68	n/a	clear	0.02
12/07/2021	1.53	8.00	n/a	clear	0.01
22/07/2021	2.64	6.89	n/a	clear	0.00
26/07/2021	2.19	7.11	n/a	clear	0.00
13/10/2021	4.61	7.64	n/a	clear	0.01
18/10/2021	-[a]	7.21	n/a	clear	0.01
08/11/2021	2.39	7.17	n/a	clear	0.01

Note a) Measurement was not made.

Note b) ‘n/a’ means no odour detected.

Note c) ‘Clear’ indicates that no oil sheen was detected.

Note d) This outlying result is assumed to be due to sampling or analytical error.

Note e) A benchmark for the for significance of these results, assuming the activity is due to tritium, is the concentration of tritium in drinking water of 100 Bq/l (0.1 Bq/ml) when investigation of the presence of artificial radionuclides is required as set out in The Water Supply (Water Quality) Regulations 2018.

Results of off-site laboratory of samples of abstracted water for hydrocarbon carbons by the TPH-CWG[5] methodology and for volatile organic compounds analysed by GCMS are summarized in Table 5. Table 5 shows only those volatile organic compounds analysed by GCMS that have been detected on at least one occasion (i.e., it shows only 1,1,1 trichloroethane).

Table 5: Results of Laboratory Analysis of Abstracted Water

Analyte	February 2021	25 May 2021	4 August 2021	9 November 2021
1,1,1 trichloroethane	8	4	4	4
>C6-C7 aliphatic	<100	<100	<100	<100
>C7-C8 aliphatic	<100	<100	<100	220
>C7-C8 aromatic	<5	<5	<5	15
>C8-C10 aliphatic	<100	<100	<100	202
>C8-C10 aromatic	<20	<20	<20	30
C5-C6 aliphatic	<100	<100	<100	<100
C5-C7 aromatic	<5	<5	<5	<5
>C10-C12 aliphatic	<10	<10	<10	<10
>C12-C16 aliphatic	<10	<10	<10	<10
>C16-C21 aliphatic	<10	<10	<10	<10
>C21-C35 aliphatic	<10	20	<10	<10
>C10-C12 aromatic	<10	<10	<10	<10
>C12-C16 aromatic	<10	<10	<10	<10
>C16-C21 aromatic	<10	<10	<10	<10
>C21-C35 aromatic	20[b]	<10	<10	10[b]
Benzene	<5	<5	<5	<5
Ethylbenzene	<5	<5	<5	15
m/p-Xylene	<10	<10	<10	<10
o-Xylene	<5	<5	<5	<5
Toluene	<5	<5	<5	15

Note a) All concentrations are in units of µg/l

Note b) Similar concentrations were detected in the blank samples and therefore little confidence should be placed in this concentration.

Table 5 shows that only 1,1,1 trichloroethane has been detected in the abstracted water but at concentrations well below the annual average environmental quality standard for 1,1,1 trichloroethane in freshwater (100 µg/l). Where hydrocarbon compounds or fractions have been detected the concentrations are below five times the laboratory limit of detection where laboratory analytical accuracy is poor. The reported concentrations may be ‘false positives’.

[5] Total Petroleum Hydrocarbons by the Criteria Working Group method

5.0 HYDROGEOLOGICAL CONCEPTUAL MODEL OF THE SOUTH SIDE OF REACTOR 1 SAFESTORE

This section describes the geometry of rock-head and the configuration of below-ground man-made infrastructure south of Reactor 1 Safestore (Section 5.1). The performance of the groundwater drains is described in Section 5.2 and pre-pumping water levels around the southern part of Reactor 1 Safestore in Section 5.3.

5.1 Geometry of Rock-head and Configuration of Below-ground Man-made Infrastructure

Pre-construction rock-head contours are shown in Figure 10. Figure 10 has been electronically joined from scans of Drawing A.1 of Golder (2000). It is therefore not to scale. The rock-head trough beneath the north part of Reactor 1 is evident. The rock-head on the south side of Reactor 1 Safestore is shown falling west to east from approximately 645‘ to 620‘ (196.6 m AOD to 189.0 m AOD). The current ground surface is at approximately 195.49 m AOD.

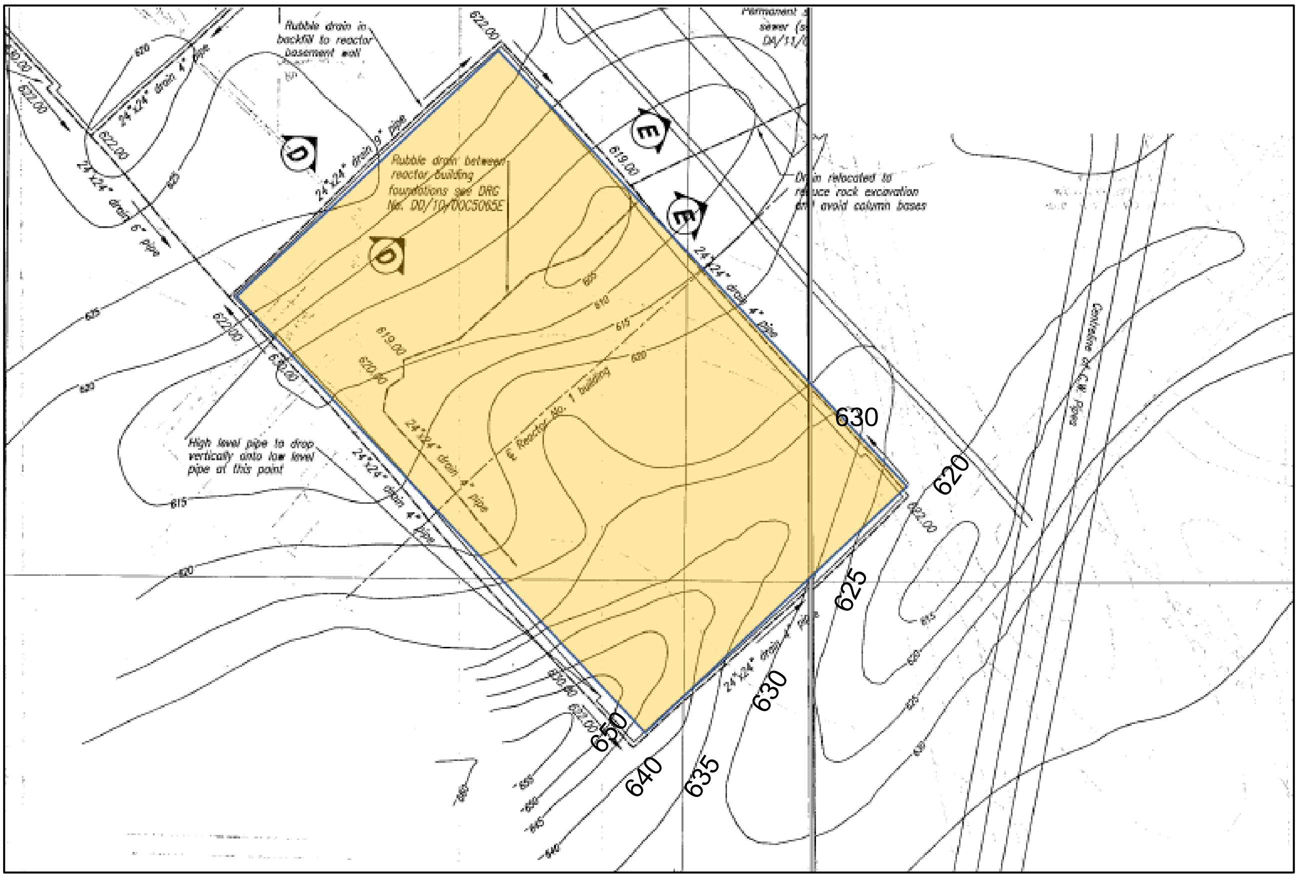


Figure 10: Pre-construction Rock-head Contours around Reactor 1 Safestore (shaded)

Figure 10 also shows the 24” by 24” drain including a 4” pipe along the external toe of the south side of Reactor 1 Safestore. Figure 11 shows a photograph of the south side of Reactor 1 during construction taken from Golder (2019a). It shows what is almost certainly the construction of the groundwater drain along the south side of Reactor 1 in progress. Beneath a scaffold platform is a wheelbarrow containing stones of fairly uniform size, similar to stone seen in the foreground, placed adjacent to the base slab of Reactor 1, as required for the groundwater drain. Beside the wheelbarrow and beneath the scaffold platform is a pale pipe lying next to the base slab, which could be the four-inch concrete pipe specified for the groundwater drain.

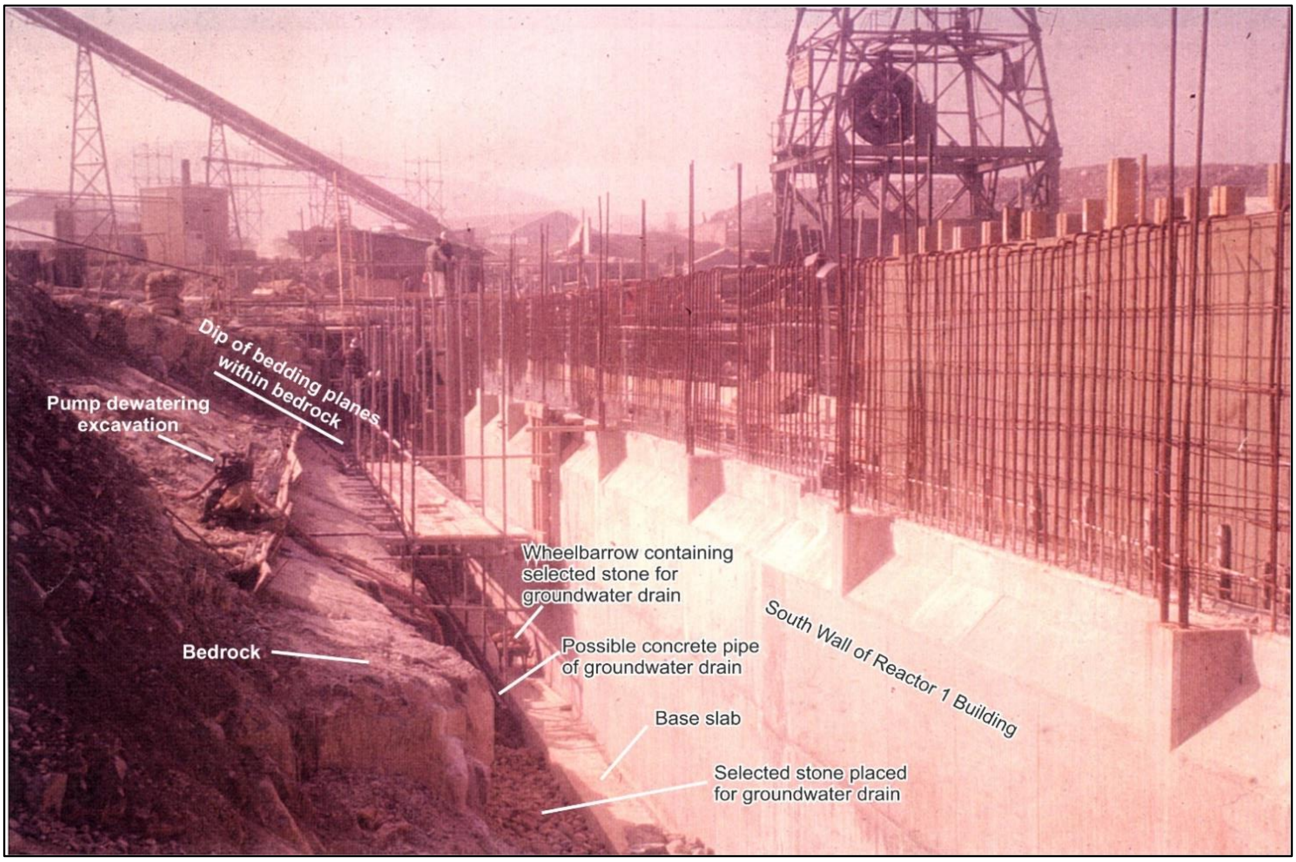


Figure 11: Colour Photograph No. 12 'Reactor 1 S Wall 1st and 2nd Lifts'

In addition to the south wall, drains at 622’ (189.58 m AOD) were specified to be installed along the north and east walls of Reactor 1. Along the west wall was specified a drain at 630’ (192.01 m AOD) that dropped into the 622’ pipe at its south and north extents (Drawing 620/7 in Appendix A).

5.2 Performance of the Groundwater Drains

Golder (2000) assesses the performance of the drains around Reactor 1 Safestore. Figure 12 is an excerpt of Drawing 620/7 of Golder (2019a)[6] that draws on Golder (2000) and shows the actual and inferred construction and function of groundwater drains around Reactor. The groundwater drain along the north side of Reactor 1 Safestore appears to perform as designed taking groundwater from west to east and then south along the drain on the east side of Reactor 1 Safestore and thence to join the Storm Drain at Manhole 6.

[6] A label and arrow pointing to BH208A has been obscured because it conflicts with the interpretation of water levels presented in this report.

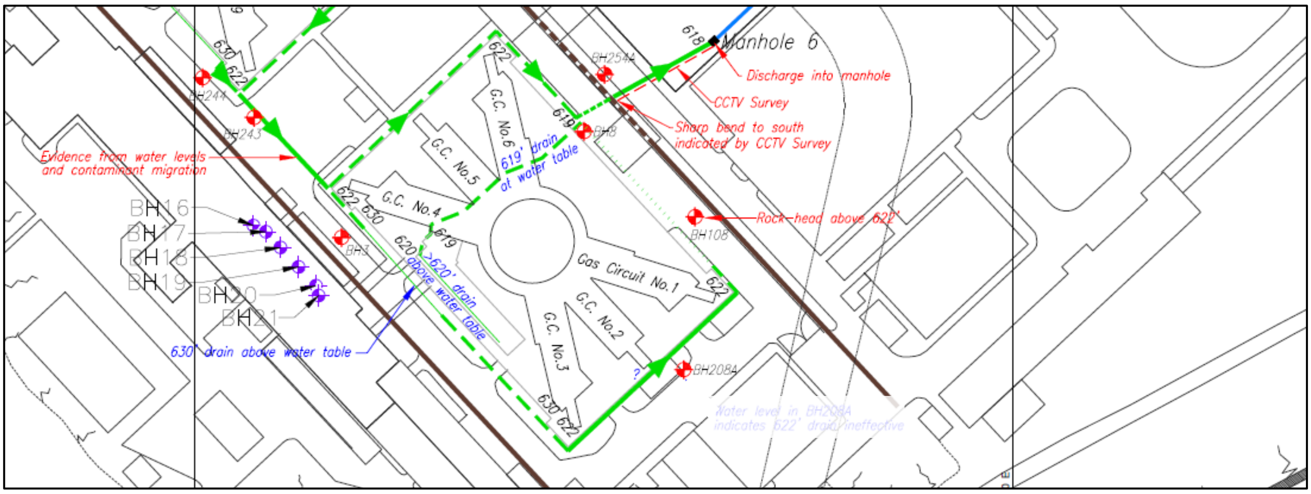


Figure 12: Plan Showing Actual and Inferred Construction and Function of Groundwater Drains (including Areas of Uncertainty)

The groundwater ingress to the Reactor 1 Safestore basement indicates that the groundwater drain along the south side of Reactor 1 Safestore is ineffective, probably because it is closed at both ends by bedrock obstructions.

5.3 Water Levels Around the Southern Part of Reactor 1 Safestore

If the typical maximum water level measured in the piezometer in Reactor 1 Safestore represents the water level in the rock fill outside the south wall of Reactor 1 Safestore, it shows groundwater was ponded against the south wall of Reactor 1 Safestore a few inches above the designed 630 feet invert level of the groundwater drain along most of the west side of Reactor 1 Safestore. This being the case, groundwater probably flows out of this ponded area along the southern part of the groundwater drain along the west side of Reactor 1 Safestore (and thence into rock fill beneath the northern part of the Reactor building). There remains the possibility that the inferred bedrock obstruction on the east side of the building is coincidently also at around 630 feet AOD (as expected by pre-construction rock-head contours, Figure 10) and this too determines the water level in the rock fill on the south side of Reactor 1 Safestore. Any flow passing this bedrock obstruction would be into rock fill to the north and east, possibly being diverted by the solid part of the Eastern Goliath track wall towards the drain leading to Manhole 6.

Boreholes constructed to investigate ground conditions around the Final Monitoring Delay Tanks and MH138/138A extend understanding of the sub-surface to the southwest of the south wall of Reactor 1 Safestore. Figure 13 is a cross section that incorporates the geological and hydrogeological information. It shows groundwater occurs in a thin saturated zone of rock fill above rock-head between the Final Monitoring Delay Tanks and the south side of Reactor 1 Safestore. The saturated rock-fill drains down the slope cut to accommodate the Reactor 1 basement where it is monitored by BH208A. Prior to dewatering commencing, groundwater ponded against the external wall of the Reactor 1 Safestore.

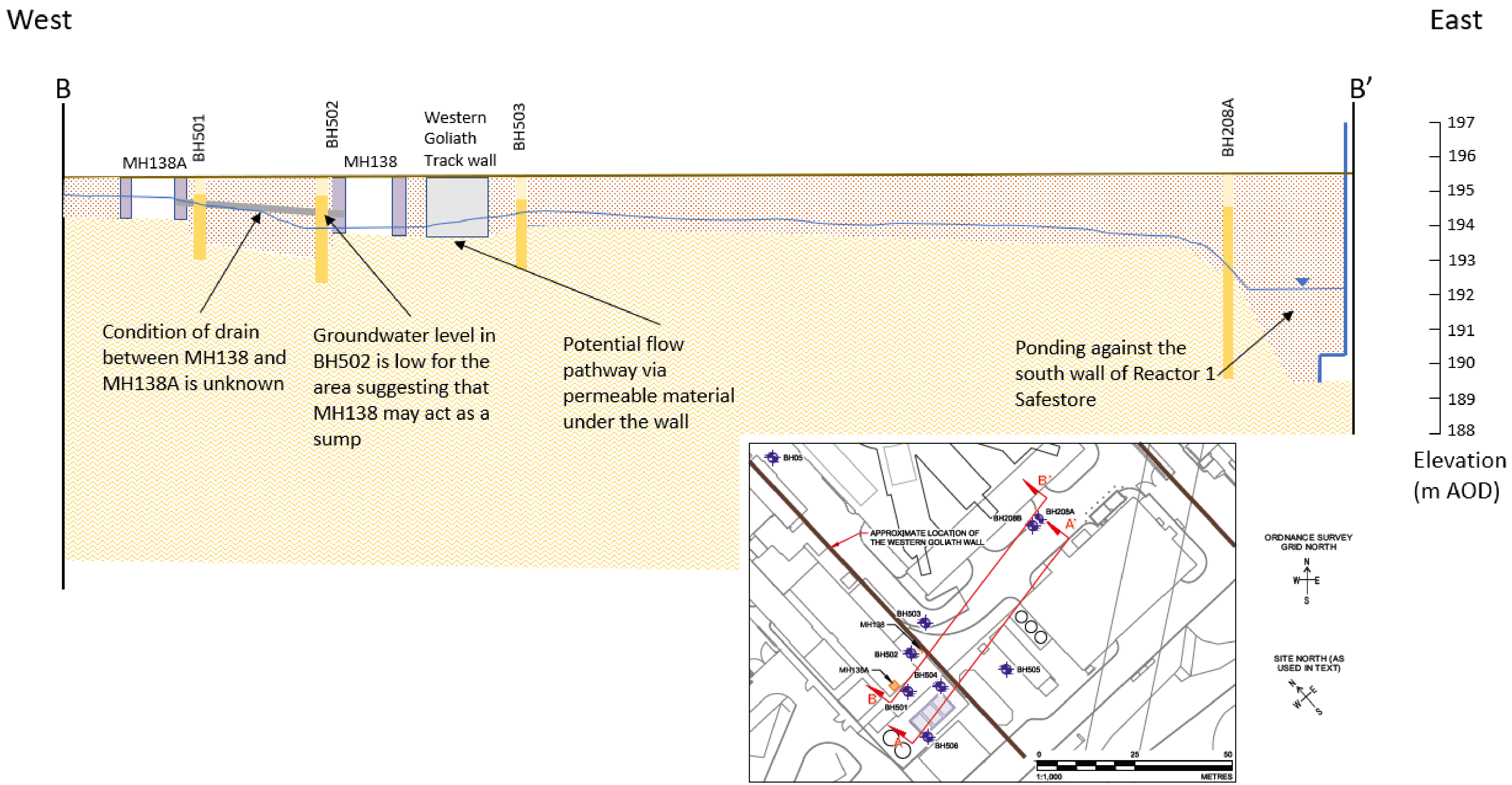


Figure 13: Schematic Sections of the Sub-surface South West of Reactor 1 Safestore

Golder (2019a) includes a hydrograph of high frequency measurements of groundwater elevation and temperature in BH208A that is reproduced as Figure 14.

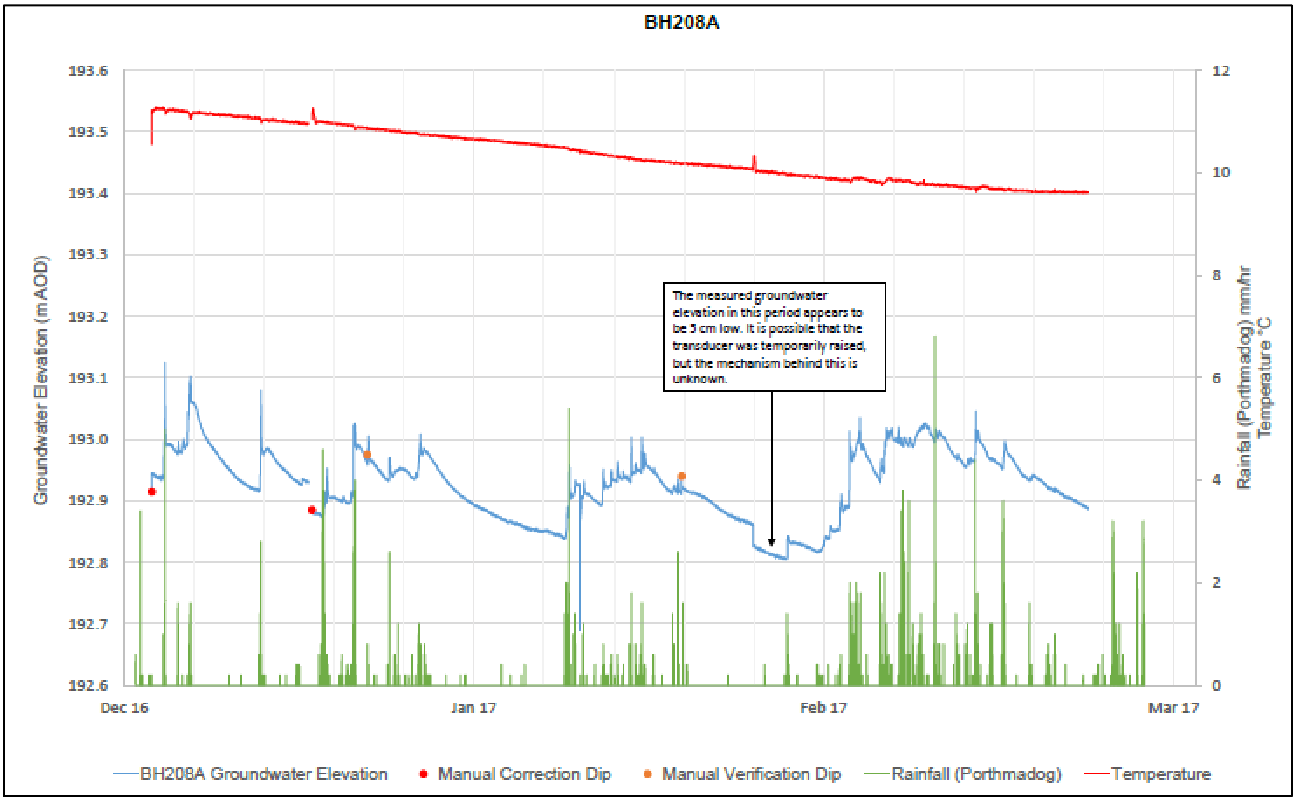


Figure 14: Hydrographs and Temperature of Groundwater Monitored in BH208A

More recent groundwater level measurements are shown in Figure 8.

Borehole BH208A is installed in rock fill and bedrock adjacent to the south wall of Reactor 1 Safestore. Its location is close to the foreground of the photograph in Figure 11. The groundwater level is in the rock fill, a few tens of cm above the rock-head (at 192.69 m AOD).

The groundwater level responds clearly and quickly to rainfall events. The response is unique in the way the water level appears to 'overshoot' at the onset of a rainfall event (i.e., the level rises quickly before quickly falling, albeit to a level that is higher than prior to the rainfall). Surface runoff entering the borehole could explain this 'overshoot', but the magnitude of the water level rise and particularly the absence of a thermal response, makes this explanation unlikely. Instead, it is postulated that the rock fill upgradient of BH208A gets quickly recharged by rainfall via drains. A possible means for this is via the "hole in drain at joint" 10.2 m from MH144 towards MH143A or other structural defects of the surface water drain between MH145 and MH142 (Golder, 2017).

Figure 15 summarises the groundwater levels and sub-surface infrastructure south of the Reactor 1 Safestore.

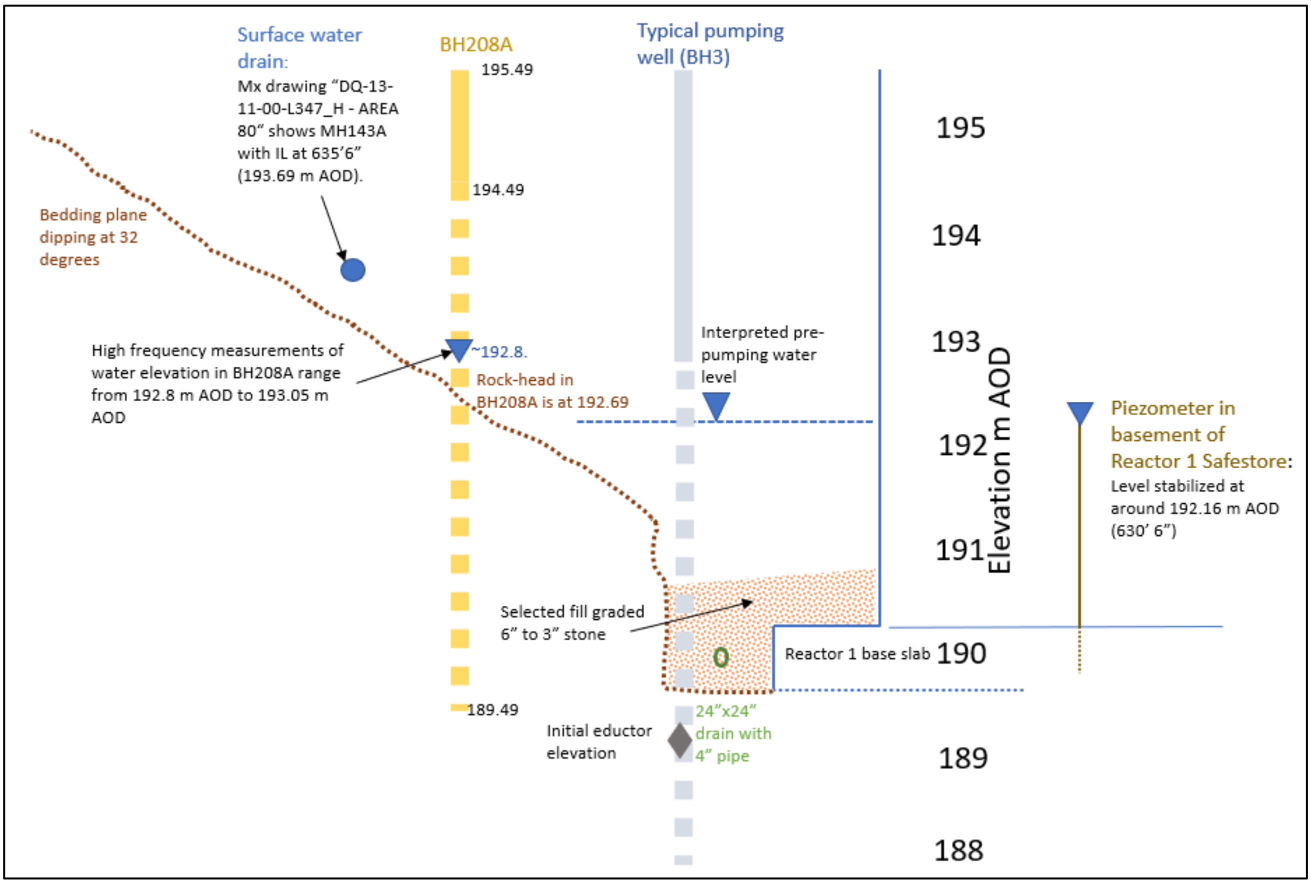


Figure 15: Groundwater Levels and Sub-surface Infrastructure South of Reactor 1 Safestore

6.0 HYDROGEOLOGICAL IMPACT APPRAISAL

In the terms of the regulatory guidance (Environment Agency, 2007) this section presents a Tier 1 (basic) HIA of the dewatering although the amount and type of information available to support the conceptual model is akin to that often required for Tier 2 (intermediate) and Tier 3 (detailed) HIA. The HIA methodology is summarised in a series of steps in Section 6.1. Subsequent sub-sections address each step, in turn.

6.1 The HIA Methodology

The HIA methodology can be summarised in terms of the following 14 steps:

- Step 1: Establish the regional water resource status.
- Step 2: Develop a conceptual model for the abstraction and the surrounding area.
- Step 3: Identify all potential water features that are susceptible to flow impacts.
- Step 4: Apportion the likely flow impacts to the water features.
- Step 5: Allow for the mitigating effects of any discharges, to arrive at net flow impacts.
- Step 6: Assess the significance of the net flow impacts.
- Step 7: Define the search area for drawdown impacts.
- Step 8: Identify all features in the search area that could be impacted by drawdown.
- Step 9: For all these features, predict the likely drawdown impacts.
- Step 10: Allow for the effects of measures taken to mitigate the drawdown impacts.
- Step 11: Assess the significance of the net drawdown impacts.
- Step 12: Assess the water quality impacts.
- Step 13: If necessary, redesign the mitigation measures to minimise the impacts.
- Step 14: Develop a monitoring strategy.

6.2 Step 1: Establish the regional water resource status

The Site is within the Llyn and Eryri groundwater body of the Western Wales River Basin District. This currently has a ‘good’ quantitative status and a ‘poor’ chemical status[7]. NRW (2016) explains the restoration objective for the chemical status is less stringent than ‘good’ because it is “Technically infeasible” because of the presence of an abandoned mine (non-coal).

Surface water is not available for abstraction from the Prysor catchment (NRW, 2015). However, the proposed groundwater dewatering scheme will not reduce the flow in nearby rivers and the availability of the surface water resource does not therefore impinge on the acceptability of the scheme.

6.3 Step 2: Develop a conceptual model for the abstraction and the surrounding area

The conceptual model for the dewatering scheme and the surrounding area is set out in Sections 2.0 and 5.0.

[7] https://waterwatchwales.naturalresourceswales.gov.uk/en/

6.4 Step 3: Identify all potential water features that are susceptible to flow impacts

Reference to Drawing 620/2 (Appendix A) shows the surface water features within 500 m of the south side of Reactor 1 Safestore are:

- Llyn Trawsfynydd;
- The "Gwylan" stream;
- Surface seepages on Roadway 5; and
- The un-named watercourse flowing off the eastern flanks of Craig Gyfynys.

The un-named watercourse flowing off the eastern flanks of Craig Gyfynys is, at its closest, approximately 380 m from the south side of Reactor 1 Safestore. It is at an elevation approximately 20 m higher than the ground surface on the south side of Reactor 1 Safestore. The stream runs on natural ground and is not fed from water in the made ground from which the dewatering will take place. It is judged that the stream is predominantly fed from surface water run off Craig Gyfynys and interflow (water that has flowed in the near surface soil to discharge in the stream). The un-named watercourse flowing off the eastern flanks of Craig Gyfynys is therefore not susceptible to flow impacts.

Llyn Trawsfynydd, the "Gwylan" stream and surface seepages on Roadway 5 are potentially susceptible to flow impacts.

6.5 Step 4: Apportion the likely flow impacts to the water features

In the absence of dewatering, most groundwater flow around the south side of Reactor 1 Safestore enters the surface water drainage system around manhole 6. This water is discharged from the Site to Llyn Trawsfynydd via the Diversion Culvert system[8], except in flood conditions when water is permitted[9] to overflow the pump sumps into the "Gwylan" stream. The groundwater that does not enter the water drainage system around manhole 6 leaves the ground on Roadway 5 from where it flows in drains to discharge from the Site via the Northern Outlet Pipe[10].

It is judged that the flow impacts to the identified water features are apportioned as follows:

- Llyn Trawsfynydd: 97%.
- The "Gwylan" stream: 1%.
- Surface seepages on Roadway 5: 2%.

6.6 Step 5: Allow for the mitigating effects of any discharges, to arrive at net flow impacts

Water that is abstracted from the south side of Reactor 1 Safestore is discharged to manhole MH142 from where it flows to manhole MH103 (Figure 16), where it meets flow from MH6 from which it mostly would otherwise have flowed. The consumptiveness of the dewatering operation is zero.

The discharge arrangements for the dewatering scheme mean that some of the water that would otherwise pass beneath the Turbine Hall basement to discharge on Roadway 5 may be intercepted and transferred to drains that feed the Diversion Culvert system. The reduction in flow at the surface seepages on Roadway 5 is judged to be 2% of the total flow impact. The typical abstraction rate has been around 100 m^3/day and on this basis the

[8] Permit number CG0087701.

[9] Permit number CG0409101.

[10] Permit number CG0409001.

net flow impact on the surface discharges on Roadway 5 is around 2 m^3/day. This flow will be transferred to Llyn Trawsfynydd and the “Gwylan” stream where there will be a small (around 2 m^3/day) positive net flow impact.

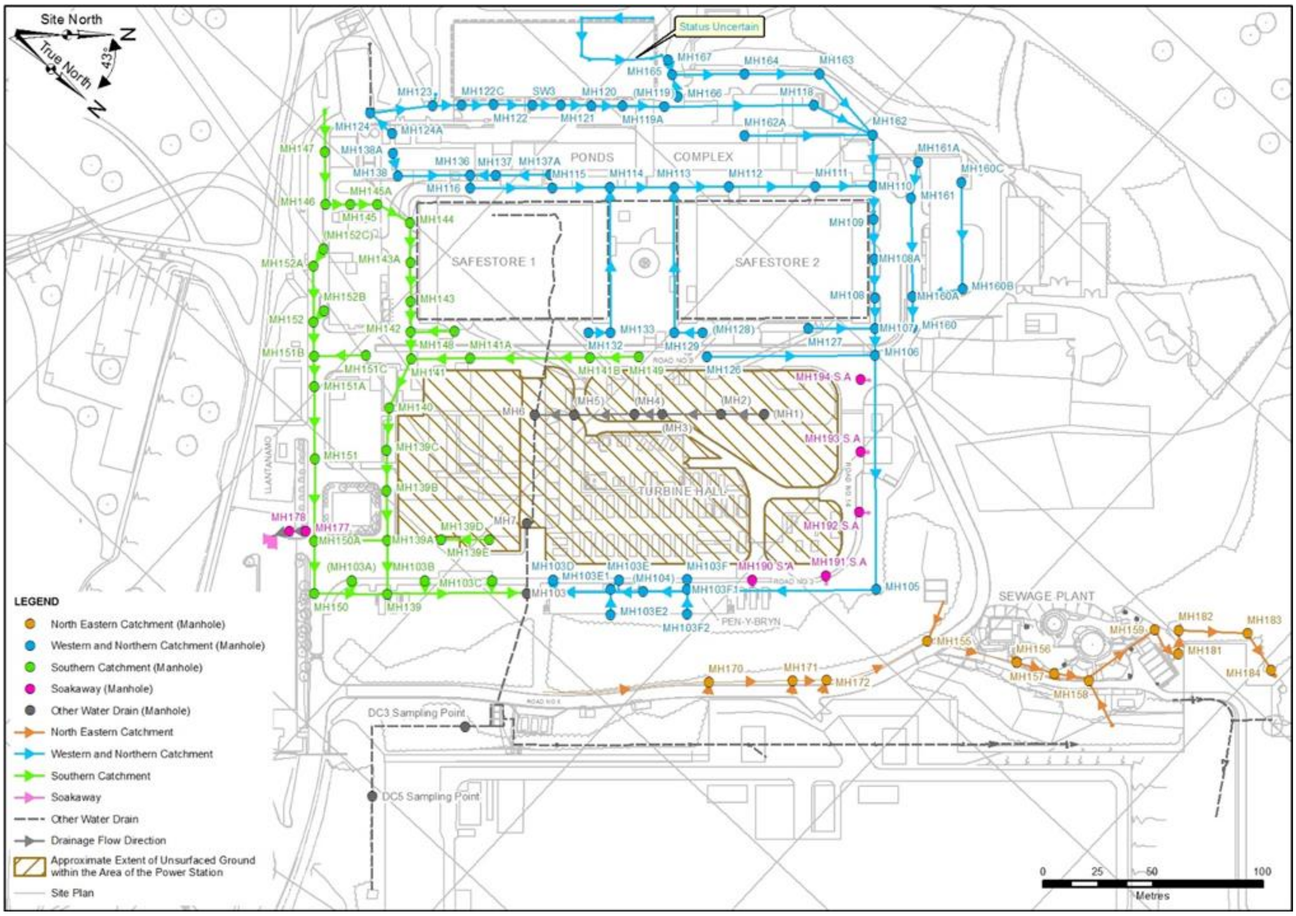


Figure 16: Surface Water Drainage Catchments

6.7 Step 6: Assess the significance of the net flow impacts

The dewatering scheme is not consumptive. There is a small positive net gain in flow to Llyn Trawsfynydd and, in flood conditions, to the “Gwylan” stream. Given the scale of Llyn Trawsfynydd and the typical flow in “Gwylan” stream (2.5 litres/second or 216 m^3/day, Golder, 2019a) the net gain is judged not significant. There is a small negative net flow (2 m^3/day) to the springs on Roadway 5. The spring water is collected and discharged via the Northern Outlet Pipe. Flow in the stream flowing off Craig Gyfynys via the Northern Outlet Pipe discharges is visually judged to be less than that in the “Gwylan” stream. Nevertheless, the small reduction in flow is not judged significant.

6.8 Step 7: Define the search area for drawdown impacts

Before pumping started the search area for drawdown impacts was defined as approximately 50 m.

6.9 Step 8: Identify all features in the search area that could be impacted by drawdown

The following ground monitoring boreholes are located within 50 m of the pumping wells and were selected for monitoring before and after pumping commenced (section 4.3.1):

- BH501;
- BH502;
- BH503;
- BH504;
- BH505;
- BH204; and
- BH208A.

There are no natural water features within 50 m of the pumping wells.

6.10 Step 9: For all these features, predict the likely drawdown impacts

Pumping commenced on 11 January 2021 and groundwater level monitoring in the boreholes listed in section 6.9 has been carried out since. The results are presented in section 4.3.1. Drawdown of water levels has not been observed in any of the monitoring boreholes.

The hydrogeological conceptual model of groundwater occurrence on the south side of Reactor 1 Safestore is of water ponded in made ground between the reactor wall and a northward dipping bedding plane that forms the south side of the excavation made to accommodate the reactor basement. The elevation of the groundwater drain on the west side of Reactor 1 Safestore and possibly a rock-head obstruction at the south east corner of Reactor 1 Safestore determines the elevation of water in the 'pond'. The 'pond' is replenished by groundwater flow through the made ground from the south and southwest that flows down the bedding plane on the south side of the former excavation. The dewatering scheme keeps the 'pond' empty. The dewatering does not extend the drawdown further than the extent of the 'pond'. Groundwater drawdown beyond the immediate confines of the outside of the south wall of Reactor 1 Safestore has not been observed and is not expected.

6.11 Step 10: Allow for the effects of measures taken to mitigate the drawdown impacts

The dewatering keeps a volume of made ground immediately adjacent to the outside of the south wall of Reactor 1 Safestore dry. Since drawdown has not extended beyond the 'pond' and is not expected in the future, mitigation is not required.

6.12 Step 11: Assess the significance of the net drawdown impacts

The dewatering scheme is meeting its objectives and has no net drawdown impacts on water features. Net drawdown impacts are not deemed to be significant.

6.13 Step 12: Assess the water quality impacts

The dewatering does not affect the hydraulic gradient beyond the made ground immediately adjacent to the south wall of Reactor 1 Safestore. It does not therefore change the natural water quality or the distribution of contamination. The pumped water has been monitored and found to be clear, without odour, free of visible oil and with a pH around neutral. Aside one outlying result that is assumed to be a sampling or analytical error, it has been demonstrably free of radioactivity. It has not contained any unexpected hydrocarbon compounds and volatile organic compounds. The compound that has been repeatedly detected, 1,1,1-trichlorethane, is at concentrations well below its environmental quality standard (section 4.6). Its occurrence is well characterised and understood (Golder, 2019b).

The dewatering will have no impact on the quality of groundwater bodies or surface water and will therefore not affect their chemical status.

The water quality impacts of the dewatering are judged insignificant and therefore acceptable.

6.14 Step 13: If necessary, redesign the mitigation measures to minimise the impacts

The environmental impacts of the dewatering are acceptable. Mitigation measures are not required, and redesign is therefore not required.

6.15 Step 14: Develop a monitoring strategy

The hydrogeological conceptual model for the dewatering scheme is well understood and water flow, water level, and water quality impacts are judged to be negligible as demonstrated by monitoring to date.

Guidance (Environment Agency, 2007) explains that monitoring should be risk based and focused on the water features that have been identified as being susceptible to flow and drawdown impacts. Given that no water features are identified as being at risk and the drawdown and flow impacts of the dewatering are judged to be negligible, no monitoring is required.

7.0 CONCLUSIONS

This hydrogeological impact appraisal of the dewatering on the south side of Reactor 1 Safestore at Trawsfynydd has found:

- Groundwater conditions have been well characterised and are well understood;
- The pumping dewaters a ‘pond’ of groundwater in made ground immediately adjacent to the south wall of Reactor 1 Safestore bounded by a northward dipping bedding plane to its south and rock-head obstructions to its east and west;
- The extent of drawdown of groundwater levels is limited to within the ‘pond’ and well constrained by monitoring data;
- There are no sensitive water features at risk;
- The scheme, in effect, intercepts the natural flow of groundwater to site drainage and transfers the intercepted water to a downgradient point in the site drainage to which it would have otherwise flowed;
- Flow to Llyn Trawsfynydd, the “Gwylan” stream and the spring on Roadway 5 is not significantly affected by the transfer; and
- The scheme does not affect water quality and contamination is not mobilised by the dewatering.

Given that no water features are identified as being at risk and the drawdown and flow impacts of the dewatering are judged to be negligible, no monitoring is required.

8.0 REFERENCES

1) Environment Agency, 2007. Hydrogeological impact appraisal for dewatering abstractions. Science report – SC040020/SR1. April 2007.

2) Golder, 2000. Groundwater Flow and Contamination Investigation, Trawsfynydd Power Station: Summary and Interpretation of Information Relating to Groundwater Drains. 99524717/1. July 2000.

3) Golder Associates (UK) Limited, 2017. Trawsfynydd Decommissioning Site. Desk based preparatory works for Scope Element 2 – land contamination from surface water drains. 1660433.513/A.0. May 2017.

4) Golder Associates (UK) Limited, 2019a. Hydrogeological Interpretation 2018. 1780044.620/A.2.

5) Golder Associates (UK) Limited, 2019b. Trawsfynydd Site. Interpretive Report for the Site Investigation of the Final Monitoring Delay Tanks (APC-20 and APC-21) and MH138/138A (APC-36). 1780044.622/A.0. March 2019.

6) Magnox Limited, 2014a. Reactor Building 1 – Observations of Ground Water Level in R1 South Basement. TRAWS/EAN/14/099. Issue 1. August 2014.

7) Magnox Limited, 2014b. 1 Safestore South -17' Basement, Ground Water Monitoring Record. File note in Active Drains Project 22034. Safestore basement sumps and gullies.

8) Magnox Limited, 2021. Magnox Groundwater Monitoring Results [2016 – to Present]. Data Reported from IMAGES on 16 August 2021.

9) Natural Resources Wales, 2015. Lleyn and Eryri Catchment Abstraction Management Strategy.

10) Natural Resources Wales, 2016. Lleyn and Eryri Management. Catchment Summary.

Signature Page

Golder Associates (UK) Ltd

David Drury
Hydrogeologist

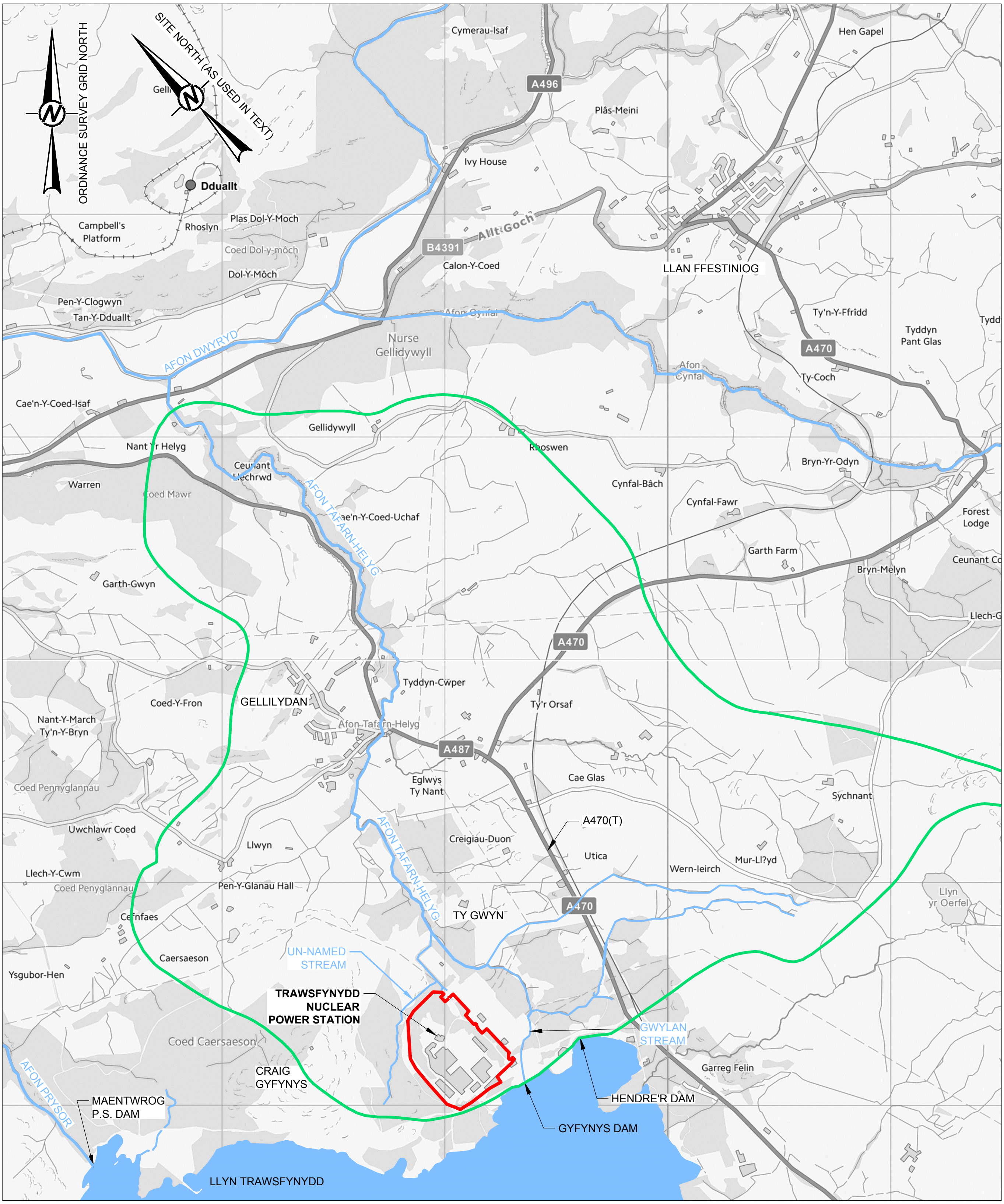
Richard Lansley
Hydrogeologist

Date: 27 January 2022

DD/RL/ab

APPENDIX A

Drawings from Golder (2019a)



LEGEND

- NUCLEAR LICENSED SITE BOUNDARY
- MAJOR WATERCOURSES
- MINOR WATERCOURSES REFERRED TO IN THIS REPORT
- APPROXIMATE CATCHMENT OF AFON TAFARN-HELYG

COPYRIGHT

0 500 1,000

1:25,000 METRES

CLIENT
MAGNOX LIMITED

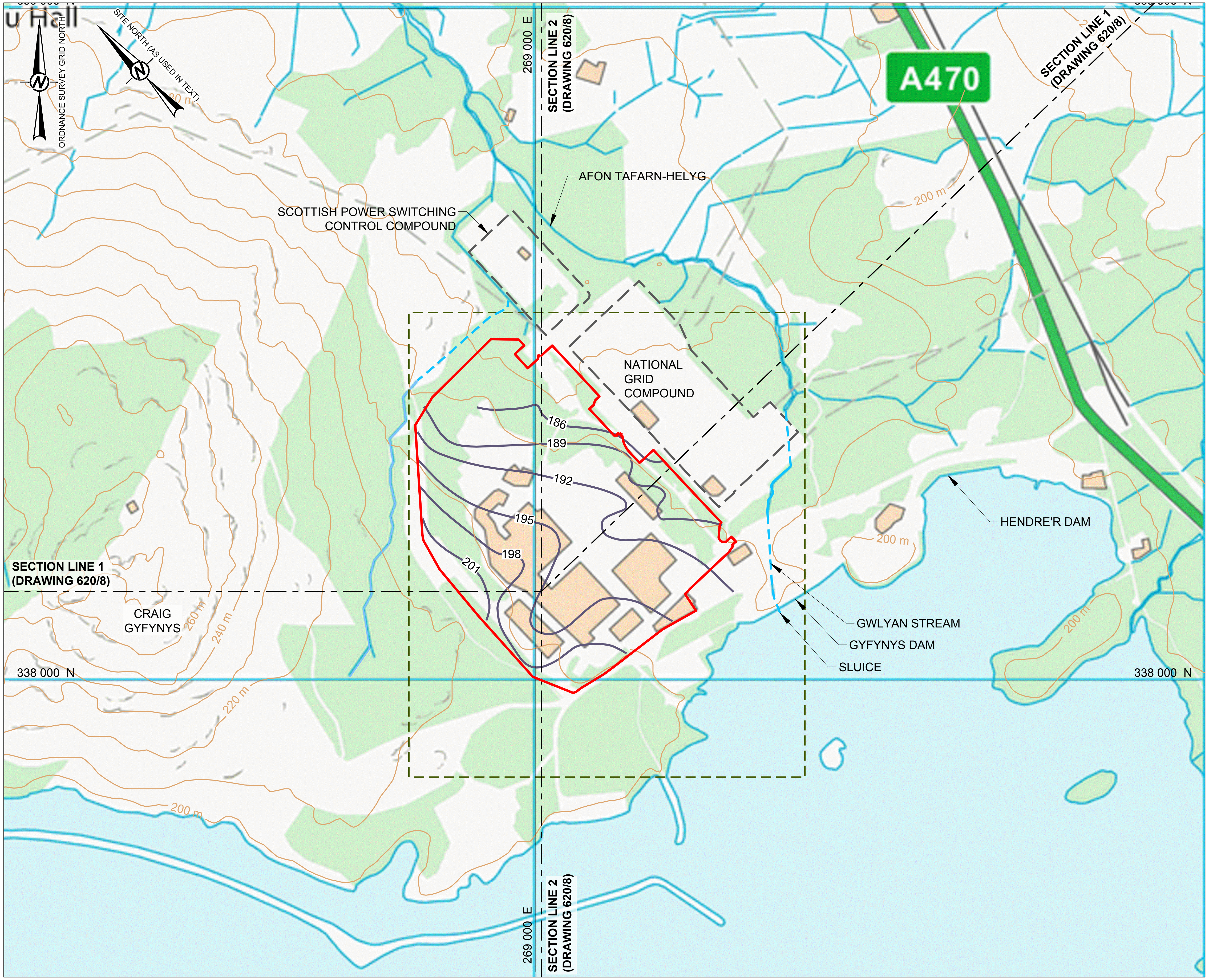
PROJECT
HYDROGEOLOGICAL INTERPRETATION 2018

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-16
DESIGNED	DD
PREPARED	ECS
REVIEWED	DD
APPROVED	CG

TITLE
SITE LOCATION SHOWING MAJOR HYDROLOGICAL FEATURES

PROJECT NO.	CONTROL	REV.	DRAWING
1780044	1010-HI-0005	A	620-1



LEGEND

- NUCLEAR LICENSED SITE BOUNDARY
- 198 PRE-CONSTRUCTION (1957) TOPOGRAPHY WITHIN SITE (mAOD)
- CONTOURS (mAOD)
- OPEN WATERCOURSE
- CULVERTED WATERCOURSE
- AREA OF DRAWING 620-3

0 100 200
1:6,000 METRES

CLIENT
MAGNOX LIMITED

PROJECT
HYDROGEOLOGICAL INTERPRETATION 2018

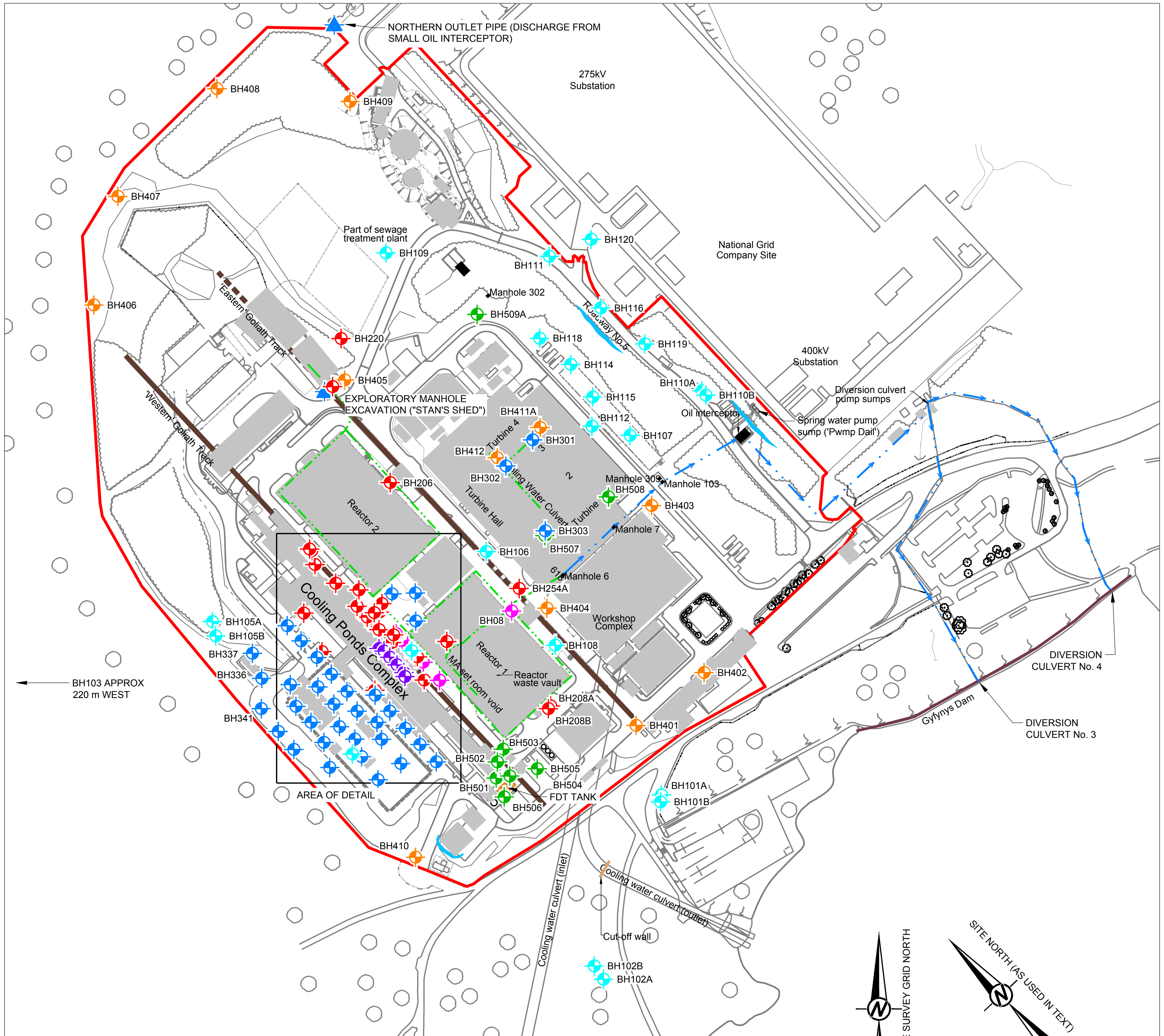
CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-13
DESIGNED	DD
PREPARED	ECS
REVIEWED	DD
APPROVED	CG

TITLE
TOPOGRAPHIC MAP OF THE AREA AROUND THE SITE

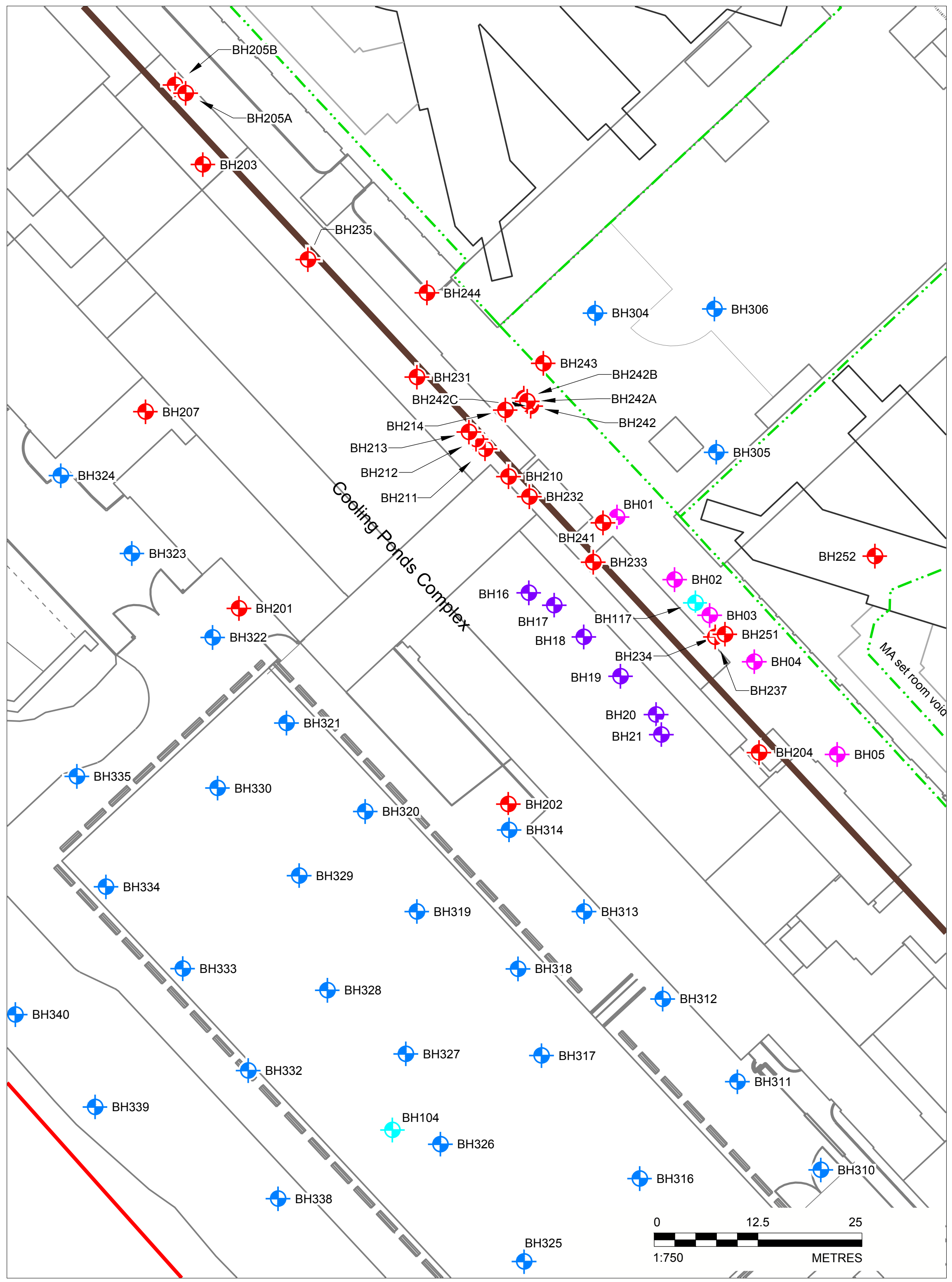
PROJECT NO.	CONTROL	REV.	DRAWING
1780044	1010-HI-0002	B	620-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3



0 50 100
1:3,000 METRES

AREA OF DETAIL



LEGEND

- NUCLEAR LICENSED SITE BOUNDARY
- MAIN STORM DRAIN / DIVERSION CULVERT SYSTEM
- GROUNDWATER DRAIN AS SHOWN IN DESIGN DRAWINGS
- GOLIATH CRANE TRACK ON PILLAR AND BEAM CONSTRUCTION
- GOLIATH CRANE TRACK ON MASS CONCRETE WALL
- DIVERSION CULVERTS Nos. 3 AND 4
- BUILDINGS PRESENT IN 1997
- SPRINGS
- BOREHOLE DRILLED IN 1984
- BOREHOLE DRILLED IN 1997 (100 SERIES)
- BOREHOLE DRILLED IN 1999 (200 SERIES)
- BOREHOLE DRILLED IN 2001 (300 SERIES)
- BOREHOLE DRILLED IN 2015
- BOREHOLE DRILLED IN 2016 (400 SERIES)
- BOREHOLE DRILLED IN 2017 (500 SERIES)
- SURFACE WATER MONITORING LOCATIONS

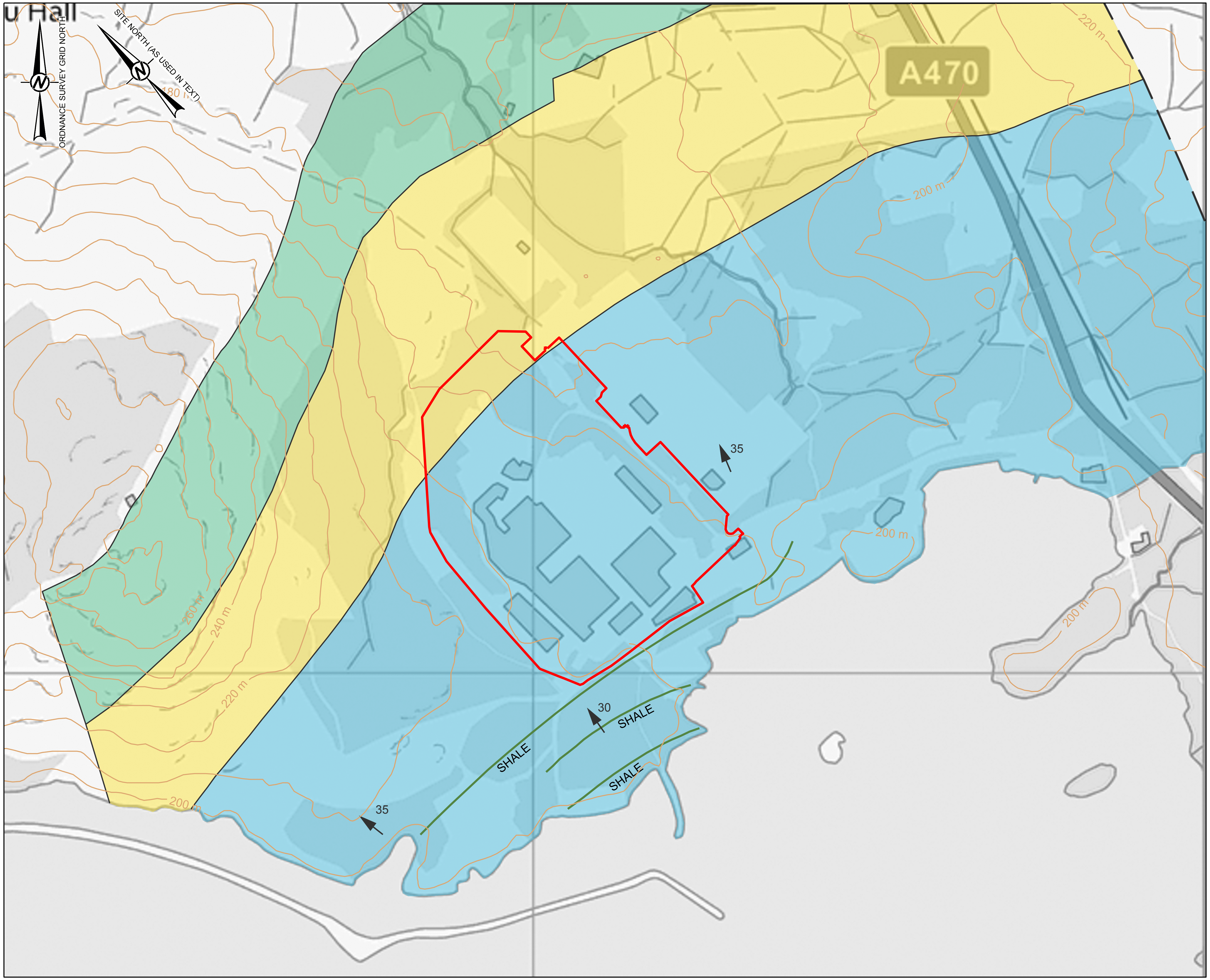
NOTE(S)

1. LOCATION OF BOREHOLE BH252 IS APPROXIMATE.
2. SSB = SLUDGE SOLIDIFICATION BUILDING.
3. DWTP = DECANTED WATER TREATMENT PLANT.
4. POSITION OF GOLIATH TRACK IS APPROXIMATE.

REFERENCE(S)

SITE PLAN SUPPLIED BY CLIENT.

CLIENT	MAGNOX LIMITED
PROJECT	HYDROGEOLOGICAL INTERPRETATION 2018
CONSULTANT	GOLDER
YYYY-MM-DD	2018-11-13
DESIGNED	DD
PREPARED	ECS
REVIEWED	DD
APPROVED	CG
TITLE	SITE PLAN SHOWING FEATURES RELEVANT TO GROUNDWATER
PROJECT NO.	1780044
CONTROL	1010-HI-0001
REV.	B
DRAWING	620-3



LEGEND

- NUCLEAR LICENSED SITE BOUNDARY
- BARMOUTH GRITS
- MANGANESE SHALES
- RHINOG GRITS
- FAULTS
- GEOLOGICAL BOUNDARY (AFTER ASPINWALL, 1995)
- 35 DIP OF STRATA (DEGREES FROM HORIZONTAL)
- CONTOURS (mAOD)

0 100 200

1:6,000 METRES

CLIENT
MAGNOX LIMITED

PROJECT
HYDROGEOLOGICAL INTERPRETATION 2018

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-13
DESIGNED	DD
PREPARED	ECS
REVIEWED	DD
APPROVED	CG

TITLE
BEDROCK GEOLOGY

PROJECT NO.	CONTROL	REV.	DRAWING
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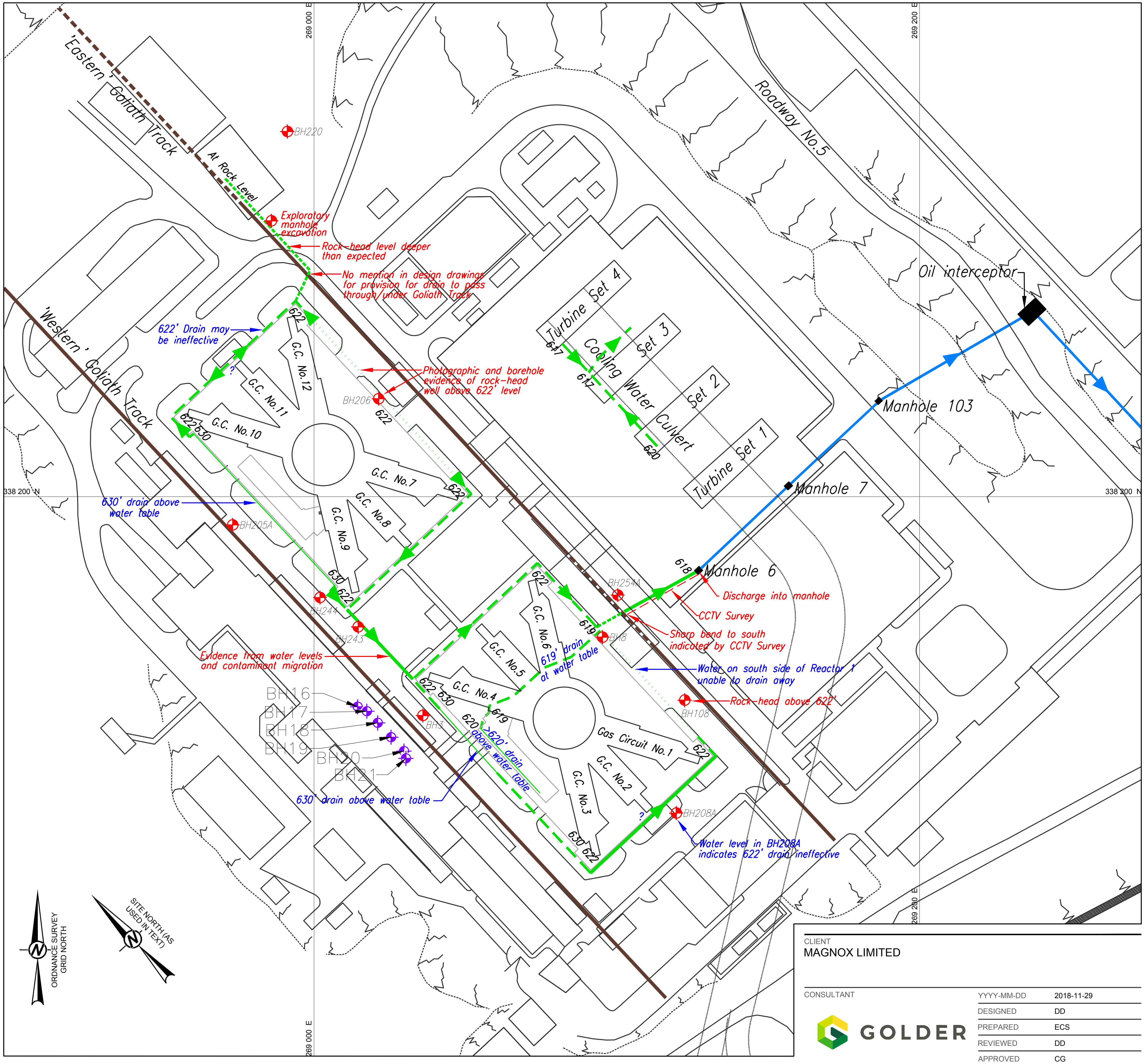


LEGEND

- CONSTRUCTION ACCORDING TO DESIGN CORROBORATED BY OTHER EVIDENCE; ARROW SHOWS INFERRED FLOW DIRECTION
- NO EVIDENCE TO SUGGEST DRAIN NOT BUILT AS DESIGNED. ARROW SHOWS INFERRED FLOW DIRECTION
- SOME EVIDENCE CASTS DOUBT ON WHETHER DRAIN BUILT AS DESIGNED
- EVIDENCE STRONGLY SUGGESTS DRAIN NOT BUILT AS DESIGNED
- DRAIN INFERRED TO BE ABOVE WATER TABLE
- MAIN STORM DRAIN
- BOREHOLE LOCATIONS
- GOLIATH CRANE TRACK ON PILLAR AND BEAM CONSTRUCTION
- GOLIATH CRANE TRACK ON MASS CONCRETE WALL
- BOREHOLE LOCATION
- BOREHOLE DRILLED IN 2015

TEXT IN RED INDICATES RELEVANT EVIDENCE

TEXT IN BLUE INDICATES INFERRED GROUNDWATER

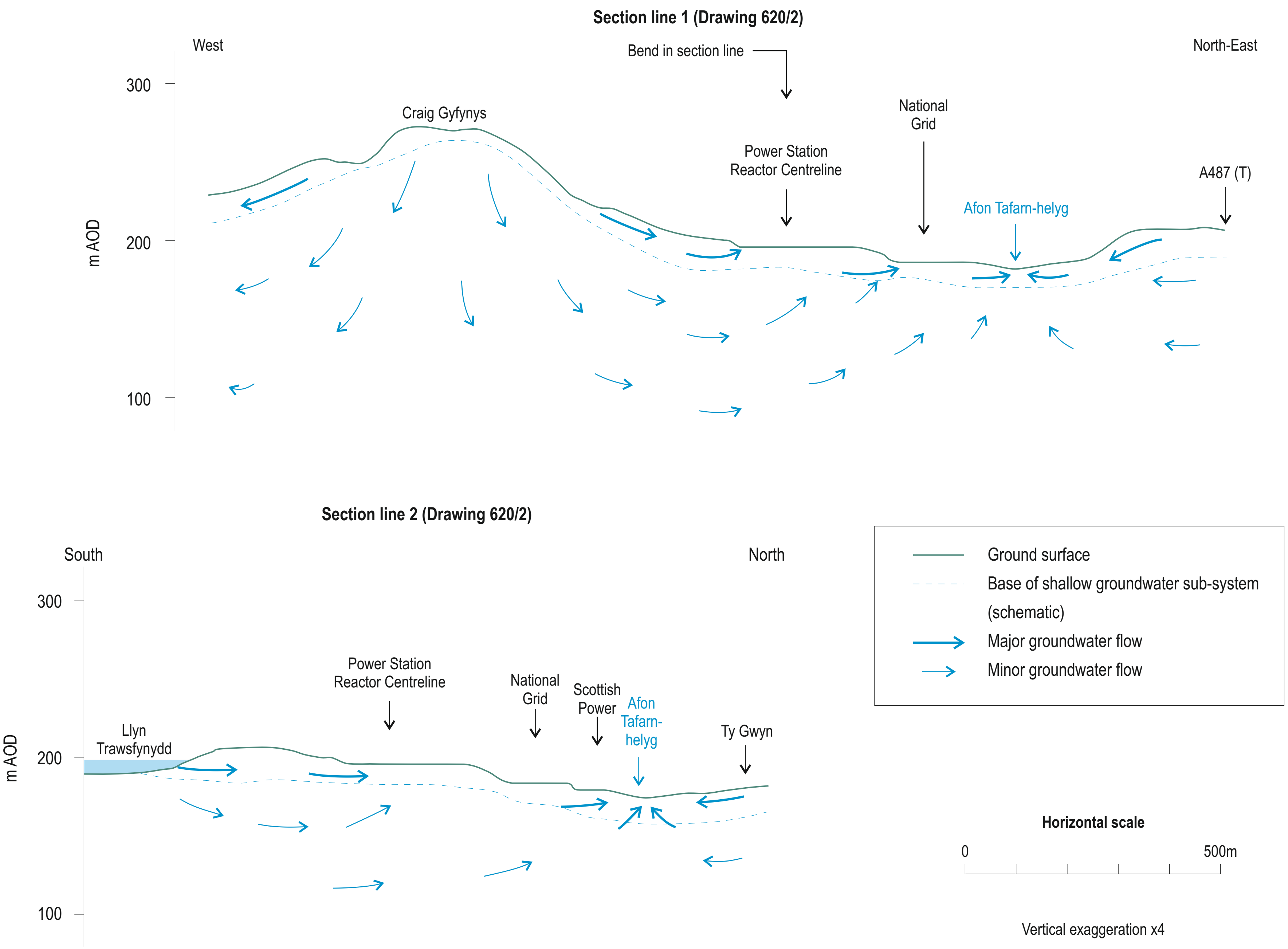
NOTE(S)

1. DUE TO IMPERFECT TRANSLATION OF MAGNOX SITE SURVEY INFORMATION TO ORDNANCE SURVEY GRID, POSITIONS MAY BE UP TO 3m IN ERROR.
2. THIS DRAWING IS REPRODUCED FROM GOLDER ASSOCIATES (UK) LIMITED, 2000. SUMMARY AND INTERPRETATION OF INFORMATION RELATED TO GROUNDWATER DRAINS, TRAWSFYNYDD POWER STATION. JULY 2000. 99524717/1, VERSION A.0.

0 25 50
1:1,250 METRES

CLIENT	MAGNOX LIMITED	PROJECT	HYDROGEOLOGICAL INTERPRETATION 2018
CONSULTANT	GOLDER	TITLE	PLAN SHOWING INFERRED ACTUAL CONSTRUCTION AND FUNCTION OF GROUNDWATER DRAINS (INCLUDING AREAS OF UNCERTAINTY)
YYYY-MM-DD	2018-11-29		
DESIGNED	DD		
PREPARED	ECS		
REVIEWED	DD		
APPROVED	CG		

PROJECT NO.	CONTROL	REV.	DRAWING
1780044	1010-HI-0007	C	620-7



GOLDER

CONSULTANT

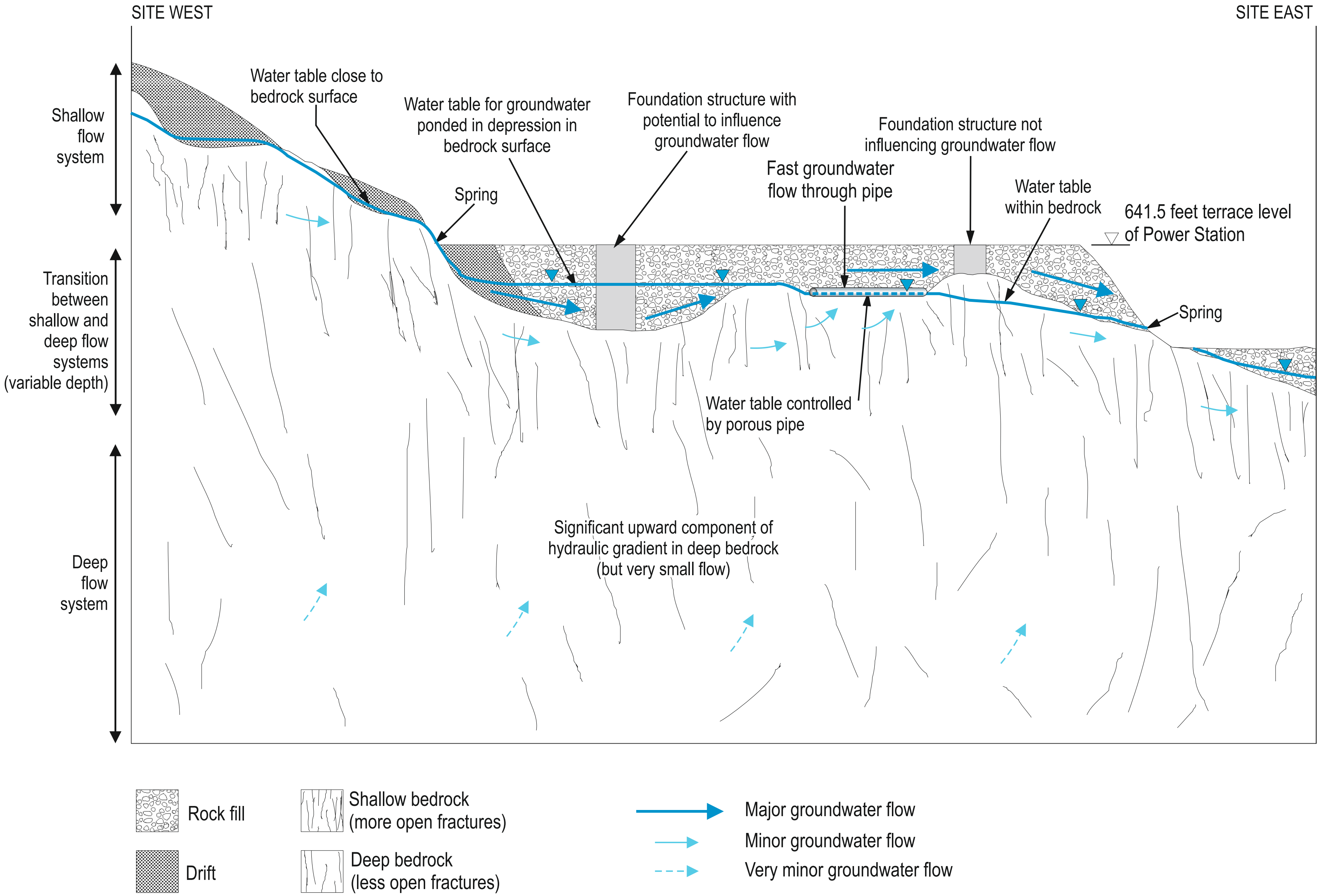
YYYY-MM-DD	2018-12-03
PREPARED	ECS
DESIGN	DD
REVIEW	DD
APPROVED	CG

CLIENT
MAGNOX LIMITED

PROJECT
HYDROGEOLOGICAL INTERPRETATION 2018

SHEET TITLE
TOPOGRAPHIC SECTIONS THROUGH THE SITE, SHOWING INDICATIVE GROUNDWATER FLOW DIRECTIONS

PROJECT NO	CONTROL	REV	DRAWING
1780044	1010-HI-0008	A	620-8



GOLDER

CLIENT
MAGNOX LIMITED

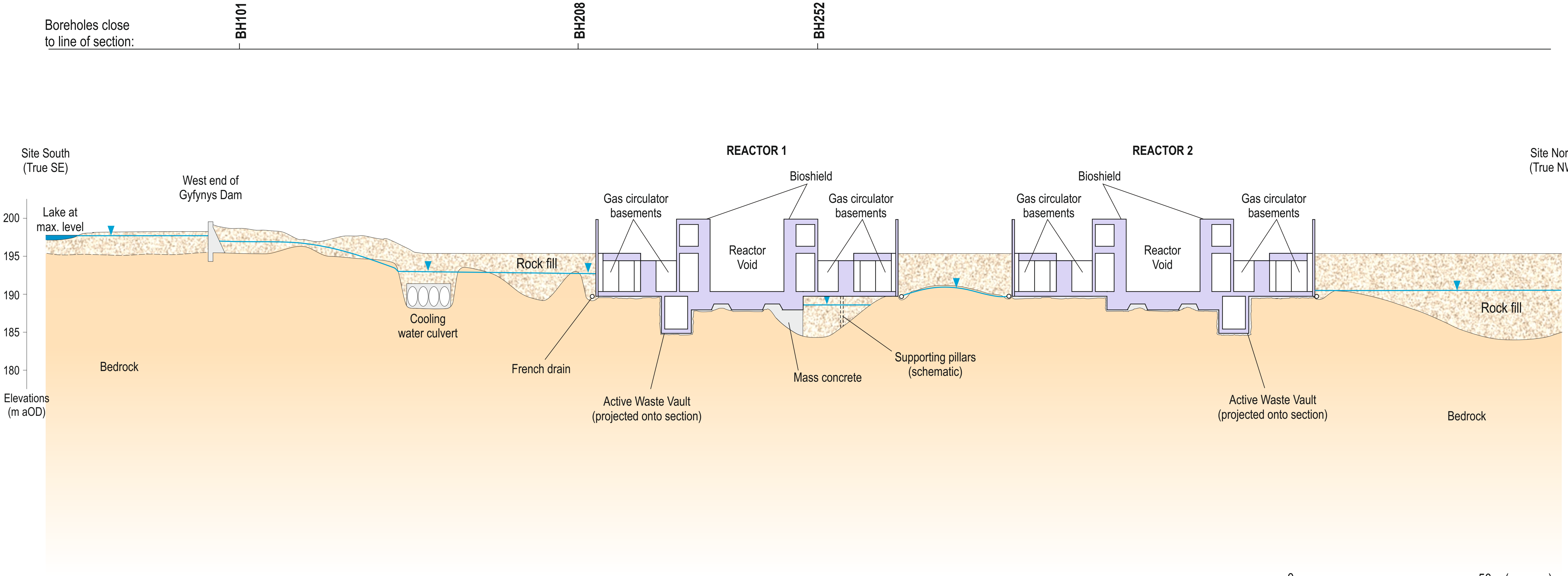
CONSULTANT

YYYY-MM-DD	2018-12-03
PREPARED	ECS
DESIGN	DD
REVIEW	DD
APPROVED	CG

PROJECT
HYDROGEOLOGICAL INTERPRETATION 2018

SHEET TITLE
SCHEMATIC ILLUSTRATION OF GROUNDWATER FLOW AT SITE SCALE

PROJECT NO	CONTROL	REV	DRAWING
1780044	1010-HI-0009	B	620-9



0 50m (approx.)

Vertical exaggeration x2

Legend

Nuclear Licensed Site Boundary

Interpreted water table

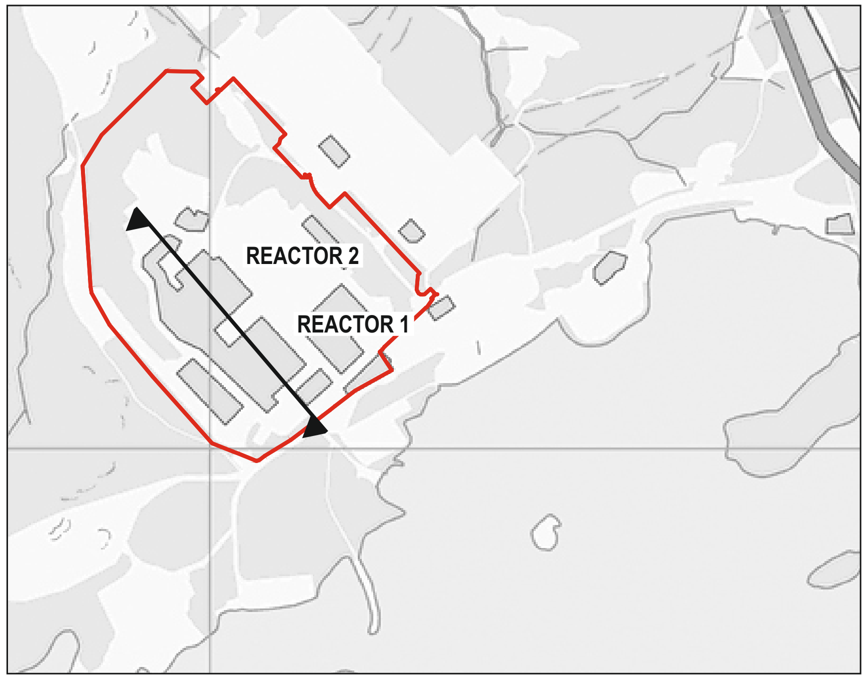
Copyright

ORDNANCE SURVEY GRID NORTH

N W E S

SITE NORTH (AS USED IN TEXT)

N E W S



SECTION LOCATION

0 500m (approx.)

CLIENT
MAGNOX LIMITED

PROJECT
HYDROGEOLOGICAL INTERPRETATION 2018

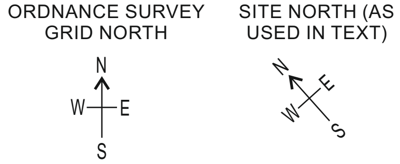
CONSULTANT

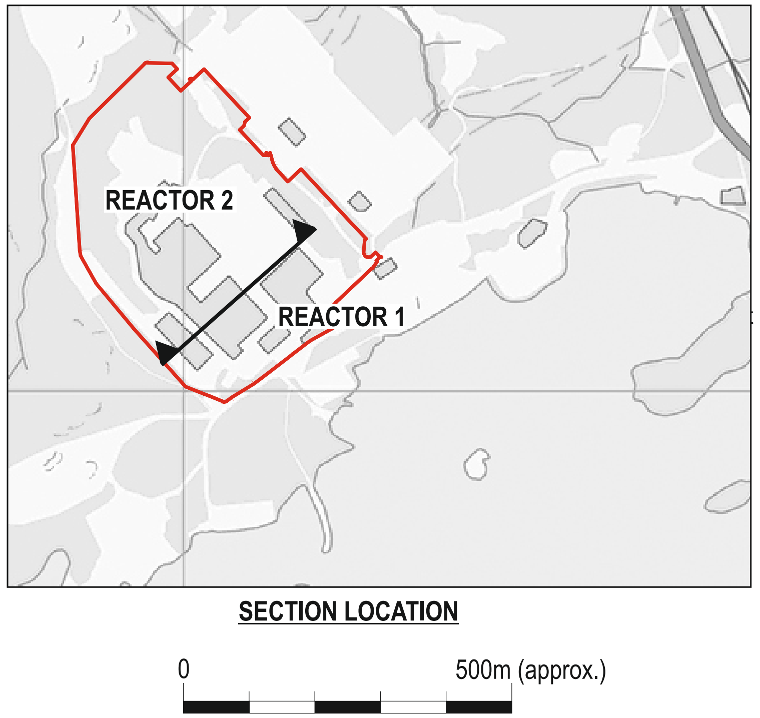
GOLDER

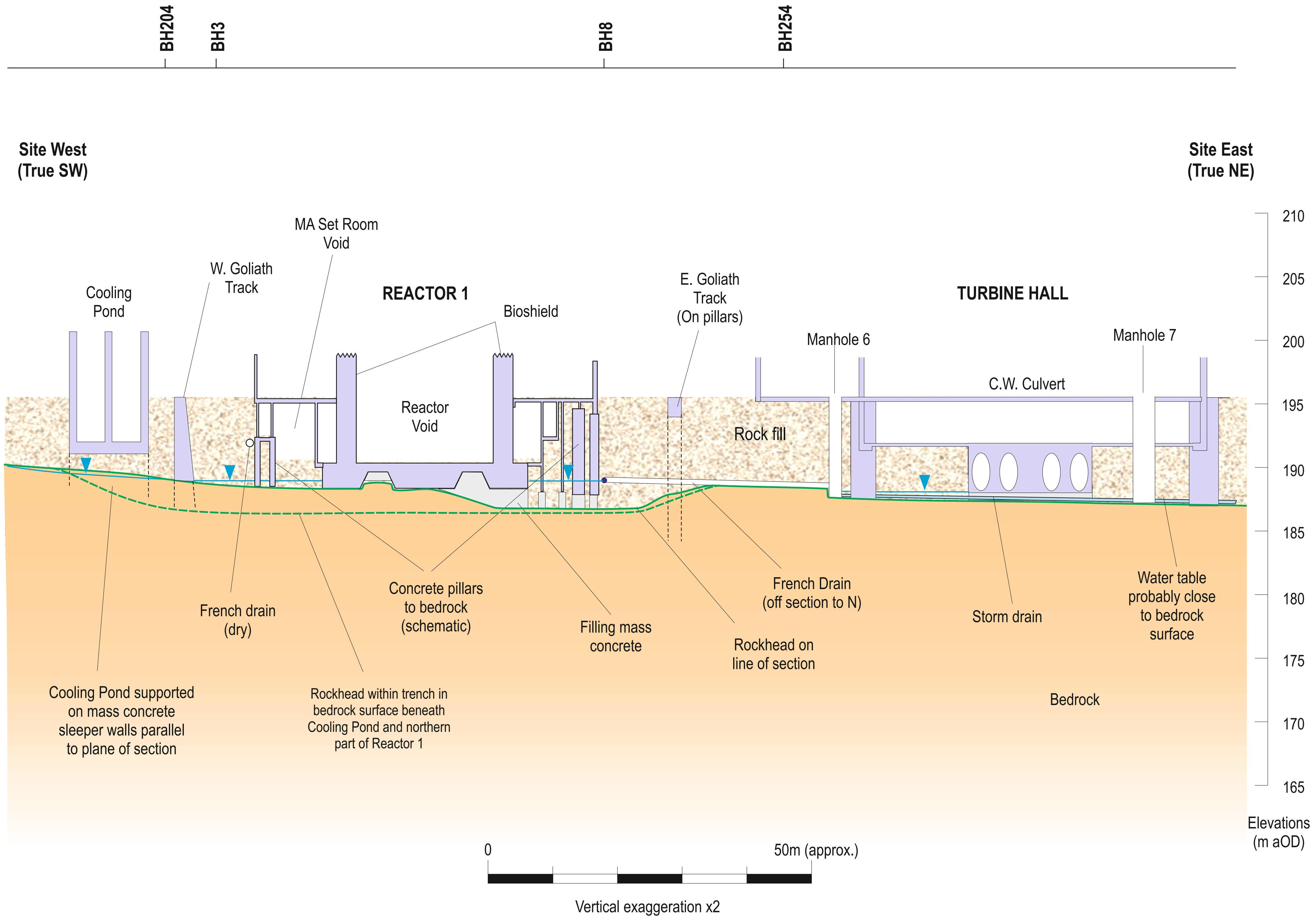
YYYY-MM-DD	2018-12-05
PREPARED	ECS
DESIGN	DD
REVIEW	DD
APPROVED	CG

SHEET TITLE
SCHEMATIC SOUTH-NORTH SECTION THROUGH REACTORS SHOWING INTERPRETED WATER TABLE

PROJECT NO	CONTROL	REV	DRAWING
1780044	1010-HI-0010	B	620-10





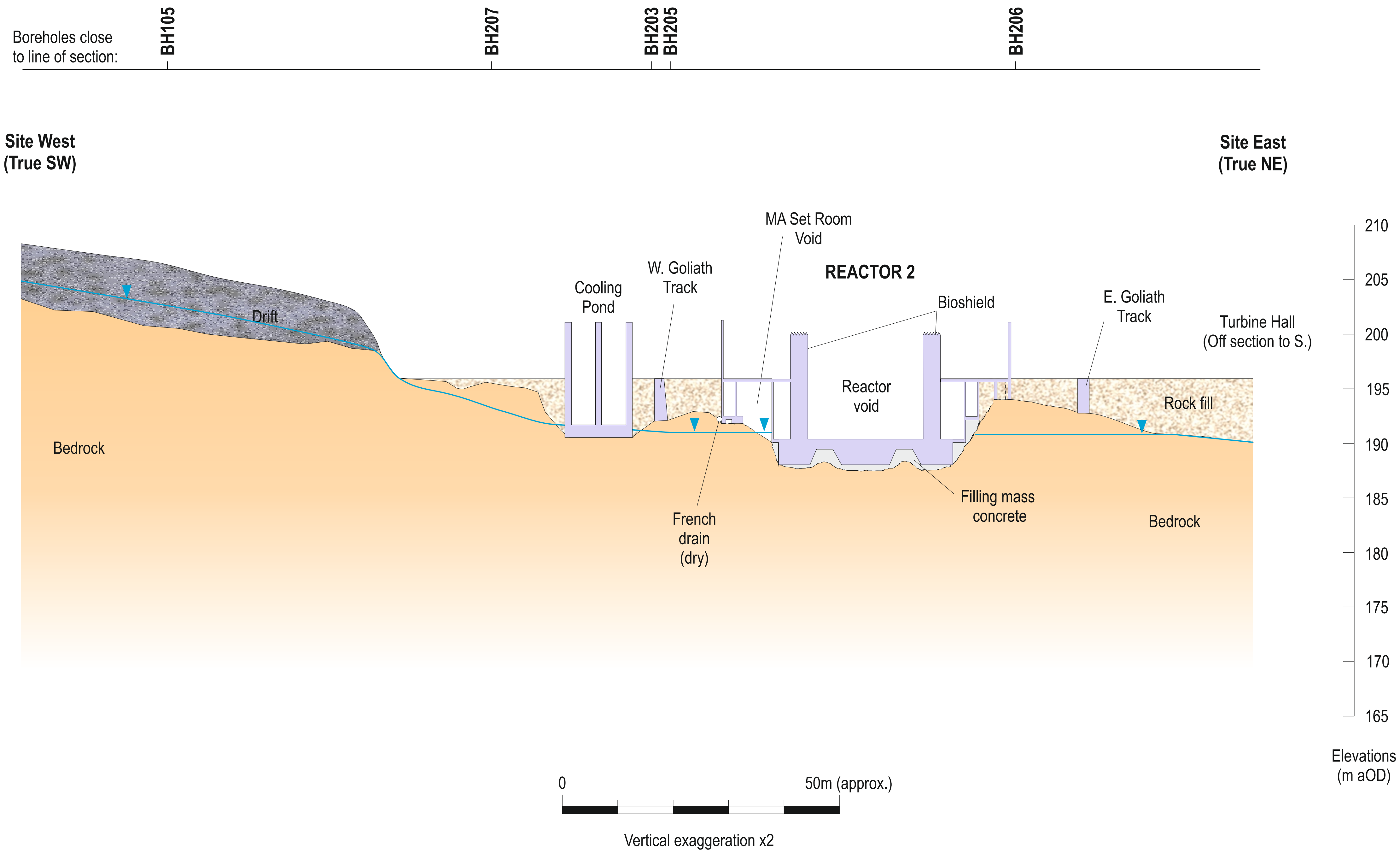


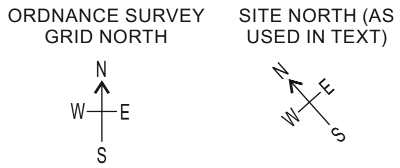
Legend

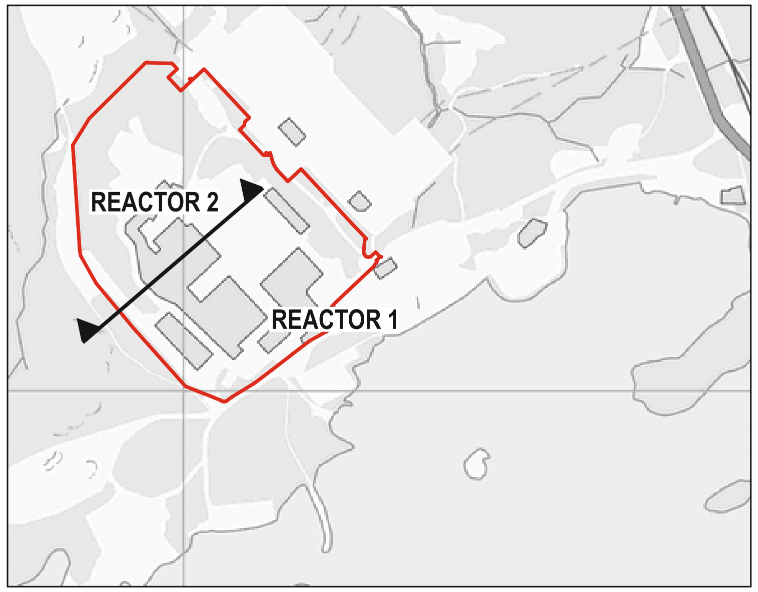
- Nuclear Licensed Site Boundary
- Interpreted water table on line of section
- Bedrock surface on line of section

Copyright

CLIENT	MAGNOX LIMITED
PROJECT	HYDROGEOLOGICAL INTERPRETATION 2018
CONSULTANT	GOLDER
YYYY-MM-DD	2018-12-05
PREPARED	ECS
DESIGN	DD
REVIEW	DD
APPROVED	CG
SHEET TITLE	SCHEMATIC SW-NE SECTION THROUGH REACTOR 1 SHOWING INTERPRETED WATER TABLE
PROJECT NO	1780044
CONTROL	1010-HI-0011
REV	B
DRAWING	620-11







SECTION LOCATION

0 500m (approx.)

Legend

- Nuclear Licensed Site Boundary
- Interpreted water table on line of section
- Bedrock surface on line of section
- Deepest elevation within trough in bedrock surface beneath Cooling Pond and northern part of Reactor 1 (to north of section line)

CLIENT MAGNOX LIMITED		PROJECT HYDROGEOLOGICAL INTERPRETATION 2018	
CONSULTANT GOLDER	YYYY-MM-DD: 2018-12-05 PREPARED: ECS DESIGN: DD REVIEW: DD APPROVED: CG	SHEET TITLE **SCHEMATIC WEST-EAST SECTION THROUGH REACTOR 2 SHOWING INTERPRETED WATER TABLE**	

PROJECT NO	CONTROL	REV	DRAWING
1780044	1010-HI-0012	A	620-12

GOLDER

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