ELTON 2 RESTORATION ENVIRONMENTAL PERMIT APPLICATION

Hydrogeological Risk Assessment

Prepared for: Ingrebourne Valley Ltd

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1.0 INTRODUCTION

Ingrebourne Valley Limited (IV) has retained SLR Consulting Limited (SLR) to prepare an Environmental Permit application to authorise a waste recovery operation for the deposit of inert waste for the restoration of Elton 2 (the Site) to agricultural land.

A planning application, reference 19/00033/MINFUL was submitted to Northamptonshire County Council in April 2019 for the 'Phased mineral extraction, construction of a bailey bridge to cross a branch of the River Nene, importation of reclamation material including ancillary activities, with restoration to agricultural pasture and wet woodland'. The planning consent granted on 31st March 2021 and a Section 106 Notice agreed on 26th March 2021 require that IV restore the Site to original levels post extraction of mineral, for use as agricultural pastureland and woodland.

1.1 Site Location

The Site lies to the north of the A605, 400m north-west of Warmington and approximately 17 miles to the south-west of Peterborough at National Grid Reference TL 070 919.

Access is from the A605 to the northeast of the Site, via a track which leads to an existing processing and waste storage area associated with the quarrying and restoration operations which are authorised under separate Environmental Permits. A haul road and bailey bridge have been constructed to transport extracted mineral and restoration materials between the processing and waste storage area and the Site.

The restoration area of the Site is surrounded on all sides by the River Nene and associated water courses and the Site is located in an area of predominantly agricultural land. The topography of the Site is generally flat, the majority of the Site at an elevation of 15 m AOD.

Warmington / Elton Lock is located on the River Nene immediately north of the Site, allowing management of river water levels. Upstream of the lock there is a channel offtake, the Mill Stream, which was constructed to provide water to Warmington Mill, from which water discharges back into the River Nene downstream of Warmington/ Elton Lock, via a 'tailrace' immediately east of the Site. In high flow conditions small weirs on the Mill Stream upstream of Warmington Mill allow water to overflow into a small channel immediately south of the site, which discharges into the tailrace of the Mill Stream.

There is a small field ditch (formerly connected to the River Nene) that crosses the Site from north-west to south-east discharging to the Mill Stream overflow channel.

A previous development, Elton 1, lies adjacent to the east of the site and has been restored to open water under a recovery permit, Reference EPR/CB3201MY, operated by IV.

1.2 Objectives

This report presents the conceptual site model (CSM) developed for the Site and assesses the risk to the hydrogeological regime posed by the proposed restoration of the Site using inert waste material.

The objectives of the assessment are to demonstrate that the Site will be compliant with Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended) and the Inert Waste Guidance (2020). These Regulations require that certain substances (Hazardous Substances) are not discharged to groundwater such that they are discernible, and that the discharge of other substances (Non-Hazardous Pollutants) is limited *"so as to prevent pollution"*.

2.0 Conceptual Hydrogeological Site Model

The conceptual hydrogeological site model is based on the source-pathway-receptor linkages. The conceptual model is shown in Drawing 09 and key elements of the hydrogeological model are discussed in further detail within the following sections below:

- waste source
- aquifer characteristics;
- groundwater flow and quality;
- groundwater quality;
- licensed groundwater abstractions; and
- Source Protection Zones.

2.1 Waste Source

2.1.1 Site Design and Construction

The Site is approximately 20 hectares in size and prior to development consisted mainly of agricultural pasture used for livestock grazing, with a commercial poplar plantation near the eastern boundary. Approximately 850 – 900,000 tonnes of sand and gravel will be extracted and the Site will be restored using a combination of site-won overburden, silt from the mineral processing (if necessary for restoration of the Eastern Phase) and imported inert wastes, with a final layer comprising replacement of the site-derived topsoil.

The proposed sequence of operations is as follows:

- a haul road and bailey bridge have been constructed to connect the adjacent, separately permitted processing and waste storage area and the Site;
- the working of the Site will proceed over approximately 10 years in 3 phases (Eastern, Central and Western) - The planning permission requires the phases to be worked sequentially from east to west and each phase must be substantially restored before the next phase can be commenced;
- dewatering of the Site is not practical given the proximity to the River Nene and high groundwater level. Gravel will be extracted ‘wet’ from each area and be transported to the process area for washing;
- mineral will be extracted down to the clay which underlies the sand and gravel seam. The underlying clay forms a natural basal geological barrier;
- during extraction of each phase, the clayey overburden will be end-tipped into water within the void as mineral extraction proceeds, to form an artificial side-wall attenuation barrier against the basal clay to restrict groundwater inflow and to protect groundwater from any impact from the inert waste to be deposited;
- Imported inert waste will be transported from the processing area, following rigorous waste acceptance checks, and placed directly into water within the void;
- If the environmental permit determination time is excessively long, infilling of the first phase will commence with non-waste consisting of site-won overburden and silt from the mineral washing settlement lagoons;

- once the imported restoration materials have been placed to the required level, site-derived subsoil and topsoil will be replaced to a finished topsoil thickness expected to be 0.2m on average. Given the inert nature of the materials employed, it is not considered that there is a requirement for an engineered cap.

Up to 550,000m^3 of imported inert waste in total, comprising carefully selected soil and stones from naturally occurring or low contamination sources, will be used for infill at a rate of approximately 75,000m^3 per annum. In addition, the restoration will incorporate approximately 284,500m^3 of site-won overburden placed either as a side wall barrier or infill, and up to approximately 50,000m^3 of silt recovered from the settlement lagoons in the processing area, following washing of the mineral.

The preferred restoration approach is that the in-situ clay overburden will be end-tipped into water within the void as mineral extraction proceeds, to form a side-wall attenuation barrier against the basal clay before the rest of the void in each area is restored using imported inert waste. However, the operational and timescale requirements of the planning permission place some constraints on how the Site can be constructed; for example, it is not possible to place a barrier around the entire Site to manage groundwater as only one phase can be worked at a time. Therefore, other options have also been assessed in addition to the preferred approach to manage any operational and timescale complexities that may arise. These include:

- commencement of Eastern Phase infill using in-situ overburden and silt only, in case that delays in obtaining the environmental permit put planning timescale requirements at risk; and
- construction of a cut-off wall using specialist techniques in the case that side slope stability issues are encountered.

2.1.2 Basal and Side Slope Attenuation Barriers

It is recognised that the Site setting poses particular challenges, given that the operational area is surrounded on all sides by the River Nene. Planning permission requires that the Site is worked sequentially, with the first phase substantially restored before the second is worked. This precludes an option to install an impermeable barrier around the whole Site ahead of operations.

As the Site is a recovery operation, there is no mandatory requirement for basal and sidewall geological barriers. However, it is proposed for the base case backfill scenario that a side-wall attenuation barrier will be constructed around each phase by placing site-won clay overburden around the void as mineral extraction proceeds, prior to infill with imported inert materials. The Site is underlain by clays of the Grantham and Whitby Mudstone formations which according to British Geological Survey are over 100m thick and which will form a natural basal geological barrier, as detailed in section 2.2.1 below.

Sufficient barrier material will be placed in order to achieve permeability equivalent to 1m at 1 x 10^{-7} m/s. All material used in the geological barrier construction will be site-won and will not require testing.

A stability risk assessment (SRA) has been carried out for the Site and is presented in Section 10 of this application which concludes that the scheme satisfies the relevant factors of safety. In case any concerns with stability are encountered as the development proceeds, an additional scenario has also been considered. The alternative engineering scenario is to construct a low permeability cut-off wall using geotechnical specialist techniques, prior to mineral extraction and infill.

2.1.3 Waste Quality and Priority Contaminants

It is proposed that only inert waste material that is suitable for its intended use will be used in the restoration of the Site. The waste categories which will be employed for general fill at the Site are all included within the list provided by EA's 'Check if your waste is suitable for deposit for recovery' guidance published on go.uk[1], as detailed within the ESSD.

Imported inert wastes for restoration will be initially tipped in the processing and waste storage area (to be regulated under a separate permit). They will have undergone rigorous waste acceptance checks to ensure that they are chemically and physically suitable for placement as restoration materials. If required, imported inert waste will be screened to separate oversize material which will then be reduced in size using a mobile crushing unit before being used for restoration

In the proposed construction scenario, where the void includes a side-wall attenuation layer and natural basal geological clay barrier, only inert wastes which are compliant with inert Waste Acceptance Criteria (iWAC) will be deposited.

The inert waste source term has been assessed based on Inert WAC limits as outlined within section 2.1.2 of the Landfill Directive 2003/33/EC and reproduced in Table 2-1 and Table 2-2.

Table 2-1
Limit values for waste acceptable at Landfills for Inert Waste

Component	L/S = 2 l/kg (mg/kg dry substance)	L/S = 10 l/kg (mg/kg dry substance)
Arsenic	0.1	0.5
Barium	7	20
Cadmium	0.03	0.04
Chromium (Total)	0.2	0.5
Copper	0.9	2.0
Mercury	0.003	0.01
Molybdenum	0.3	0.5
Nickel	0.2	0.4
Lead	0.2	0.5
Antimony	0.02	0.06
Selenium	0.06	0.1
Zinc	2	4
Chloride	550	800
Fluoride	4	10
Sulphate	560*	1000*
Phenol	0.5	1
DOC**	240	500
TDS***	2500	4000

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[1] https://www.gov.uk/government/publications/deposit-for-recovery-operators-environmental-permits/check-if-your-waste-is-suitable-for-deposit-for-recovery dated 21 April 2021

Component	L/S = 2 l/kg (mg/kg dry substance)	L/S = 10 l/kg (mg/kg dry substance)
* if the waste does not meet these values for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1,500mg/l as C_0 at L/S = 0.1l/kg and 6000mg/kg at L/S = 10l/kg. ** If the waste does not meet these values for DOC at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH between 7,5 and 8,0. The waste may be considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500 mg/kg. *** The values for total dissolved solids (TDS) can be used alternatively to the values for sulphate and chloride.		

Table 2-2
Limits for Total Content of Organic Contaminants

Parameter	Value (mg/kg)
TOC (total organic carbon)	30 000 (*)
BTEX compounds (benzene, toluene, ethyl benzene & xylenes)	6
Polychlorinated biphenyls (PCBs) (7 congeners)	1
Mineral oil (C10 to C40)	500
PAHs (Polycyclic aromatic hydrocarbons) (Total of 17)	100
* In the case of soils, a higher limit value may be admitted by the competent authority, provided the DOC value of 500 mg/kg is achieved at L/S = 10 l/kg, either at the soil's own pH or at a pH value between 7,5 and 8,0.	

EA guidance *'Testing for Disposal to Landfill*[2]*'* clarifies: *"While limits are set for these tests in the Council Decision annex, the Environmental Permitting Regulations, schedule 10 state that the L:S 10 l/kg test must be used."*. It is therefore proposed that the L:S 10l/kg WAC limits will be used for determining priority contaminants.

2.2 Pathways

The following sources of information have been consulted to characterise the site geology and hydrogeology:

- British Geological Survey (BGS) online mapping (www.bgs.ac.uk/data/mapViewers/home.html) for details of geology, borehole logs and groundwater classifications;
- Environment Agency Website (www.environment-agency.gov.uk) for details on aquifer classification, source protection zones, groundwater vulnerability and Water Framework Directive classifications for groundwater, rivers and coast;
- National Soils Resource Institute Website for details on soils (https://www.landis.org.uk/soilscapes/);
- Natural England Website for details on groundwater and surface water dependent designated sites (http://www.natureonthemap.naturalengland.org.uk);
- Environment Agency information request providing details of licensed abstractions, discharges, environmental monitoring data including, groundwater levels/quality and rainfall data;
- information request from E. Northamptonshire District Council for details of private water supplies; and

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[2] Environment Agency (2013). *Waste Sampling and Testing for Disposal to Landfill*. Ref. EBPRI 11507B Final

- site investigations undertaken in 2015 and 2019 including borehole logs, groundwater levels and permeability testing. Relevant borehole logs are included as Appendix 01.

2.2.1 Geology

Soils

The Cranfield Soilscapes online soil map viewer[3] indicates that the Site is underlain by '*Loamy and clayey floodplain soils with naturally high groundwater*'. Site investigation found top-soils with a thickness of 0.1- 0.2m.

Superficial Deposits

A detailed description of the site geology was provided in the 2019 Hydrogeological Impact Appraisal[4] (HIA) and the following summary is based on the information presented in that report. The regional superficial geology is summarised in Table 2-3 below and shown in Drawing 07.

Table 2-3
Summary of Regional Superficial Geology

Parent Group	Geological Strata	Lithological Description	Approx. Thickness (m)
Quaternary Superficial	Topsoil	Loamy and clayey floodplain soils with naturally high groundwater.	0.1 – 0.2
	Alluvium	Brown, sandy, silty-clay to gravelly-sand.	1 – 3
	River Terrace Deposits	Orange, very sandy gravels with infrequent, non-continuous clay bands.	3 – 7

BGS online mapping indicates that the Site is underlain by alluvial deposits, and this was confirmed by site investigations which encountered superficial deposits comprising brown, sandy, silty clay up to approximately 3m thick.

The River Terrace Deposits to be worked underlie the alluvial deposits and also outcrop offsite to the immediate north and east of the site. The site investigations described these as very sandy gravels with infrequent, non-continuous clay bands. The deposits are present beneath the Site at thicknesses varying from approximately 3 - 7m.

Bedrock Geology

As detailed in the 2019 HIA, the regional bedrock geology is shown in Drawing 08 and the local bedrock geology is summarised in Table 2-4 below.

The regional bedrock geology comprises sandstone, mudstone and limestone strata of the Lias Group which have been exposed by the course of the River Nene. The Lower Lias strata underlying the Site itself are overlain by

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[3] Cranfield Soil and Agrifood Institute Soilscapes Online Soil Map Viewer (Accessed 08/01/18) http://www.landis.org.uk/soilscapes/

[4] *Elton 2 Sand and Gravel Quarry Hydrogeological Impact Appraisal,* April 2019, *SLR* Ref: 422.01526.00029 (enclosed in Appendix 10).

Upper Lias Lincolnshire Limestone approximately 200m south-west of the site and by Upper Lias Rutland Formation mudstone approximately 20m north of the Site.

Table 2-4
Summary of Local Bedrock Geology

Parent Group	Geological Strata	Lithological Description	Approx. Thickness (m)
Upper Lias	Rutland Fm.	Grey marine mudstone passing into non-marine mudstone and siltstone. Subordinate sandstone beds occur higher in the sequence as well as marine limestones and calcareous mudstones.	8 – 12
	Lincolnshire Limestone Fm.	Limestone - typically calcilutites, peloidal wackestones and packstones in lower part (Lower Lincolnshire Limestone) and ooidal and shell fragmental grainstones in upper part (Upper Lincolnshire Limestone).	1.5
Lower Lias	Grantham Fm.	Mudstones, sandy mudstones and argillaceous siltstone-sandstone.	7
	Whitby Mudstone Fm.	Medium, dark-grey, fossiliferous mudstone and siltstone, laminated and bituminous in part, with thin siltstone or silty mudstone beds and rare fine-grained calcareous sandstone beds.	120+

Underlying the base of the eastern and southern parts of the Site, and oldest within the above geological sequence, is the Whitby Mudstone Formation. This stratum is described by the BGS as ‘medium, dark-grey, fossiliferous mudstone and siltstone’ and is present with thicknesses in excess of 120m.

The Grantham Formation, comprising ‘mudstones, sandy mudstones and argillaceous siltstone-sandstone’ overlies the Whitby Mudstone Formation and outcrops in the north-western area of the Site only. As detailed in the July 2021 SLR memo[5] , site boreholes indicate Grantham Formation lithology immediately underlying the superficials as in Table 2-5 below.

Table 2-5
Grantham Formation Lithology in Site Boreholes

Borehole (from W to E)	Thickness Proven	Lithology
BH01 (2019)	>2.2m	Soft to firm blue CLAY
BH No 01 (2015)	>0.5m	Firm blue CLAY
BH No 02 (2015)	>1.5m	Gritty blue grey CLAY with cobbles
BH06 (2019)	>0.5m	Firm to stiff gravelly Clay with cobbles
BH No 03 (2015)	>1.4m	Gritty CLAY with cobbles
BH02 (2019)	>0.5m	Firm to stiff gravelly CLAY with cobbles

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[5] ‘*Elton 2 – Requirement for Artificial Attenuation Barrier*’, July 2021, SLR Memo Ref: 210721_01526_00029

2.2.2 Hydrogeology

A detailed description of the hydrogeology of the area was presented in the 2019 HIA and the following summary is based on the information presented in that report and on updated groundwater monitoring data.

Aquifer Characteristics

The Environment Agency (EA) online mapping service[6] classifies the River Terrace Deposits as a Secondary A Aquifer, described as:

> *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers"*

The Alluvium and Whitby Mudstone Formation are classified as Un-Productive Strata, described as:

> *"rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow"*

The Grantham Formation is classified as a Secondary (Undifferentiated) Aquifer, described as:

> *"rock layers where it has not been possible to attribute either category A or B. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type".*

However, as detailed in the July 2021 SLR memo[7] , site boreholes indicate Grantham Formation lithology immediately underlying the superficials to be clay, hence the Grantham Formation is not considered to be a receptor of concern at the site.

Rainfall Infiltration

The Met Office climate summary (1981 – 2010) for Peterborough[8] indicates that the average annual rainfall for the area is 608.9mm per annum, The Centre for Ecology and Hydrology Joint UK Land Environment Simulator indicates that effective winter rainfall in 2012 for the 1km square around the site was 117 mm/year, while long-term mean effective rainfall for MAFF Area 28[9] was 130 mm/year.

As the gravels are overlain by clay-rich alluvium deposits which cover the entire site, it is expected that direct recharge to the water table on Site is low. There will be interaction between the River Nene and groundwater in the Terrace Gravels and potentially through any permeable bands in the alluvial deposits.

Groundwater Levels and Flow

Site groundwater level data for the River Terrace Deposits aquifer for monitoring period 2019-2021 are summarised in Table 2-6, and a hydrograph is presented in Appendix 02.

Table 2-6
Summary of Groundwater Level Data 2019-2021

Borehole	Ground Level	Gravel Horizon	Groundwater Elevation	Range	Min Saturated

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[6] Environment Agency website: What's In My Backyard? (Accessed 12/01/18) http://maps.environment-agency.gov.uk/wiyby/

[7] *'Elton 2 – Requirement for Artificial Attenuation Barrier'*, July 2021, SLR Memo Ref: 210721_01526_00029

[8] MetOffice Website (Accessed 12/01/18) *http://www.metoffice.gov.uk/public/weather/climate/gcpsvg2yz*

[9] Technical Bulletin 34 'Climate and Drainage', MAFF

Borehole	Ground Level	Gravel Horizon	Groundwater Elevation			Range	Min Saturated
	(mAOD)	(mAOD)	Min	Mean	Max	(m)	Thickness (m)
BH1	16.10	12.80 – 13.10	15.21	15.47	15.79	0.58	0.3
BH2	16.03	9.03 – 12.73	12.95	14.09	14.79	1.84	3.7
BH3	14.92	6.72 – 12.62	12.77	13.77	14.25	1.48	5.9
BH4B	14.82	6.32 – 12.82	12.64	14.02	14.65	2.01	6.5
BH5	15.33	7.63 – 13.13	13.83	14.46	14.91	1.08	5.5
BH6	15.07	9.57 – 12.77	13.26	14.27	15.07	1.81	3.2

A review of the groundwater levels as outlined in Table 2-6, the hydrographs provided as Appendix 02, and the groundwater contours included on Drawing 09 indicates the following:

- groundwater levels within the River Terrace Deposits at the Site have ranged from 15.79mAOD (BH1 in October 2019) to 12.64mAOD (BH4B in September 2020);
- the River Terrace Deposits remain fully saturated, with a seasonal variation in the confined groundwater level of between 0.5 to 2m;
- groundwater flow across the Site is broadly towards the east with a typical hydraulic gradient of 0.004; and
- the limited water level data available for the River Nene and the Mill Stream suggest that surface water levels upstream of the locks are slightly higher than nearby groundwater levels, while surface water levels downstream of the locks are similar to groundwater levels at nearby boreholes BH2 and BH4B, while BH3 generally has lower water levels; and
- it is possible that the base of the watercourses may have some hydraulic continuity with the River Terrace Deposits aquifer, but this could be limited both by silt in the watercourse base and the typical 2-3m depth of low permeability alluvium on the watercourse sidewalls.

Aquifer properties

Particle size distribution analysis carried out on trial pits in the top of the River Terrace Deposits has found the d_{10} to range from 0.35 – 0.8mm. As the sandy gravel is poorly sorted but clean (i.e. no silt or clay), it is appropriate to estimate the hydraulic conductivity using use the Hazen formula $k = Cd_{10}^2$ with a C factor of 0.7. This gives a hydraulic conductivity range of 0.0008 – 0.0045 m/sec.

2.2.3 Groundwater Quality

Groundwater quality has been monitored at the six Site boreholes since 2019, generally on a monthly basis. Test results are presented below in Table 2-7 (shaded values exceed DWS), and selected groundwater quality chemographs are presented in Appendix 03.

Groundwater quality is generally within the relevant UK Drinking Water Standards (DWS), apart from:

- ammoniacal nitrogen concentrations have generally been slightly elevated above DWS at all boreholes, and particularly elevated (typically above 2 mg/l) at upgradient borehole BH01;
- pH values have occasionally fallen below the minimum DWS value of 6.5;
- concentrations of iron and manganese have often exceeded DWS; and
- the above trends may reflect varying redox conditions in the confined River Terrace Deposits.

Table 2-7
Summary of Groundwater Quality at Elton 2 Quarry 2019-2021

Determinand	Unit	DWS	BH01			BH02			BH03		
			Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
pH (Field/Lab combined)	pH units	6.5–9.5	6.45	7.18	7.87	6.42	7.16	8.12	6.48	7.20	8.05
EC (Field/Lab combined)	us/cm	2500	745	866	1080	727	919	1090	772	906	1080
Amm N (2 LODs combined)	mg/l	0.39	1.49	2.37	3.25	<0.2	0.50	0.72	<0.2	0.44	0.75
Alkalinity	mg/l	-	227	247.2	260	205	281.1	327	228	278.6	325
BOD	mg/l	-	<1	7.11	33.90	<1	-	2.45	<1	-	39.40
DOC	mg/l	-	<3	4.26	5.55	<3	4.29	5.13	<3	4.09	7.39
TON as N	mg/l	-	<0.1	-	0.13	<0.1	-	1.23	<0.1	-	0.72
Chloride	mg/l	250	78.0	84.7	89.6	50.7	69.4	89.9	52.7	69.5	88.3
Sulphate as SO4	mg/l	250	80.6	95.2	120.0	108.0	137.2	163.0	109.0	124.1	142.0
Nitrate	mg/l	50	<0.3	-	0.56	<0.3	-	5.32	<0.3	-	3.09
Nitrite	mg/l	0.5	<0.05	-	0.073	<0.05	-	0.29	<0.05	-	0.14
Orthophosphate as PO4	mg/l	-	<0.05	-	0.057	<0.05	-	<0.05	<0.05	-	<0.05
Arsenic (diss.filt)	mg/l	0.01	<0.0005	0.0021	0.0045	<0.0005	0.0007	0.0014	0.000812	0.0020	0.0034
Cadmium (diss.filt)	mg/l	0.005	<0.00008	-	<0.00008	<0.00008	-	0.00	<0.00008	-	0.00011
Calcium (diss.filt)	mg/l		112	121.3	133	112	150.5	178	119	143.4	169
Chromium (diss.filt)	mg/l	0.05	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	-	<0.001
Copper (diss.filt)	mg/l	2	<0.0003	-	0.00044[b]	<0.0003	-	0.0037	<0.0003	0.00043	0.0012
Iron (diss.filt)	mg/l	0.2	<0.019	0.73	3.69	<0.019	-	0.44	<0.019	-	0.93
Lead (diss.filt)	mg/l	0.01	<0.0002	-	0.00043	<0.0002	-	0.00030	<0.0002	-	0.00038
Magnesium (diss)	mg/l	-	5.55	6.35	7.00	6.12	8.49	10.00	6.31	8.09	10.60
Manganese (diss)	mg/l	0.05	0.25	0.37	0.43	0.072	0.20	0.27	0.16	0.35	0.46
Mercury (diss.filt)	mg/l	0.001	<0.00001	-	<0.00001	<0.00001	-	<0.00001	<0.00001	-	<0.00001
Nickel (diss.filt)	mg/l	0.02	0.0013	0.0018	0.0022	0.0020	0.0028	0.0035	0.0028	0.0032	0.0041
Potassium (diss.filt)	mg/l	-	2.58	3.11	3.96	4.75	5.89	11.00	4.85	7.18	11.90
Sodium (diss.filt)	mg/l	200	51.40	55.08	61.70	36.20	47.39	61.80	37.30	48.49	62.70
Zinc (diss.filt)	mg/l	-	<0.001	0.0027	0.0054[a]	<0.001	0.0011	0.0043	<0.001	0.0020	0.0039

Table Notes:

Fluoride and Dissolved Selenium not detected above respective detection limits of 0.5 mg/l and 0.001 mg/l

Average values have been excluded for substances detected in less than half of monitoring rounds

a- Excluding outlier of 0.016 mg/l on 20/8/2019; b – Excluding outlier of 0.0064 mg/l on 16/6/21

Determinand	Unit	DWS	BH04B			BH05			BH06		
			Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
pH (Field/Lab combined)	pH units	6.5–9.5	6.25	7.05	8.01	6.24	7.12	8.02	6.33	7.10	7.79
EC (Field/Lab combined)	us/cm	2500	664	890	1050	731	895	1050	755	892	1050
Amm N (2 LODs combined)	mg/l	0.39	0.41	0.69	1.49	0.51	0.71	0.92	0.38	0.71	2.42
Alkalinity	mg/l	-	225	301.2	330	250	300.9	320	195	245.1	265
BOD	mg/l	-	<1	1.60	7.37	<1	1.20	6.34	<1	2.45	20.30
DOC	mg/l	-	<3	3.25	4.00	<3	3.86	4.84	<3	3.39	4.64
TON as N	mg/l	-	<0.1	-	0.16	<0.1	-	<0.1	<0.1	-	0.18
Chloride	mg/l	250	52.0	58.6	73.7	57.3	68.2	81.9	68.3	81.2	96.4
Sulphate as SO4	mg/l	250	104	112.9	124.0	98.8	105.8	116.0	124.0	133.1	155.0
Nitrate	mg/l	50	<0.3	-	0.65	<0.3	-	<0.3	<0.3	-	0.79
Nitrite	mg/l	0.5	<0.05	-	0.057	<0.05	-	0.06	<0.05	-	<0.05
Orthophosphate as PO4	mg/l	-	<0.05	-	0.053	<0.05	-	<0.05	<0.05	-	<0.05
Arsenic (diss.filt)	mg/l	0.01	0.0014	0.0025	0.0040	<0.0005	0.0026	0.0051	0.00065	0.0026	0.0062
Cadmium (diss.filt)	mg/l	0.005	<0.00008	-	<0.00008	<0.00008	-	<0.00008	<0.00008	-	<0.00008
Calcium (diss.filt)	mg/l		143	155.9	168	138	147.9	163	128	133.3	140
Chromium (diss.filt)	mg/l	0.05	<0.001	-	<0.001	<0.001	-	<0.001	<0.001	-	0.0011
Copper (diss.filt)	mg/l	2	<0.0003	-	0.00043	<0.0003	-	0.00042	<0.0003	-	0.0012
Iron (diss.filt)	mg/l	0.2	<0.019	0.62	2.19	<0.019	0.44	2.62	<0.019	0.36	2.18
Lead (diss.filt)	mg/l	0.01	<0.0002	-	<0.0002	<0.0002	-	0.0011	<0.0002	-	0.00058
Magnesium (diss)	mg/l	-	7.7	8.25	9.22	8.2	8.81	9.51	8.4	8.89	9.57
Manganese (diss)	mg/l	0.05	0.49	0.55	0.62	0.44	0.47	0.52	0.46	0.52	0.58
Mercury (diss.filt)	mg/l	0.001	<0.00001	-	<0.00001	<0.00001	-	0.000010	<0.00001	-	<0.00001
Nickel (diss.filt)	mg/l	0.02	0.0028	0.0034	0.0040	0.0030	0.0039	0.0056	0.0023	0.0034	0.0047
Potassium (diss.filt)	mg/l	-	<0.2	4.04	5.79	5.34	5.85	6.45	6.61	7.03	7.35
Sodium (diss.filt)	mg/l	200	33.30	37.08	52.30	41.60	46.84	53.50	52.00	56.10	81.40
Zinc (diss.filt)	mg/l	-	<0.001	0.0018	0.0057	<0.001	0.0019	0.0053	<0.001	0.0029	0.0082

Table Notes:
Fluoride and Dissolved Selenium not detected above respective detection limits of 0.5 mg/l and 0.001 mg/l
Average values have been excluded for substances detected in less than half of monitoring rounds

2.3 Receptors

2.3.1 Abstractions and Source Protection Zones

Online mapping[10] confirms that the proposed development is not located within a groundwater Source Protection Zone (SPZ) and that the only licensed groundwater abstraction within a 2km radius is a catchpit for agricultural use 600m north-west (up-gradient) of the Site.

East Northampton District Council has indicated that there is one private water supply located 3km to the west of the Site at NGR: 503792 292313. The private water supply abstracts from a borehole for single domestic use.

A review of the River Nene catchment abstraction licensing strategy[11] indicates that groundwater in superficial sands and gravels in the area of the Site, is available for licensing except where in continuity with surface water, where “Hands Off Level conditions” would apply.

2.3.2 Surface Water

Surface water potential receptors at or immediately adjacent to the Site are:

- the River Nene immediately north with a standoff at the northern site boundary;
- the Mill Stream immediately west with a standoff at the western site boundary and tailrace;
- the Mill Stream overflow channel immediately south with a standoff at the southern site boundary;
- the Mill Stream tailrace immediately east with a standoff at the eastern site boundary;
- the small field ditch (formerly connected to the River Nene) crossing the site from north-west to south-east discharging to the Mill Stream overflow channel; and
- a lake and wetland at the former Elton 1 quarry site, c. 100m to the east across the Mill Stream tailrace.

It is noted that these surface water receptors are likely to be perched on low permeability overburden restricting hydraulic continuity with groundwater in the River Terrace Deposits underlying the site. The River Nene Q95 low flows[12] are 2.9 m^3/s, which is likely to be over 100 times the upper estimate of groundwater flows in the underlying River Terrace Deposits of approximately 0.027 m^3/s.

2.3.3 Ecological Sites

A review of MAGIC map confirms that there are no internationally or nationally designated sites within a 2km radius of the Site boundary, and the only locally designated sites are:

- Tansor Gravel Pits West and East (former landfill) – approximately 1500m to the west of the site;
- Lady Margaret’s Wood – 360m to the east of the site; and
- Eaglethorpe New Lake – adjacent to the east of the site.

2.3.4 Receptor Locations for Modelling

The primary receptors assumed for this assessment are in accordance with those required by Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations, 2016, these are as follows:

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[10] https://magic.defra.gov.uk and https:/www.arcgis.com/home/webmap

[11] Environment Agency (March 2021) *Nene Catchment Abstraction Licensing Strategy*

[12] NRFA Station Mean Flow Data for 32010 - Nene at Wansford (ceh.ac.uk)

- for Hazardous Substance the receptor is assumed to be the groundwater within the River Terrace gravel aquifer beneath the Site taking account of immediate dilution in the aquifer[13] but without any dispersion or attenuation in the aquifer pathway; and
- for Non-Hazardous Pollutants the receptor has been assumed to be the groundwater within the River Terrace gravel aquifer at the down-gradient Site boundary (down-gradient boreholes in the gravel).

For the purposes of defining receptors, the compliance points are taken to be at the down-gradient Site boundaries. It is noted that there may be other, physical receptors further away from the down-gradient Site boundary. Compliance with the Regulations at the points defined above will ensure that other receptors are adequately protected.

2.4 Priority Contaminants & Environmental Assessment Limits

To assess the risk posed from the Site, first Environmental Assessment Limits (EALs) must be assessed. These have been set for all substances included in WAC testing based on the requirements of the Environmental Permitting Regulations 2016 (as amended) whereby no discernible release of Hazardous Substances is permitted, and the release of Non-Hazardous Pollutants is sufficiently limited as to avoid pollution. The EALs have therefore been set as follows:

- for Hazardous Substances, the EALs shall be the minimum reporting values (MRV's) as defined in the current EA HRA guidance[14] (also taking account of UKTAG Limits of Quantification[15]) unless current background groundwater quality exceeds the specific limit;
- for Non-Hazardous Pollutants the EALs have been set at as follows:
    - where background groundwater quality exceeds the relevant Drinking Water Standard (DWS) the EAL has been set at the maximum background groundwater;
    - if background groundwater quality is below the DWS then then the EAL has been set mid-way between average background groundwater quality and the DWS;
    - where the background quality is comparable to or only slightly below the DWS then the EAL has been set at the DWS.

As no waste deposition has taken place at the Site to date it is considered that all six site monitoring boreholes reflect background groundwater quality.

There is no confirmed waste stream for the Site therefore IWAC limits have been used as an estimate of the worst-case leachate source likely to be present within the inert waste. In Table 2-7 below, IWAC limits converted

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[13] UK Government, *Groundwater Protection Technical Guidance*, Available at: https://www.gov.uk/government/publications/groundwater-protection-technical-guidance/groundwater-protection-technical-guidance (Accessed 22/07/2020)

[14] UK Government, *Hazardous Substances to Groundwater: Minimum Reporting Values* Guidance, Available at: https://www.gov.uk/government/publications/values-for-groundwater-risk-assessments/hazardous-substances-to-groundwater-minimum-reporting-values (Accessed 22/07/2020)

[15] Limit of Quantification from UK Technical Advisory Group (UKTAG) on the Water Framework Directive (September 2016): Technical Report in Groundwater Hazardous Substances [https://www.wfduk.org/resources/groundwater-hazardous-substances-standards]

to mg/l have been assessed against respective UK DWS and background groundwater quality to determine which substances pose the highest risk to the groundwater receptor for inorganic substances.

Table 2-8
Inorganic Inert Waste Quality Risk Factors

Substance	IWAC Limit L/S = 10 l/kg	Conversion to mg/l (L/S=10 value x 0.1)	Hazardous or Non-Haz[2]	UK DWS (mg/l) or EQS if lower	MRV / LOQ / Detection Limit	Average GW quality (mg/l)	Proposed EAL	Risk Factor[1]
Arsenic	0.5	0.05	Haz	0.01	0.005(b)	0.0021	0.005(c)	10
Barium	20	2	Non-Haz	1.30(a)	Non-Haz	-	0.65(d)	3.07
Cadmium	0.04	0.004	Non-Haz	0.0015 (MAC EQS)	Non-Haz	<0.00008	0.0008(g)	5.0
Cr (Total)	0.5	0.05	Non-Haz	0.032 (MAC EQS)	Non-Haz	<0.001	0.019(g)	2.65
Copper	2.0	0.2	Non-Haz	0.024 (AA EQS)	Non-Haz	0.0004	0.012(g)	16.7
Mercury	0.01	0.001	Haz	0.00007 (MAC EQS)	0.00001(f)	<0.00001	0.00001(c)	100
Molybdenum	0.5	0.05	Non-Haz	0.07(a)	Non-Haz	-	0.035(d)	1.43
Nickel	0.4	0.04	Non-Haz	0.014	Non-Haz	0.003	0.008(g)	5.0
Lead	0.5	0.05	Haz	0.01	0.0002(b)	<0.0002	0.0002(c)	250
Antimony	0.06	0.006	Non-Haz	0.005	Non-Haz	-	0.0025(d)	2.40
Selenium	0.1	0.01	Non-Haz	0.01	Non-Haz	<0.001	0.005(d)	2.0
Zinc	4	0.4	Non-Haz	0.038(e)	Non-Haz	0.0021	0.02(e)	20
Chloride	800	80	Non-Haz	250	Non-Haz	72	161(d)	0.50
Fluoride	10	1	Non-Haz	1.5	Non-Haz	<0.5	0.75(d)	1.33
Sulphate	6000	600	Non-Haz	250	Non-Haz	118	184(d)	3.24
DOC	500	50	N/A	-	-	3.9	-	-
TDS	4000	400	N/A	-	-	630	-	-

[1] Risk factor calculated as assumed max waste quality divided by EAL; [2] As classified by JAGDAG 2018; [a] No DWS therefore WHO Limit used; [b] UKTAG Limit of Quantification; (c) EAL set at the respective MRV / LOQ; (d) EAL set mid-way between mean background groundwater quality and DWS; (e) Zinc has no DWS hence EQS calculated by mBAT tool using SW1 water quality of pH 8, DOC 7.4 and mean Zn 0.015 mg/l; and EAL set midway between mean background and EQS; (f) EA defined MRV; (g) EAL set midway between mean background and EQS; [h]- if the waste does not 1000 mg/kg at L/S = 10l/kg, for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed 6000mg/kg at L/S = 10l/kg.

Based on the risk factors as outlined in Table 2-8 it is proposed that Hazardous Substances arsenic, mercury and lead pose the highest risk to groundwater from the Site. The risk from Non-Hazardous inorganics is relatively low due to the low concentrations of the IWAC limits. Nonetheless fluoride has been modelled as the highest risk major ion based on IWAC and copper, nickel and zinc have been modelled as the highest risk metals. Sulphate could also be modelled as a source term up to 6000 mg/kg can be permitted under IWAC in certain circumstances.

An assessment of organic substances is outlined in Table 2-9. Risk factors have been derived by comparing the MRVs with maximum leachable values for each individual determinand, which were back-calculated from IWAC solid waste limits using the EA P20 Remedial Targets Worksheet with input parameters such as typical porosity and bulk density of inert waste, and substance-specific Henry's Law constant and soil-water partition coefficients.

Table 2-9
Organics Results for Proposed Inert Waste Stream

Suite	Speciated Substance	IWAC Limit Solid Ratio (mg/kg)	Max Leachable (mg/l)	Haz / Non-Haz	MRV (mg/l)	Max Background Groundwater Quality (mg/l)	Risk Factor
BTEX	Benzene	6.0(a)	1.26	Hazardous	0.001 (e)	<0.001	1260
	Toluene		0.464	Hazardous	0.004 (e)	<0.001	116
	Ethylbenzene		0.218	Hazardous	0.001 (f)	<0.001	218
	Xylene		0.218	Hazardous	0.003 (e)	<0.001	72.7
PAHs	Acenaphthene	100(b)	0.141	Hazardous	0.000005 (f)	0.0000143	28200
	Acenaphthylene		0.397	Undefined	-	0.0000188	-
	Anthracene		0.0339	Hazardous	0.00001 (g)	0.0000156	3390
	Benzo(a)anthracene		0.0129	Undefined	-	0.0000183	-
	Benzo(a)pyrene		0.00776	Hazardous	0.00001 (h)	0.0000266	776
	Benzo(b)fluoranthene		0.00955	Hazardous	0.0001 (h)	0.0000453	95.5
	Benzo(g, h, i) perylene		0.0024	Hazardous	0.0001 (h)	0.0000224	24
	Benzo(k)fluoranthene		0.00676	Hazardous	0.0001 (h)	<0.000005	67.6
	Chrysene		0.0182	Undefined	-	0.0000261	-
	Dibenzo(a,h)anthracene		0.00537	Undefined	-	<0.000005	-
	Fluoranthene		0.0549	Hazardous	0.000005 (f)	0.0000649	10980
	Fluorene		0.0724	Undefined	-	0.00000766	-
	Indeno(1,2,3-cd) pyrene		0.0115	Hazardous	0.0001 (h)	0.0000223	115
	Naphthalene		1.52	Non-Haz	-	0.000564	-
	Phenanthrene		0.0436	Undefined	-	0.0000319	-
	Pyrene		0.0616	Undefined	-	0.000057	-
Mineral Oil C10 – C40	Aliphatics >C10-C12	500(c)	Not assessed further as low risk (EA TPH Guidance 2009)			0.491	-
	Aliphatics >C12-C16						-
	Aliphatics >C16-C21						-
	Aliphatics >C21-C35						-
	Aromatics >C10-C12		1.99	Hazardous	0.01(d)		199
	Aromatics >C12-C16		0.997	Hazardous	0.01(d)		99.7
	Aromatics >C16-C21		Not assessed further as low risk (EA				-

Suite	Speciated Substance	IWAC Limit Solid Ratio (mg/kg)	Max Leachable (mg/l)	Haz / Non-Haz	MRV (mg/l)	Max Background Groundwater Quality (mg/l)	Risk Factor
	Aromatics >C21-C35		TPH Guidance 2009)				-

(a) Speciated max leachable concentrations back-calculated using remedial target worksheet based on typical porosity & bulk density of inert waste and substance specific Henry's Law and soil water partition coefficients (assuming any one speciated substance <33% of the Total BTEX (i.e. 2.0mg/kg)
(b) Speciated max leachable concentrations back-calculated using remedial target worksheet based on typical porosity & bulk density of inert waste and substance specific Henry's Law and soil water partition coefficients (assuming any one speciated substance <20% of the Total PAH (i.e. 20mg/kg)
(c) Speciated max leachable concentrations back-calculated using remedial target worksheet based on typical porosity & bulk density of inert waste and substance specific Henry's Law and soil water partition coefficients (assuming any one speciated substance <20% of Total Mineral Oil (i.e. 100mg/kg)
(d) Target value in EA TPH Guidance 2009
(e) MRV from EA website
(f) MRV based on detection limit for groundwater in site samples
(g) Limit of Quantification from UK Technical Advisory Group (UKTAG) on the Water Framework Directive (September 2016): Technical Report in Groundwater Hazardous Substances [https://www.wfduk.org/resources/groundwater-hazardous-substances-standards]
(h) Drinking Water Standard

The highest risk BTEX, PAH and Mineral Oil substances should be included within the key determinands to be assessed as listed below. Two PAHs have been selected, benzo(a)pyrene as the highest risk PAH which has a Drinking Water Standard, and acenaphthene as the highest risk PAH compared with MRV. The proposed EALs for these substances are the MRVs specified in Table 2-10 above.

The following key determinands are proposed:

Hazardous Substances:

- arsenic;
- lead;
- mercury
- acenaphthene;
- benzene;
- benzo(a)pyrene; and
- aromatic C10-C12.

Non-Hazardous Pollutants:

- fluoride;
- copper;
- nickel;
- sulphate; and
- zinc.

2.5 Summary of Hydrogeological Site Conceptual Model

The Site's hydrogeological conceptual model is summarised in Table 2-10.

Table 2-10
Summary of Hydrogeological Site Conceptual Model

Linkage	Site Details
Source	The void created by extraction of alluvium and River Terrace Deposits is to be restored with inert wastes. Given the nature of the waste streams no leachate collection system or artificial sealing liner is required. The waste placed within the void will comprise inert material only and will meet the IWAC limits as specified in guidance. Due to the nature of the adjacent River Terrace Deposits aquifer there is a requirement for an artificial sidewall attenuation layer. The sidewalls will be constructed from site derived clayey overburden with a permeability equivalent to 1 metre at 1 x 10^{-7}m/s.
Pathway	Any potential leachate generated by infiltration into the inert waste will migrate through the artificially established sidewall attenuation layer and into the adjacent groundwater. Attenuation of potential contaminants will take place within the attenuation layer.
Receptor	In order to comply with Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations, 2016, the following are considered appropriate receptors: • for Hazardous Substances the receptor is assumed to be the groundwater within the River Terrace Deposits aquifer at the site, taking account of immediate dilution in the aquifer but without any dispersion or attenuation in the aquifer pathway; and • for Non-Hazardous Pollutants the receptor has been assumed to be the groundwater at the down-gradient site boundary (down-gradient boreholes) within the River Terrace Deposits aquifer.
Compliance Points	For the purposes of defining receptors, the compliance points are taken to be at the down-gradient site boundaries. It is noted that there may be other, physical receptors further away from the down-gradient Site boundary. Compliance with the Regulations at the points defined above will ensure that other receptors are adequately protected.

3.0 Hydrogeological Risk Assessment

3.1 Nature of the Hydrogeological Risk Assessment

As set out within current HRA technical guidance[16], the *“appropriate complexity of assessment for a site should be determined from the potential risks presented by the site, which are linked to the nature of potential hazards, the sensitivity of the surrounding environment, degree of uncertainty and likelihood of a risk being realised.”*

Given the nature of the Site and its environmental setting in a Secondary A Aquifer, it is considered appropriate to carry out a detailed quantitative assessment.

The Site will accept inert waste, which is defined as follows;

(a) it does not undergo any significant physical, chemical or biological transformations;

(b) it does not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm to human health; and

(c) total leachability, pollutant content and the ecotoxicity of its leachate are insignificant and, in particular, do not endanger the quality of any surface water or groundwater.

Based on this definition of inert waste, the Site should not produce any leachate that could result in any significant discharge of Hazardous Substances or Non-Hazardous Pollutants throughout the lifecycle of the Site.

Therefore, with regard to this inert waste stream, the Site:

- presents a negligible risk to groundwater and surface water quality;
- falls outside the Environmental Permitting Regulations 2016 (Schedule 22 Groundwater Activities); and
- does not require environmental management systems (artificial sealing liner, leachate management or other engineering and management structures), or the consideration of the degradation of such systems.

However, notwithstanding the above, it is considered that a quantitative risk assessment is required given that the EPR Inert Waste Guidance[17] 2020 states that a quantitative risk assessment is likely to be necessary for inert waste where the receiving environment is particularly sensitive, for example (as at Elton) in a Secondary A aquifer near a river.

In order to assess the risk to the environment, it is considered appropriate to assess the potential worst-case leachate quality that could potentially be generated from the Site.

3.2 The Proposed Assessment Scenario

3.2.1 Lifecycle Phases

It is recognised that the HRA must assess the proposed development’s compliance with the requirements of Schedule 22 of the Environmental Permitting Regulations 2016 (as amended), throughout the lifecycle of the

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[16] EA and DEFRA (February 2016) *Landfill developments: groundwater risk assessment for leachate guidance*, Available at: https://www.gov.uk/guidance/landfill-developments-groundwater-risk-assessment-for-leachate (Accessed 22/07/2020)

[17] Environment Agency (July 2009): *Environmental Permitting Regulations: Inert Waste Guidance*

operation i.e. from the start of the operational phases until the point at which the waste no longer poses an unacceptable environmental risk.

Based on the hydrogeological conceptual site model, as outlined within Section 2.0, the potential pathway for leachate to impact groundwater quality is advective migration through the engineered geological barrier and dilution within the River Terrace Deposits aquifer, which has been assessed through RAM3 software modelling. As a conservative approach the modelling has been run using worst case assumptions with regards to potential source term, attenuation layer and aquifer characteristics.

3.2.2 Accidents and their Consequences

With respect to the deposition of potentially contaminated wastes, it is considered that the risks and potential consequences of such accidents are extremely low for the following reasons:

- all waste deliveries will be pre-arranged and come from known sources to ensure no contaminated material is delivered;
- if deemed necessary, characterisation testing will be undertaken to demonstrate that the waste will not give rise to polluting leachate, prior to the acceptance of waste at the Site;
- if deemed necessary compliance testing will be undertaken to ensure the continued acceptability of the waste stream;
- visual inspection will be undertaken of every waste load deposited at the Site; and
- in the event of suspicion regarding the acceptability of the waste, quarantine procedures will be enforced.

In the unlikely event of contaminants from a rogue load being deposited at the Site, attenuation processes will occur within the waste body, and most organic Hazardous Substances are very likely to be degraded and retarded during migration through the surrounding inert wastes within the waste mass and the artificially emplaced geological barrier. Other processes such as volatilisation can also be expected for volatile and semi-volatile organic substances resulting in a mass loss of contaminant from the waste.

Details of accidental occurrences at the Site that could present a potential risk to groundwater quality adjacent to the Site are provided in Table 3-1 below.

Table 3-1
Qualitative Assessment of Accidents and Mitigation

Accidental Occurrence	Risk to Groundwater	Likelihood of Occurrence	Mitigation and Corrective Measures
Deposition of non-inert wastes.	Generation of leachate containing Hazardous Substances or Non-Hazardous Pollutants.	Low – due to the essential and technical precautions.	Any incorrectly accepted wastes will be immediately returned to the customer or moved to a suitable storage area prior to removal to a suitable site.
Spillage of fuels from vehicles.	Release of hydrocarbons (Hazardous Substances) into the ground and migration to groundwater.	Low – no fuel is stored within the permitted boundary. A traffic system and speed limit will be imposed at the Site	Any spillage will be cleaned up immediately and any resulting contaminated soils removed to a suitable installation.

Accidental Occurrence	Risk to Groundwater	Likelihood of Occurrence	Mitigation and Corrective Measures
		to reduce both the risk of accidents and the likelihood of spillage occurring.	

3.3 Numerical Modelling

3.3.1 Model Parameterisation

The nature of all of the input parameters used, together with the appropriate probability distributions used to describe them are presented in the following:

- Drawing 09: provides an indication of the Site's conceptual model; and
- Appendix 04: presents the detailed RAM3 parameterisation

Parameter values were determined from information directly measured at Site wherever possible. If no Site data were available, conservative parameter values were taken from authoritative sources or after previous SLR experience at similar sites.

3.3.2 Assessment Methodology

In order to represent worst case conditions and assess the most sensitive determinands, risk factors were used to choose suitable determinands which pose the greatest risk of causing either pollution to the aquifer or a derogation of groundwater quality. As detailed within Section 2.0 the following determinands have been modelled:

- Hazardous Substances: arsenic, lead, mercury, benzene, acenaphthene, benzo(a)pyrene and aromatic C10-C12; and
- Non-Hazardous Pollutants: fluoride, copper, nickel, sulphate and zinc.

As detailed in Section 3.2 above, the fate of Hazardous Substances and Non-Hazardous Pollutants has been considered using RAM3 modelling developed by SLRF for the site, including the following assumptions:

- the sidewall attenuation layer is engineered to a thickness of 1m and a maximum permeability of $1x10^{-7}$m/s, although sensitivity analyses have also been run with a permeability of $1x10^{-6}$m/s and with no attenuation layer as an extreme worst case. It is also noted that the attenuation layer installed may be significantly thicker than 1m in order to support earth-moving plant used during construction;
- the source term has been set at the Inert WAC limit, although in reality most results will be well below IWAC. A sensitivity model with waste concentrations at 3 x IWAC has also been run as a conservative worst case;
- seepage of infiltration through the inert waste has been modelled at 130 mm/yr which is the effective rainfall for this area; and
- attenuation of Hazardous Substances has been included within the engineered barrier only.

3.4 Assessment Results

The predicted discharge from the development has been assessed against EALs presented in Table 2-8 and MRVs / EALs presented in Table 2-9 to determine whether the Site complies with the requirements of Schedule 22

(Groundwater Activities) of the Environmental Permitting Regulations 2016. The model and results are presented in Appendix 05.

3.4.1 Hazardous Substances

Hazardous Substances have been assessed against their respective EALs in down-gradient groundwater following immediate localised dilution but prior to any attenuation or dispersion. The model results summarised in Table 3-2 below indicate:

- predicted resultant concentrations are below EALs with an attenuation layer of maximum permeability 1x10^{-7}m/s or 1x10^{-6}m/s; and
- predicted resultant concentrations are also below EALs if waste with 3 x IWAC is deposited within an attenuation layer of maximum permeability 1x10^{-7}m/s.

Table 3-2

Hazardous Substances - Maximum Predicted Concentration after Dilution in Downgradient Groundwater

Determinand (mg/l)	EAL / MRV	Maximum Resultant Concentration depending on Attenuation Layer Permeability			
		1x10^{-7} m/s	1x10^{-6}m/s	3 x IWAC with 1x10^{-7}m/s	3X IWAC with 1x10^{-6}m/s
Arsenic	0.005	6.07X10^{-4}	6.31X10^{-4}	0.0018	0.00188
Lead	0.0002	1.35X10^{-5}	7.45X10^{-6}	4.07X10^{-5}	4.19x10^{-5}
Mercury	0.00001	8.55X10^{-7}	8.53X10^{-7}	2.51X10^{-6}	2.54x10^{-6}
Acenaphthene	0.000005	1.47x10^{-29}	9.00x10^{-30}	3.69x10^{-29}	2.72x10^{-29}
Aromatic C10-C12	0.01	4.83x10^{-40}	1.94x10^{-39}	1.51x10^{-38}	1.59x10^{-39}
Benzene	0.001	4.73x10^{-8}	4.34x10^{-8}	1.47x10^{-7}	1.42x10^{-7}
Benzo(a)pyrene	0.00001	<1x10^{-40}	<1x10^{-40}	<1x10^{-40}	<1x10^{-40}

3.4.2 Non-Hazardous Pollutants

Non-Hazardous Pollutants have been assessed against their respective EALs in down-gradient groundwater following immediate localised dilution but prior to any attenuation or dispersion. The model results summarised in Table 3-3 below indicate:

- predicted resultant concentrations are below EALs with an attenuation layer of maximum permeability 1x10^{-7}m/s or 1x10^{-6}m/s; and

  predicted resultant concentrations are also below EALs if waste with 3 x IWAC is deposited within an attenuation layer of maximum permeability 1x10^{-7}m/s.

Table 3-3

Non-Hazardous Pollutants – Max Predicted Concentrations after Dilution and Attenuation in Groundwater

Determinand (mg/l)	Max GW Background	EAL	Max Resultant Concentration for Attenuation Layer Permeability			
			1x10^{-7} m/s	1x10^{-6}m/s	3 x IWAC with 1x10^{-7}m/s	3X IWAC with 1x10^{-6}m/s
Fluoride	<0.5	0.75	0.069	0.069	0.207	0.208
Copper	0.0037[b]	0.012	0.0019	0.0019	0.0056	0.0057

Determinand	Max GW	EAL	Max Resultant Concentration for Attenuation Layer Permeability			
Nickel	0.0056	0.011	$1.79\text{x}10^{-4}$	$1.78\text{x}10^{-4}$	$4.78\text{x}10^{-4}$	$4.80\text{x}10^{-4}$
Sulphate	163	184	52.43	52.19	156.4	156.7
Zinc	0.0082[a]	0.02	$2.53\text{x}10^{-5}$	$2.52\text{x}10^{-5}$	$7.60\text{x}10^{-5}$	$7.43\text{x}10^{-5}$

[a] - Excluding outlier of 0.016 mg/l at BH01 on 20/8/2019; [b] – Excluding outlier of 0.0064 mg/l at BH01 on 16/6/21

Table 3-2 and Table 3-3 demonstrate that the predicted resultant concentrations at the respective compliance points are lower than the appropriate EALs if an attenuation layer of maximum permeability $1\text{x}10^{-7}$m/s or $1\text{x}10^{-6}$m/s is installed. It is therefore considered that the modelling has shown that the discharge of Hazardous Substances and Non-Hazardous Pollutants will be sufficiently limited so as to avoid pollution.

3.5 Assessment Conclusions

The modelling results demonstrate that the proposed importation of inert waste at Elton 2 will remain compliant with the Environmental Permitting Regulations 2016 (as amended) provided that the waste meets inert WAC limits, assuming that a 1m thick attenuation layer is installed with a maximum permeability of $1 \text{ x } 10^{-7}$ m/s. It is noted that even with a lower specification attenuation layer of $1 \text{ x } 10^{-6}$ m/s and/or waste up to 3 x IWAC the modelling predicts that the discharge of Hazardous Substances and Non-Hazardous Pollutants would be sufficiently limited so as to avoid pollution.

3.6 Review of Technical Precautions

Essential and technical precautions are those measures required to ensure that the Site complies with Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended). Essential and technical precautions typically include both restrictions on waste types and the engineering and other environmental management measures. Given the proposed classification as inert waste, the Site will not require leachate management. However, the following essential and technical precautions are proposed:

- a sidewall attenuation layer at least 1 metre thick with a maximum permeability of $1 \text{ x } 10^{-7}$ m/s;
- all waste deliveries will be pre-arranged and come from known sources;
- all wastes will be subjected to stringent waste acceptance criteria and waste acceptance procedures;
- all wastes will be inspected at the weighbridge and again once tipped in the waste processing and storage area. All Site operatives will be trained to inspect waste upon tipping to ensure that it meets the waste acceptance criteria and to implement an accident management plan to remove non-conforming materials immediately; and
- environmental monitoring, as specified in Section 4 will be undertaken.

3.7 Hydrogeological Completion Criteria

Due to the nature of the waste it is concluded that the Site will be complete (that is, the Site no longer has the potential to cause damage to or deterioration of the environment and risk to human health) with respect to hydrogeology immediately after the completion of restoration works and/or definite closure of the Site.

4.0 Requisite Surveillance

The Environmental Permitting Regulations 2016 (as amended), require that "*requisite surveillance*" is undertaken where disposal of substances potentially giving rise to Hazardous Substances or Non-Hazardous Pollutants has been authorised by the EA. Therefore, environmental monitoring will be undertaken to provide assurance that the Site is not resulting in any detrimental effects on water quality.

4.1 Leachate Monitoring

WAC testing will be completed on selected wastes prior to deposition at the Site. There is no requirement for leachate monitoring.

4.2 Groundwater Monitoring

The monitoring of groundwater quality around the perimeter of the Site will be carried out using the existing network of monitoring boreholes.

Although this is a recovery application, in keeping with inert landfill guidance, it is proposed that ongoing groundwater level and quality monitoring is undertaken from at least one up-gradient and two down-gradient boreholes within the River Terrace Deposits sand and gravel aquifer.

Groundwater level monitoring indicates that groundwater flow broadly towards the east across the Site. It is therefore proposed that the following Site boreholes are used for groundwater quality monitoring purposes going forward:

- Up-Gradient: BH1
- Cross-Gradient: BH5
- Down-Gradient: BH3 and BH4

The proposed monitoring schedule is outlined in Table 4-1 below, and monitoring locations are shown on Drawing 09. The proposed schedule is based on current EA landfill monitoring guidance and the results of this HRA.

Table 4-1
Proposed Groundwater Monitoring Schedule

Groundwater Monitoring Locations	Monitoring Frequency	Measurement and Analytical Suite
Up-gradient: BH1 Cross-gradient: BH5 Down-gradient: BH3, BH4	Quarterly	Groundwater level (mAOD), electrical conductivity, chloride, ammoniacal nitrogen, pH, fluoride, copper, nickel, sulphate, lead, arsenic, zinc.
	Annual	Total alkalinity, magnesium, potassium, calcium, sodium, chromium, copper, iron, selenium, manganese, cyanide, mercury, BTEX (benzene, toluene, ethylbenzene & xylene), acenaphthene, benzo(a)pyrene, total PAHs, Aromatic C10-C12, well base (mAOD).
Note: all metals to be analysed as filtered/dissolved		

4.3 Surface Water Monitoring

The risk of any impact from the Site on water quality in the River Nene is considered to be relatively low due to the intervening low permeability overburden on which the Rive Nene is likely to be perched, plus the relatively high flows in the Nene. Furthermore, the location of the groundwater monitoring wells means that these provide early identification of any release which could impact the surface water down-gradient of the Site.

However, as an additional precaution it is also considered to monitor surface water at the upstream and downstream ends of the Mill Stream at locations SWA and SWB shown on Drawing 09, including copper and sulphate as the only substances for which model results were not negligible compared with EQS. The proposed surface water monitoring schedule is presented in Table 4-2.

Table 4-2
Proposed Surface Water Monitoring Schedule

Surface Water Monitoring Points	Monitoring Frequency	Parameters
SWA SWB	Quarterly	Ammoniacal Nitrogen, chloride, suspended solids, visual oil and grease, pH, electrical conductivity, dissolved copper, sulphate

4.4 Control Levels and Compliance Limits

4.4.1 Groundwater

The HRA has demonstrated that the Site will limit the release of both Hazardous Substances and Non-Hazardous Pollutants. However, it is appropriate to set appropriate control levels and compliance limits for suitable representative determinands. Based on the above assessment it is considered appropriate to use the following determinands for compliance monitoring:

- Arsenic: representative of Hazardous Substance in inert waste with relatively low background concentrations; and
- Sulphate: conservative determinand which can potentially provide an early indicator of leachate leakage.

Control levels and compliance limits have been set for each of the determinands above for the proposed compliance boreholes within the chalk aquifer.

The control levels and compliance limits have been set as follows:

- Arsenic: as the maximum background exceeds the EAL which was set at the UKTAG *'concentration in groundwater below which the danger of deterioration in the quality of the receiving groundwater is avoided'* the compliance limit was set at maximum background*;*
- Sulphate and Copper: the compliance limits have been set at the EALs used for this HRA i.e. midway between average baseline and the UK DWS / EQS respectively and the control level has been set at the mean baseline + 2 x Standard Deviations.

The above approach is considered highly conservative as the proposed compliance limits for sulphate and copper are well below DWS / EQS respectively. This approach has been used to reflect the potential sensitivity of the aquifer and to ensure there is no significant deterioration in groundwater quality.

The proposed groundwater compliance limits and control levels are provided in Table 4-3 below.

Table 4-3
Proposed Groundwater Compliance Limits and Control Levels

BHID	Determinand	Proposed Compliance Limit (mg/l)	Proposed Control Level (mg/l)
BH3 & BH4	Arsenic	0.0062	-
	Copper	0.012	0.002
	Sulphate	184	154

5.0 Conclusions

5.1 Compliance with Schedule 10 of the Environmental Permitting Regulations, 2016

The results of this risk assessment have established the following:

- the proposed operation will only accept inert waste streams, therefore there is no significant contaminant source and leachate management is not required;
- a sidewall and basal attenuation barrier with a minimum thickness of 1 metre and a maximum permeability of 1×10^{-7}m/s will be provided;
- the modelling undertaken has demonstrated that the proposed waste deposit will not result in the release of Hazardous Substances, and the release of Non-Hazardous Pollutants will be sufficiently limited as to avoid pollution of the River Terrace Deposits aquifer;
- essential and technical precautions have been outlined;
- requisite surveillance, which includes the monitoring of groundwater around the Site has been detailed to ensure the installation remains in compliance with the Environmental Permitting Regulations 2016 (as amended).
- control levels /compliance limits have been set in order to ensure the adequate protection of ground and surface water resources; and
- the Site should comply with the relevant requirements of the Schedule 10 of the Environmental Permit Regulations 2016 (as amended).

5.2 Compliance with Schedule 22 of the Environmental Permitting Regulations 2016

The results of this risk assessment have established the following:

- the proposed development poses a potential hazard to groundwater quality. Consequently, it falls within the scope of Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended);
- this assessment has outlined the CSM that must be developed for waste deposit operations;
- the proposed technical precautions will prevent the discernible discharge of Hazardous Substances to groundwater throughout the Site lifecycle;
- the proposed technical precautions will limit the introduction of Non-Hazardous Pollutants into groundwater so as to avoid pollution throughout the Site lifecycle; and
- the following essential and technical precautions have been identified as part of the HRA:
    - the wastes to be accepted to the Site will meet inert WAC limits;
    - a risk-based programme of groundwater and the implementation of control levels and compliance limits have been outlined.

The Site therefore complies with the relevant requirements of the Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended).

APPENDICES

APPENDIX 01

Borehole Logs

BOREHOLE LOG

BOREHOLE No
BH01

Sheet 1 of 1

Client:
Ingrebourne Valley

Project No:	Date:	Ground Level:	Co-ordinates:
422.01526.00041	16-04-2019	16.10m OSGB	E506859 N292038

Project:
Elton 2 Groundwater Boreholes

SAMPLES & TESTS

Depth	Sample Type	Test Type	Test Result	SPT N Value 10 20 30 40

STRATA

Water	Reduced Level	Depth (Thickness)	DESCRIPTION
	15.90	0.20	Firm light orangish brown slightly sandy CLAY. Sand is fine. (TOPSOIL)
	14.80	(1.10) 1.30	Stiff light brown slightly sandy slightly gravelly CLAY. Gravel is sub-angular fine to medium of flint. Sand is fine to medium.
	13.30	(1.50) 2.80	Stiff dark blue grey and yellowish orange mottled CLAY.
▼	13.10	3.00	Soft dark grey CLAY.
	12.80	3.30	Dark bluish grey slightly clayey sandy GRAVEL. Sand is fine to medium. Gravel is sub-rounded to sub-angular fine to coarse of mudstone and flint.
	10.60	(2.20) 5.50	Soft to firm dark bluish grey silty sandy CLAY. Sand is fine. *4.00 Sands and silts becoming finer.*

Borehole Complete at 5.50m

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling

From	To	Hours

Water Added

From	To

General Remarks

Cover Level: 16.43 mAOD. Borehole installed for the purposed of groundwater monitoring. Borehole installed with 50mm diameter slotted well screen. Rest water level 2.15mbgl.

All dimensions in metres
Scale 1:66

Contractor: SI Drilling
Plant: Dando 2000/No3

Method: Cable percussion (shell and auger)
Hole Size: 150

Logged By: Anna Hill

Approved By: GK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH02

Client:
Ingrebourne Valley

Project No:	Date:	Ground Level:	Co-ordinates:
422.01526.00041	17-04-2019	16.03m OSGB	E507268 N292066

Project:
Elton 2 Groundwater Boreholes

Sheet
1 of 1

Depth	Sample Type	Test Type	Test Result	SPT N Value 10 20 30 40

Water	Reduced Level	Depth (Thickness)	DESCRIPTION
	15.93	0.10	Stiff dark brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is sub-angular fine to coarse of flint.
	12.73	(3.20) 3.30	Firm to stiff dark brown slightly gravelly CLAY. Gravel is sub-rounded to sub-angular fine to coarse of flint and sandstone occasional cobbles of flint. *0.50 Occasional gravels of flint.* *1.30 Becoming dark bluish grey, red and yellow mottled.* *3.25 Slightly sandy.*
▼ (3.30)	9.03	(3.70) 7.00	Dark greyish brown sandy GRAVEL. Sand is fine to coarse. Gravel is sub-rounded to sub-angular fine to coarse of flint and sandstone. Occasional cobbles of flint. *5.70 Dark bluish grey gravels of mudstone.*
	8.53	(0.50) 7.50	Firm to stiff dark bluish grey gravelly CLAY. Gravel is sub-rounded to sub-angular fine to coarse of mudstone. Frequent cobbles of strong mudstone.

Borehole Complete at 7.50m

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling

From	To	Hours

Water Added

From	To

General Remarks

Cover Level: 16.35 mAOD. Borehole installed for the purpose of groundwater monitoring borehole. Borehole installed with 50mm diameter slotted well screen. Rest water level at 1.00mbgl.

All dimensions in metres Scale 1:66	Contractor: SI Drilling Plant: Dando 2000/No3	Method: Cable percussion (shell and auger) Hole Size: 150	Logged By: Anna Hill	Approved By: GK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH03

Client:
Ingrebourne Valley

Project No:	Date:	Ground Level:	Co-ordinates:
422.01526.00041	16-04-2019	14.92m OSGB	E507481 N292152

Project:
Elton 2 Groundwater Boreholes

Sheet
1 of 1

SAMPLES & TESTS						STRATA				
Depth	Sample Type	Test Type	Test Result	SPT N Value 10 20 30 40	Water	Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
						14.72		0.20	Firm orangish brown slightly sandy CLAY. Sand is fine to medium.	
						12.62		(2.10) 2.30	Stiff yellowish brown CLAY.	
					▼	12.22		2.70	Yellowish brown gravelly fine to medium SAND. Gravel is sub-rounded to sub-angular fine to medium of flint.	
						7.92		(4.30) 7.00	Yellowish brown slightly sandy sub-rounded to sub-angular fine to medium GRAVEL of flint. Sand is fine to medium. *4.00 Becoming sandy.*	
						7.42		(0.50) 7.50	Dark brownish grey sandy sub-rounded to angular fine to coarse GRAVEL of flint and sandstone with occasional cobbles of sandstone. Sand is fine to medium.	
						6.72		(0.70) 8.20	Dark brownish grey sandy GRAVEL. Sand is fine to medium. Gravel is sub-rounded to angular fine to coarse of flint and sandstone. With occasional cobbles of sandstone. *8.00 Becoming clayey.*	
						6.22		(0.50) 8.70	Firm greyish brown gravelly CLAY. Gravel is sub-rounded to sub-angular fine to coarse of mudstone. Cobbles of mudstone.	

Borehole Complete at 8.70m

Boring Progress and Water Observations						Chiselling			Water Added	
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt	From	To	Hours	From	To

General Remarks

Cover Level: 15.26 mAOD. Borehole installed for the purpose of groundwater monitoring. Borehole installed with 50mm diameter slotted well screen. Rest water level 1.15mbgl.

All dimensions in metres Scale 1:66	Contractor: SI Drilling Plant: Dando 2000/No3	Method: Cable percussion (shell and auger) Hole Size: 150	Logged By: Anna Hill	Approved By: GK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH04b

Client:
Ingrebourne Valley

Project No:	Date:	Ground Level:	Co-ordinates:
422.01526.00041	15-04-2019	14.82m OSGB	E507407 N291848

Project:
Elton 2 Groundwater Boreholes

Sheet
1 of 1

SAMPLES & TESTS

Depth	Sample Type	Test Type	Test Result	SPT N Value 10 20 30 40

STRATA

Water	Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	Instrument	Backfill
	14.72	▨	0.10	Firm dark brown sandy gravelly CLAY. Sand is fine to medium. Gravel is sub-angular fine to coarse of flint and sandstone. (TOPSOIL)	■	■
▼	13.62	▤	(1.10) 1.20	Firm to stiff orangish brown slightly sandy CLAY. Sand is very fine to fine.	■	■
	12.82	▤	(0.80) 2.00	Very stiff dark grey to black gravelly CLAY. Gravel is sub-rounded to sub-angular fine to coarse of mudstone and sandstone with occasional cobbles.	■	■
	10.32	░	(2.50) 4.50	Brown to dark grey slightly sandy GRAVEL. Sand is fine to medium. Gravel is sub-rounded to angular fine to coarse of mudstone, sandstone and flint with occasional cobbles of flint. *3.00 Occasional cobbles of flint*	░	░
	7.32	░	(3.00) 7.50	Dark greyish brown gravelly SAND. Gravel is rounded to sub-angular fine to coarse of flint, sandstone and mudstone. With occasional cobbles of flint. Sand is fine to medium. *5.00 More gravel than sand. Sandy GRAVEL.* *5.50 Gravel becoming darker grey to black of mudstone.* *5.75 More sand than gravel Gravelly SAND.*	░	░
	6.32	░	(1.00) 8.50	Dark greyish brown sandy GRAVEL. Sand is fine to medium. Gravel is rounded to sub-angular fine to coarse of flint, sandstone and mudstone. Occasional cobbles of flint and mudstone. *8.00 Becoming clayey.* *8.20 Stiff clay lense.*	░	░
	5.82	▤	(0.50) 9.00	Stiff dark grey gravelly CLAY. Gravel is sub-angular fine to coarse of mudstone.	■	■

Borehole Complete at 9.00m

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

Cover Level: 15.15 mAOD, due to obstruction and very hard ground the borehole location was moved three times. Borehole installed for the purpose of groundwater monitoring. Borehole installed with 50mm diameter slotted well screen. Rest water level 1.2mbgl.

All dimensions in metres Scale 1:66	Contractor: SI Drilling Plant: Dando 2000/No3	Method: Cable percussion (shell and auger) Hole Size: 150	Logged By: Anna Hill	Approved By: GK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH05

Client:
Ingrebourne Valley

Project No:	Date:	Ground Level:	Co-ordinates:
422.01526.00041	16-04-2019	15.33m OSGB	E507029 N291766

Project:
Elton 2 Groundwater Boreholes

Sheet
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SAMPLES & TESTS

Depth	Sample Type	Test Type	Test Result	SPT N Value 10 20 30 40

STRATA

Reduced Level	Depth (Thickness)	DESCRIPTION
14.93	0.40	Firm dark brown slightly sandy CLAY. Sand is fine to medium. With rootlets and organic material. (TOPSOIL).
13.83	(1.10) 1.50	Stiff yellowish brown slightly gravelly CLAY. Gravel is sub-angular fine of flint. *1.30 No gravel. Clay turning bluish grey in colour.*
13.13	(0.70) 2.20	Soft dark grey to black CLAY. Very damp.
12.33	(0.80) 3.00	Dark bluish grey and brown slightly sandy GRAVEL. Sand is fine. Gravel is sub-rounded to angular fine to coarse of mudstone and flint.
8.83	(3.50) 6.50	Dark blue grey and brown sandy GRAVEL. Sand is fine to medium. Gravel is round to angular fine to coarse of mudstone and flint. With occasional cobbles of mudstone and flint. *3.50 Slightly sandy GRAVEL.* *4.20 Sandy GRAVEL.*
7.63	(1.20) 7.70	Light greyish brown gravelly SAND. Gravel is sub-rounded to sub-angular fine to coarse of mudstone and flint. Sand is fine to medium. *7.00 Becoming dark blue grey with cobbles of mudstone.*
7.13	(0.50) 8.20	Soft to firm dark greyish blue slightly gravelly CLAY. Gravel is sub-angular fine to coarse of mudstone. Occasional cobbles of mudstone.

Borehole Complete at 8.20m

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling

From	To	Hours

Water Added

From	To

General Remarks

Cover Level: 15.68 mAOD. Borehole installed for the purpose of groundwater monitoring. Borehole installed with 50mm diameter slotted well screen. Rest water level 0.9mbgl.

All dimensions in metres Scale 1:66	Contractor: SI drilling Plant: Dando 2000/No3	Method: Cable percussion (shell and auger) Hole Size: 150	Logged By: Anna Hill	Approved By: GK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH06

Client:
Ingrebourne Valley

Project No:	Date:	Ground Level:	Co-ordinates:
422.01526.00041	17-04-2019	15.07m OSGB	E507170 N291957

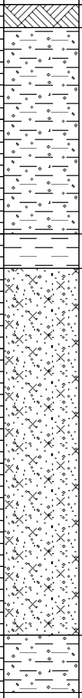
Project:
Elton 2 Groundwater Boreholes

Sheet
1 of 1

SAMPLES & TESTS

Depth	Sample Type	Test Type	Test Result	SPT N Value 10 20 30 40	Water

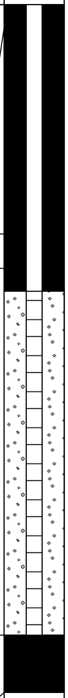
STRATA



Reduced Level	Depth (Thick-ness)	DESCRIPTION
14.87	0.20	Firm dark brown slightly sandy gravelly CLAY. Sand is fine to medium. Gravel is sub-angular fine to medium of flint. Rootlets and organic material present. (TOPSOIL).
13.07	(1.80) 2.00	Stiff light brown slightly gravelly CLAY. Gravel is sub-angular fine to medium of flint.
12.77	2.30	Very soft dark grey CLAY.
9.57	(3.20) 5.50	Dark blueish grey slightly silty gravelly SAND. Gravel is sub-angular fine to coarse of flint and sandstone. *3.50 Sandy GRAVEL. Occasional cobbles of flint.* *5.20 Becoming darker in colour. Clay present.*
9.07	(0.50) 6.00	Firm to stiff dark grey slightly gravelly CLAY. Gravel is rounded to sub-angular fine to coarse of mudstone. With cobbles of mudstone.

Borehole Complete at 6.00m

Instrument Backfill



Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling

From	To	Hours

Water Added

From	To

General Remarks

Cover Level: 15.38 mAOD. Borehole installed for the purpose of groundwater monitoring. Borehole installed with 50mm diameter slotted well screen. Rest water level 1.2mbgl.

All dimensions in metres Scale 1:66	Contractor: SI Drilling Plant: Dando 2000/No3	Method: Cable percussion (shell and auger) Hole Size: 150	Logged By: Anna Hill	Approved By: GK

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No: 01

SITE REF: IV Ltd Elton

DATE: 02.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)	SAMPLING NOTES
TS/SS		0.2	
firm silty brown CLAY		1.0 1.2	
v.soft v.silty grey/brown CLAY		2.0 2.4	
v.sandy(coarse) GRAVEL (<20mm)		3.0 4.0 5.0 5.2	LR01/1 (2.5-5.5m)
v.sandy(coarse) GRAVEL (<50mm)		5.5	
firm blue CLAY		6.0 6.0	
		7.0 8.0 9.0 10.0 11.0 12.0	

BOREHOLE LOG

BOREHOLE No: 02

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)	SAMPLING NOTES
TS/SS		0.2	
brown CLAY		1.0 1.3	
med. – soft grey/brown CLAY		1.8	
soft clayey black SILT		2.0 2.1	
v.sandy GRAVEL(<30mm)		3.0 4.0 4.3	LR02/1 (2.2-4.2m)
sandy orange CLAY		4.5	
gritty blue/grey CLAY with limestone cobbles		5.0 6.0 6.0	
		7.0 8.0 9.0 10.0 11.0 12.0	

BOREHOLE LOG

BOREHOLE No: 03

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)	SAMPLING NOTES
TS/SS		0.2	
brown CLAY		1.0 2.0	
soft clayey grey SILT		2.3	
v.sandy GRAVEL(<20mm)		3.0 4.0 5.0 6.0 6.1?	LR02/1 (2.3-6.0m)
gritty CLAY with cobbles		7.0 7.5	
		8.0 9.0 10.0 11.0 12.0	

BOREHOLE LOG

BOREHOLE No: 04

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)	SAMPLING NOTES
TS/SS		0.1	
		1.0	
brown CLAY		1.7	
		2.0	
		3.0	LR04/1 (1.8-6.0m)
		4.0	
		5.0	
orange v.sandy GRAVEL(<20mm)		5.5	
silty brown CLAY		5.7	
		6.0	
		7.0	
v.sandy GRAVEL(<20mm, some large cobbles)		7.1	
gritty grey CLAY		7.5	
		8.0	
		9.0	
		10.0	
		11.0	
		12.0	

BOREHOLE LOG

BOREHOLE No: 05

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)		SAMPLING NOTES
TS/SS			0.2	
brown CLAY			0.4	
		1.0		
v.sandy silty grey/brown CLAY			1.7	
v.silty fine-med. SAND		2.0	2.1	
		3.0		
				LR05/1 (3.0-4.5m)
		4.0		
V.sandy GRAVEL(<20mm)		5.0		
v.sandy GRAVEL(<50mm)				
firm blue CLAY		6.0	6.0	
		7.0		
		8.0		
		9.0		
		10.0		
		11.0		
		12.0		

BOREHOLE LOG

BOREHOLE No: 06

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)	SAMPLING NOTES
TS/SS		0.1	
brown CLAY		1.0 1.3	
brown/grey CLAY		2.0 2.1	
v.silty brown CLAY		2.4	
v.sandy GRAVEL(<20mm)		3.0 4.0 5.0 6.0 6.3	LR06/1 (2.56-6.0m)
firm grey CLAY with cobbles		7.0 7.2	
X Obstruction X		8.0 9.0 10.0 11.0 12.0	

BOREHOLE LOG

BOREHOLE No: 07

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)		SAMPLING NOTES
TS/SS			0.1	
		1.0		
firm brown CLAY becoming soft with depth				
			1.7	
brown/black SILT		2.0	2.1	
v.clayey gravelly SAND			2.6	
		3.0		
		4.0		
				LR07/1 (3.0-7.5m)
		5.0		
		6.0		
		7.0		
v.sandy GRAVEL(<20mm)				
			7.6	
firm gritty grey CLAY		8.0		
			8.5	
		9.0		
		10.0		
		11.0		
		12.0		

BOREHOLE LOG

BOREHOLE No: 08

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)		SAMPLING NOTES
TS/SS			0.2	
disturbed sandy brown CLAY			0.8	
		1.0		
firm brown CLAY			1.1	
orange SAND, SILT and CLAY			1.3	
grey/dark blue SAND, SILT and CLAY			1.6	
dark blue sandy SILT and CLAY		2.0	2.0	
grey/dark blue GRAVEL, SAND and SILT			2.4	
		3.0		
		4.0		
				LR08/1 (3.0-6.0m)
		5.0		
		6.0		
				* Auger scoured clean below 6.0m
		7.0		
v.sandy GRAVEL(<20mm)				
firm pale grey CLAY			7.5	
		8.0		
		9.0		
		10.0		
		11.0		
		12.0		

BOREHOLE LOG

BOREHOLE No: 09

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)		SAMPLING NOTES
TS/SS			0.2	
firm brown CLAY			0.5	
		1.0		
soft brown/grey CLAY			1.2	
v.soft brown/grey CLAY			1.6	
v.silty brown CLAY			1.9	
		2.0		
		3.0		
		4.0		
		5.0		
		6.0		
v.sndy GRAVEL(<20mm)			6.1?	
		7.0		
sandy(fine) pale grey SILT				
silty firm grey/brown CLAY				
		8.0		
sandy pale grey CLAY with boulders? X Obstruction X			8.7	
		9.0		
		10.0		
		11.0		
		12.0		

BOREHOLE LOG

BOREHOLE No: 10

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)		SAMPLING NOTES
TS/SS			0.2	
firm brown CLAY			0.5	
		1.0		
soft brown/grey CLAY			1.8	
soft grey CLAY		2.0	2.1	
v.soft black SILT and CLAY			2.5	
		3.0		
		4.0		LR10/1 (2.5-7.5m)
		5.0		
		6.0		
		7.0		
v.sandy GRAVEL(<20mm)		8.0	8.2	
firm gritty dark grey CLAY		9.0	9.0	
		10.0		
		11.0		
		12.0		

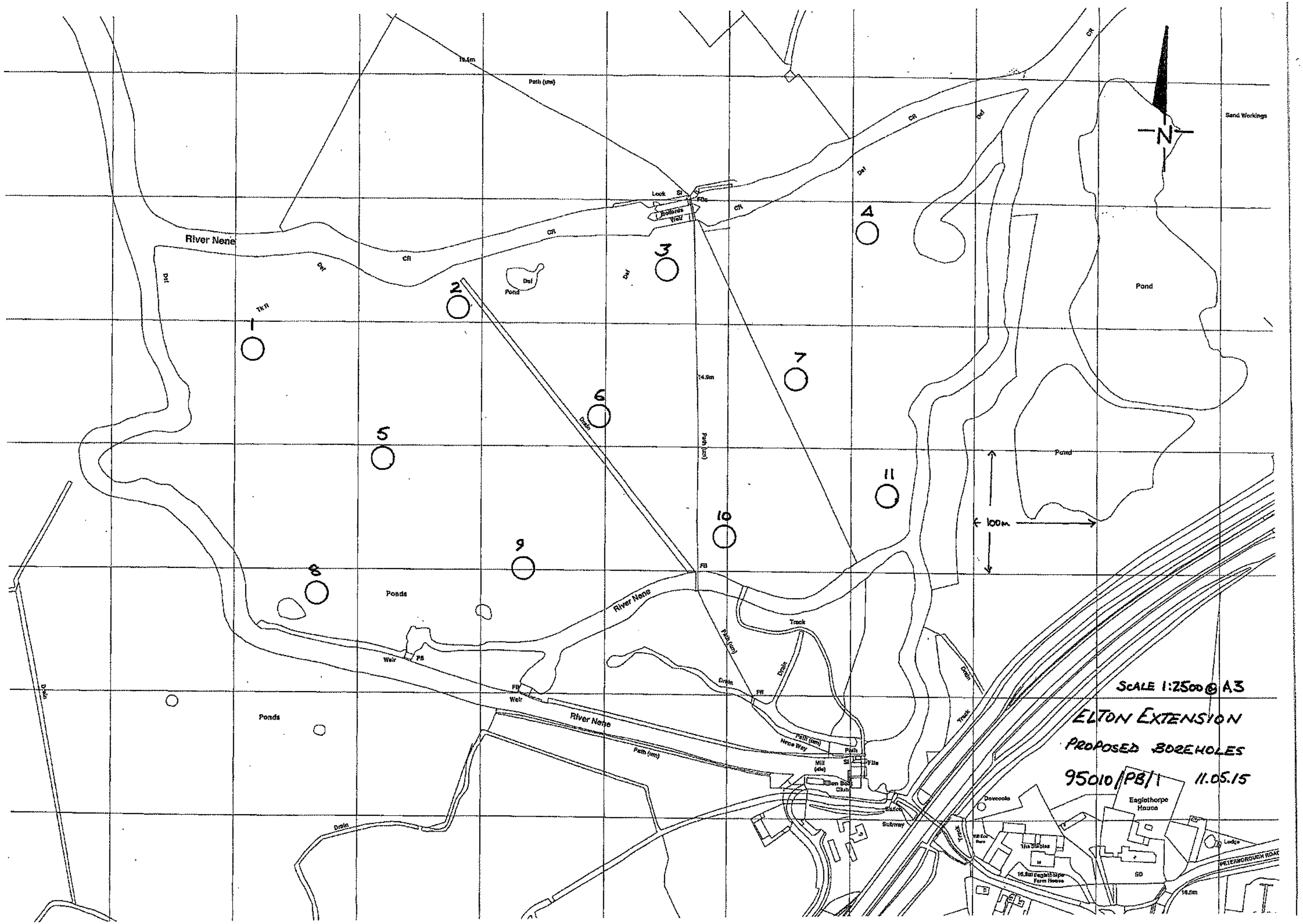
BOREHOLE LOG

BOREHOLE No: 11

SITE REF: IV Ltd Elton

DATE: 03.06.15

DESCRIPTION OF STRATA	LEGEND	DEPTH(m)	SAMPLING NOTES
TS/SS		0.2	
soft brown CLAY		1.0 1.2	
soft silty black CLAY		1.5	
v.gravelly SAND and SILT		1.7	
v.sandy GRAVEL(<20mm) becoming larger at base		2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 9.1	LR11/1 (2.0-7.5m)
firm gritty grey CLAY		10.0 10.0	
		11.0 12.0	



SCALE 1:2500 @ A3

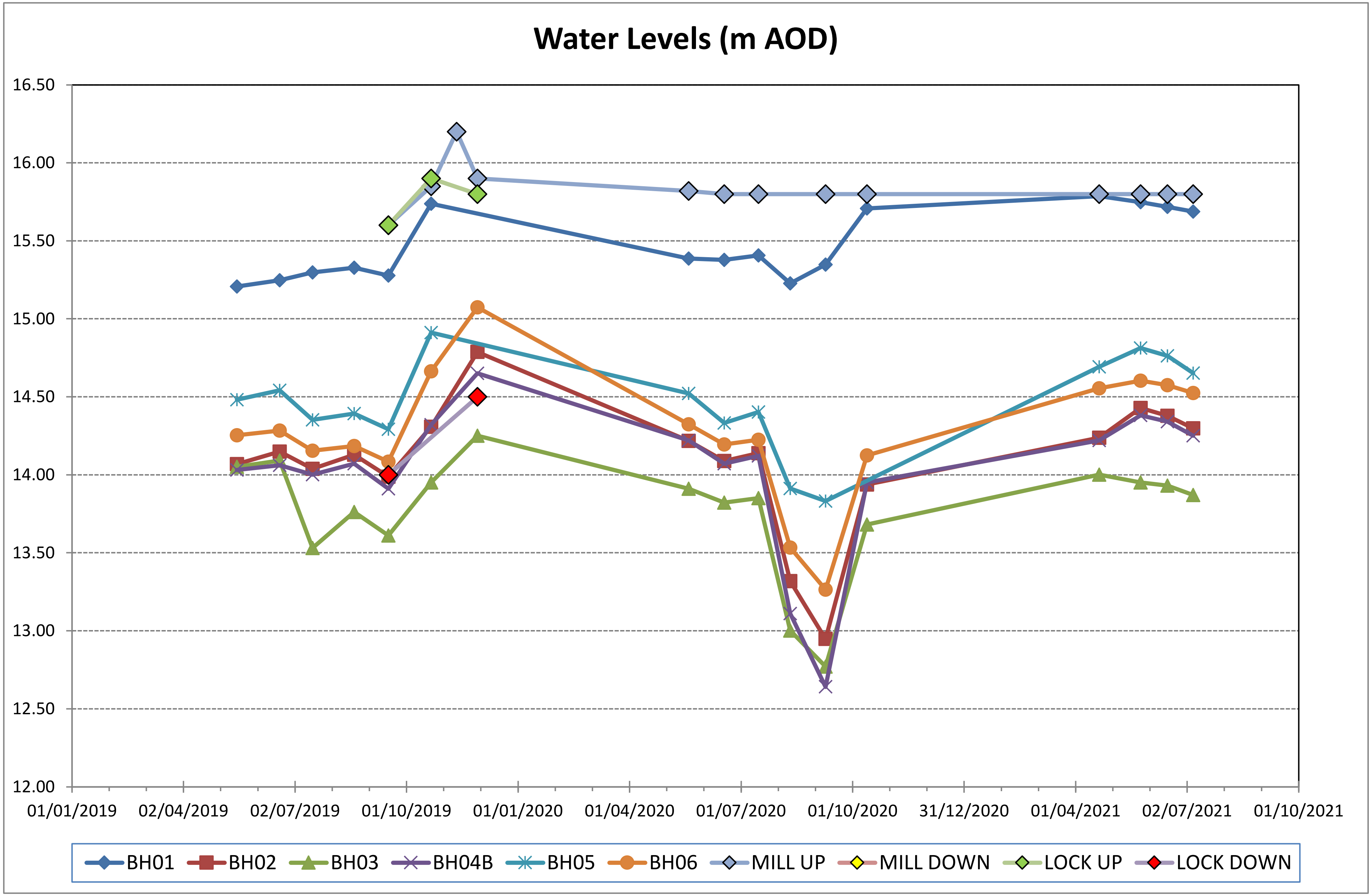
ELTON EXTENSION

PROPOSED BOREHOLES

95010/PB/1 11.05.15

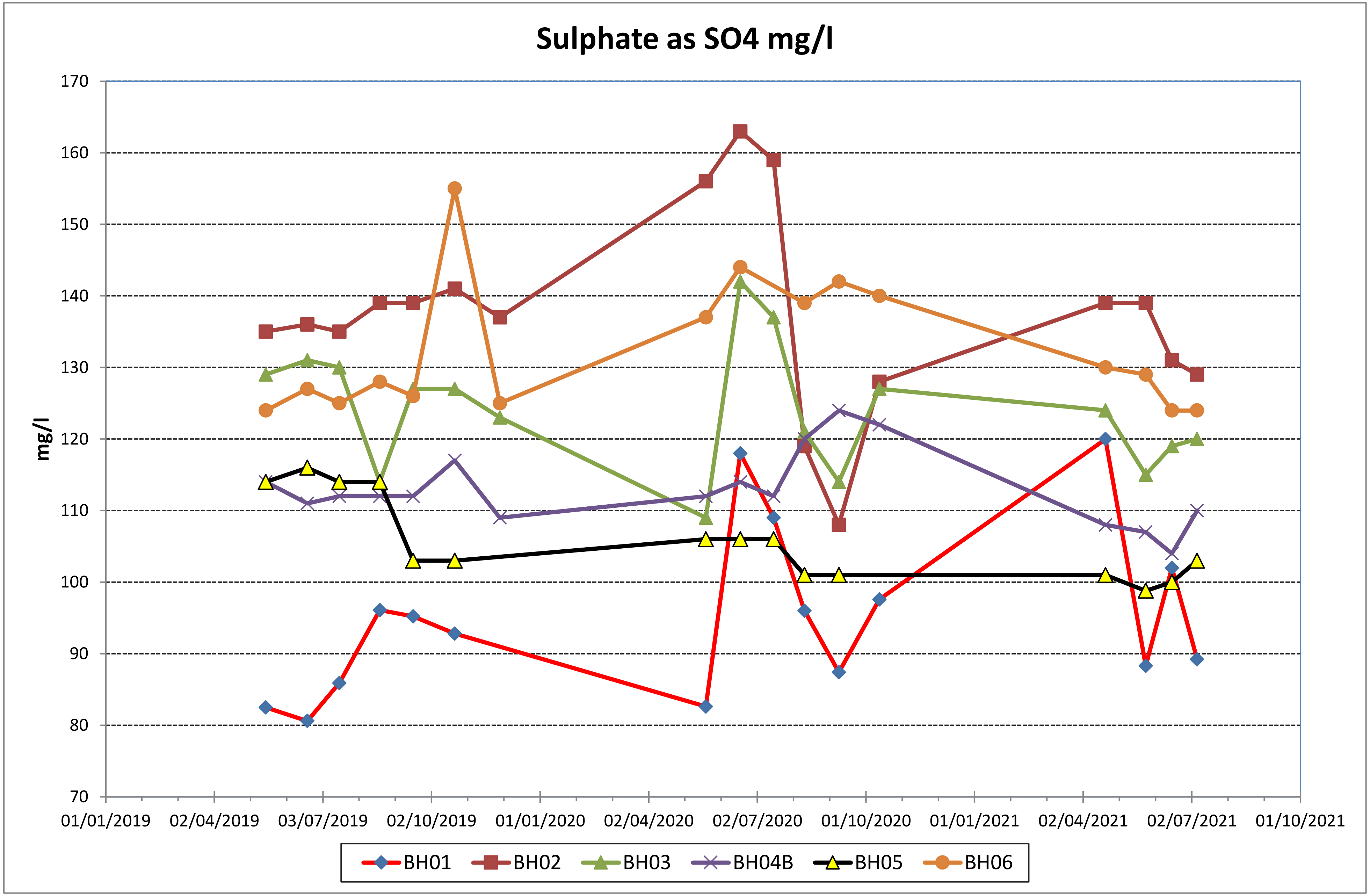
APPENDIX 02

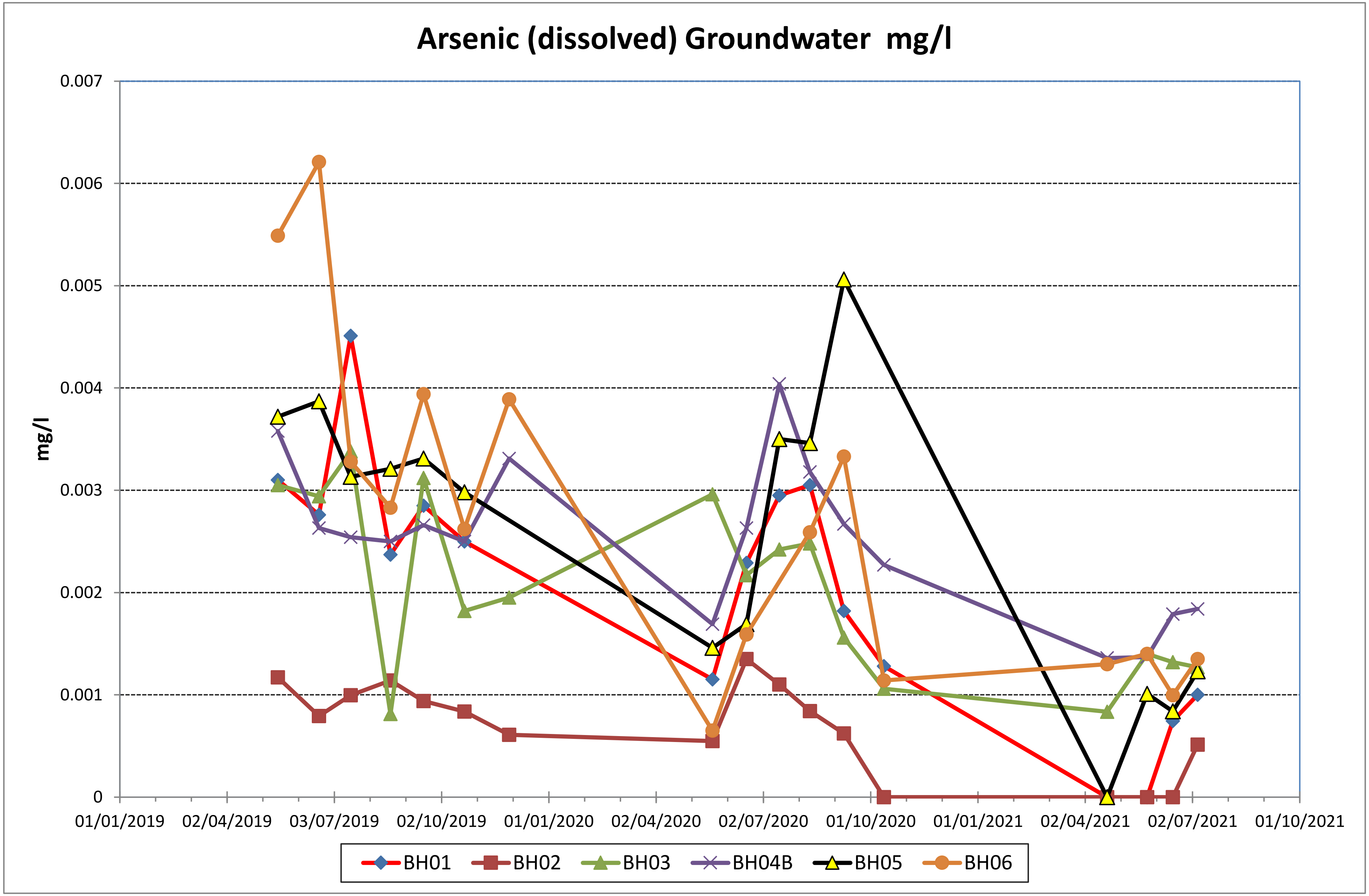
Groundwater Hydrographs

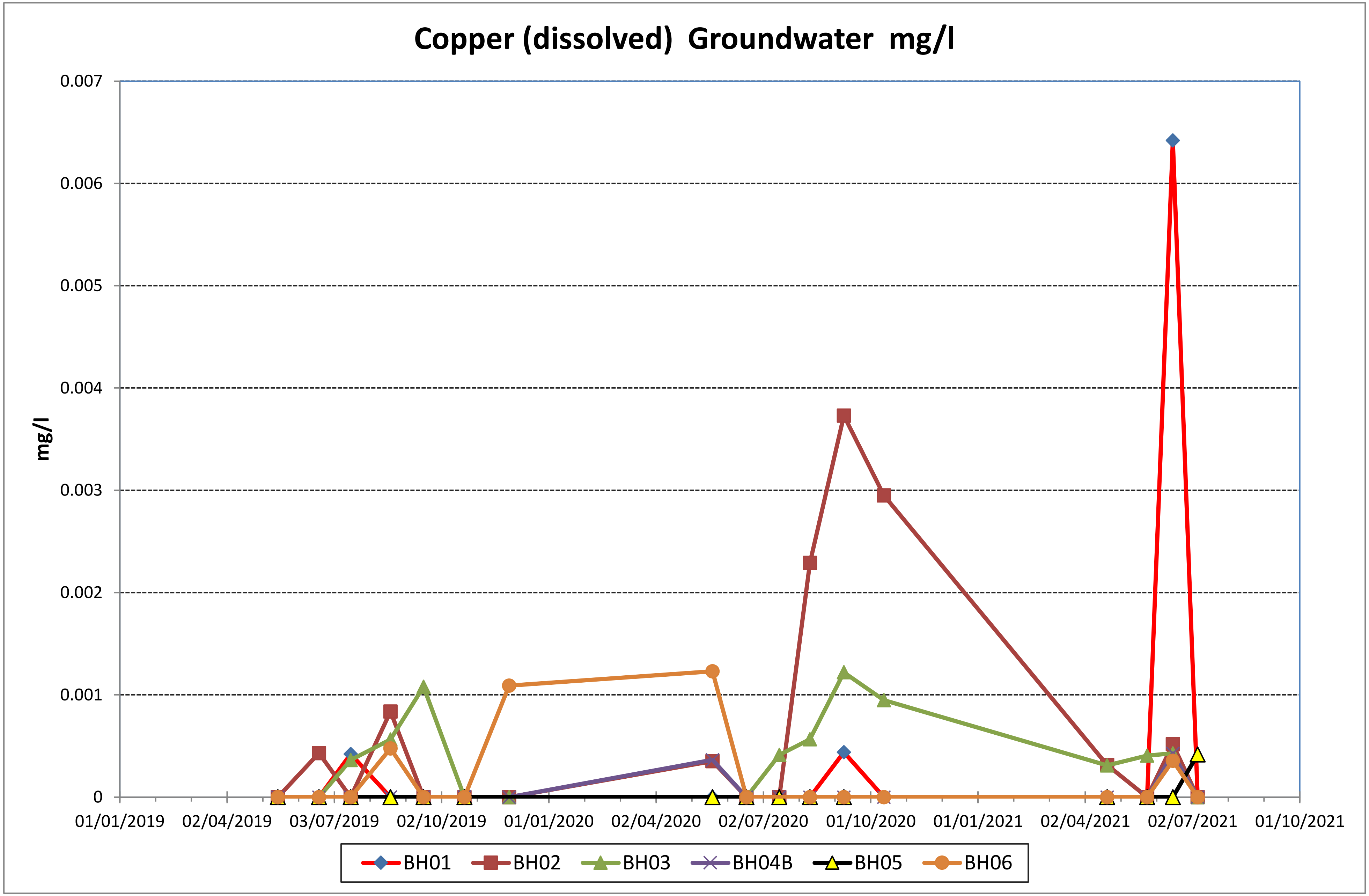

Water Levels (m AOD)
16.50
16.00
15.50
15.00
14.50
14.00
13.50
13.00
12.50
12.00
01/01/2019
02/04/2019
02/07/2019
01/10/2019
01/01/2020
01/04/2020
01/07/2020
01/10/2020
31/12/2020
01/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06
MILL UP
MILL DOWN
LOCK UP
LOCK DOWN

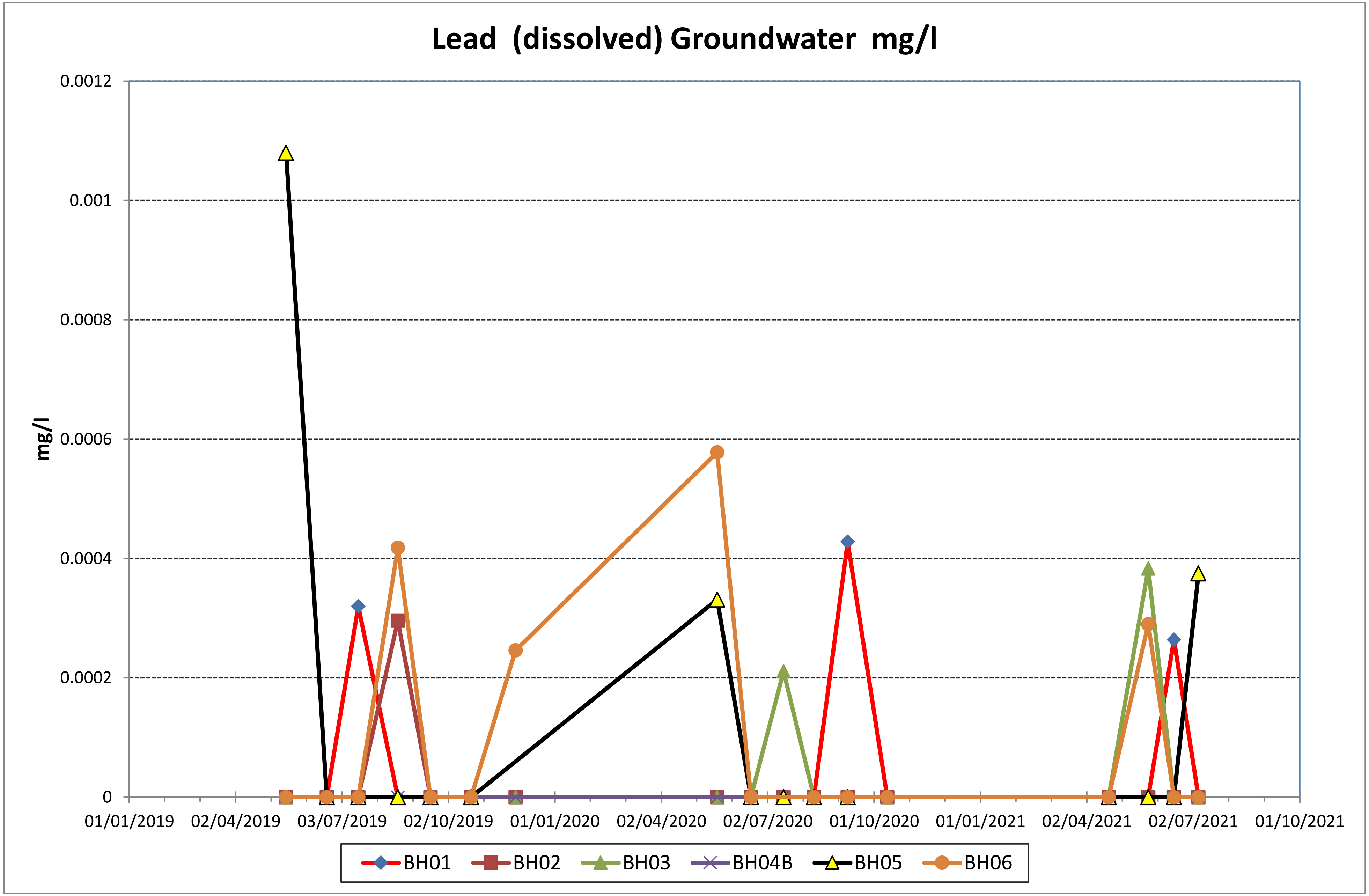
APPENDIX 03

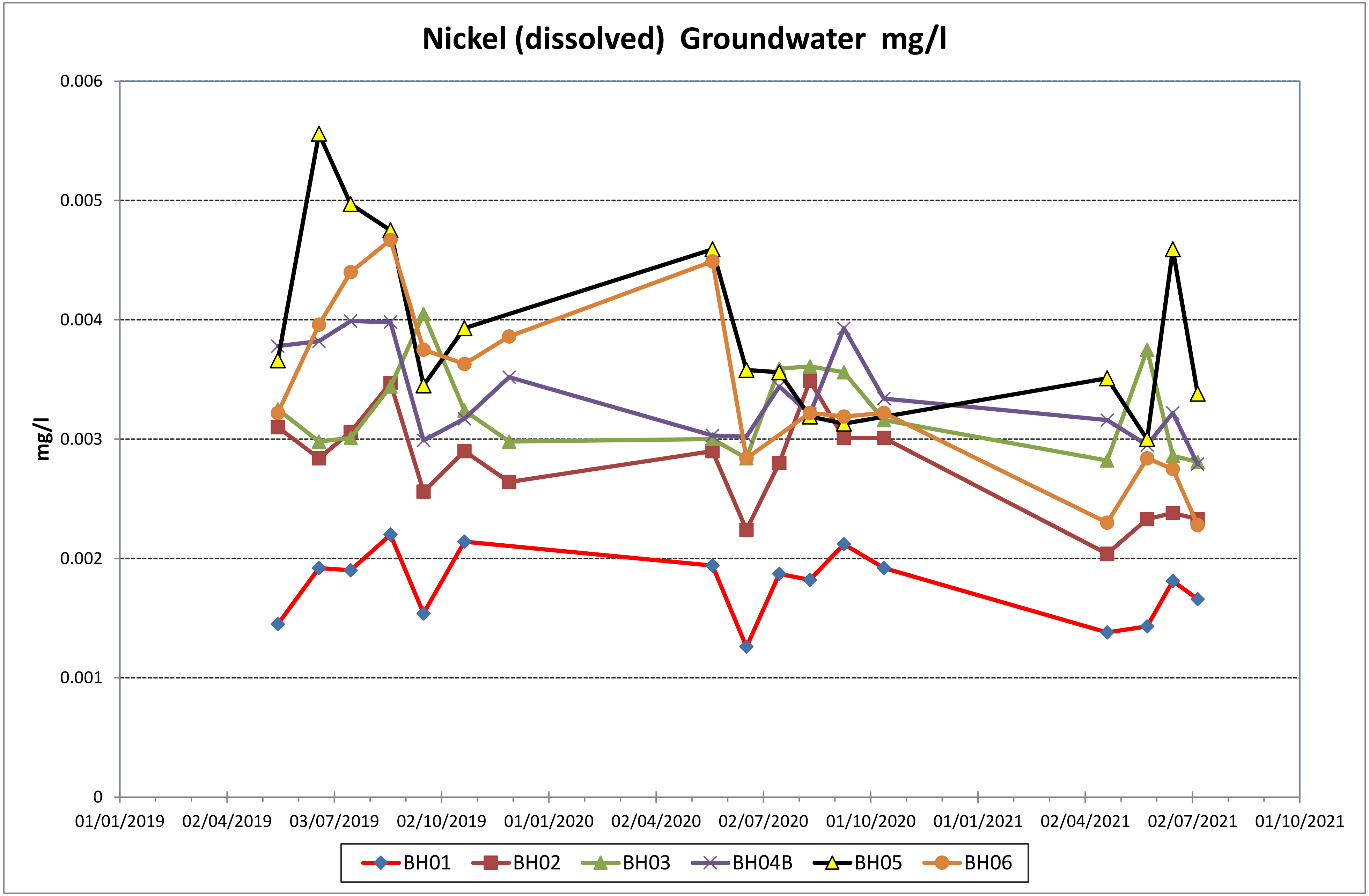
Groundwater Quality Chemographs

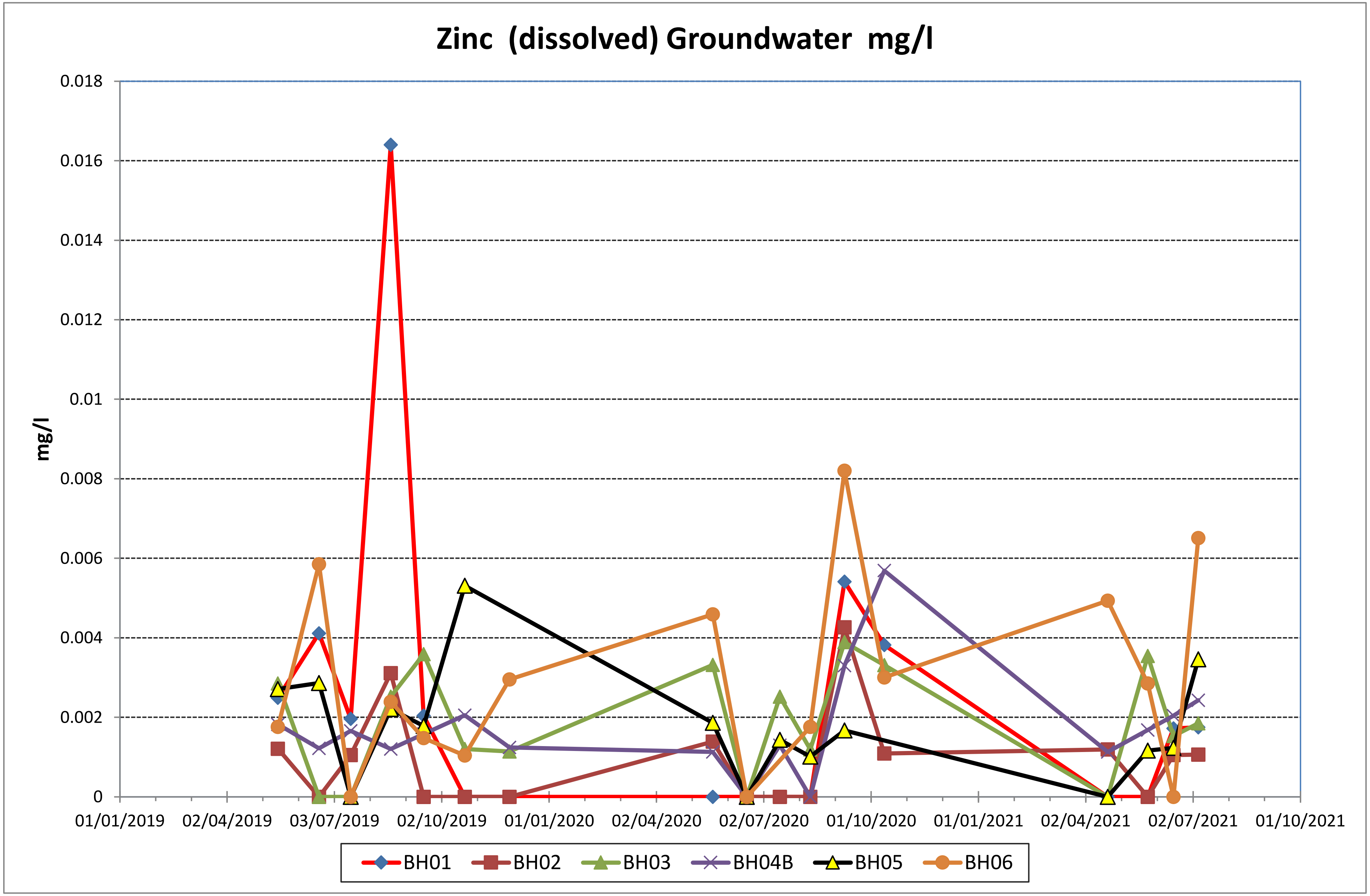

Sulphate as SO4 mg/l
mg/l
170
160
150
140
130
120
110
100
90
80
70
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06

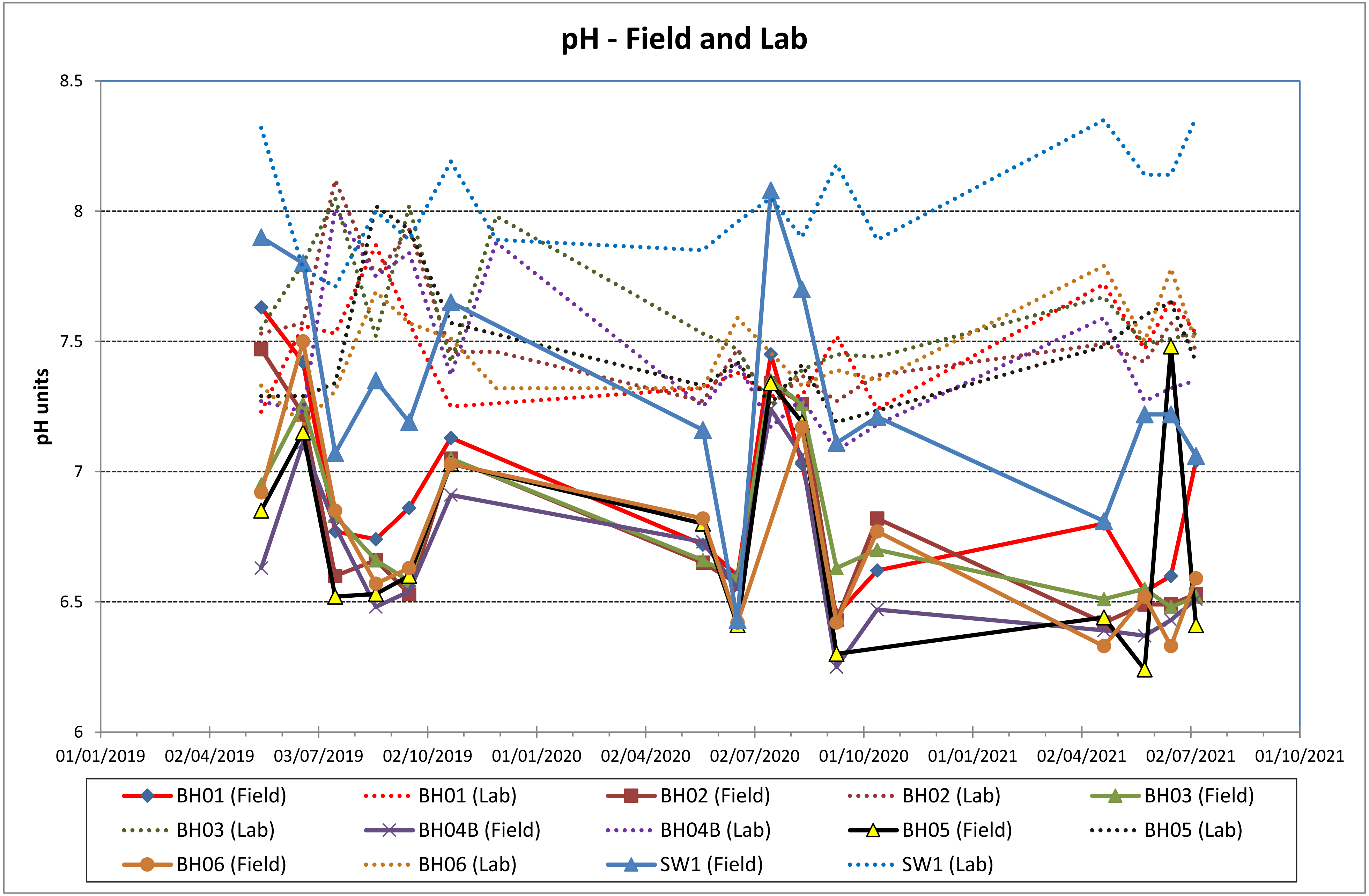

Arsenic (dissolved) Groundwater mg/l
mg/l
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06

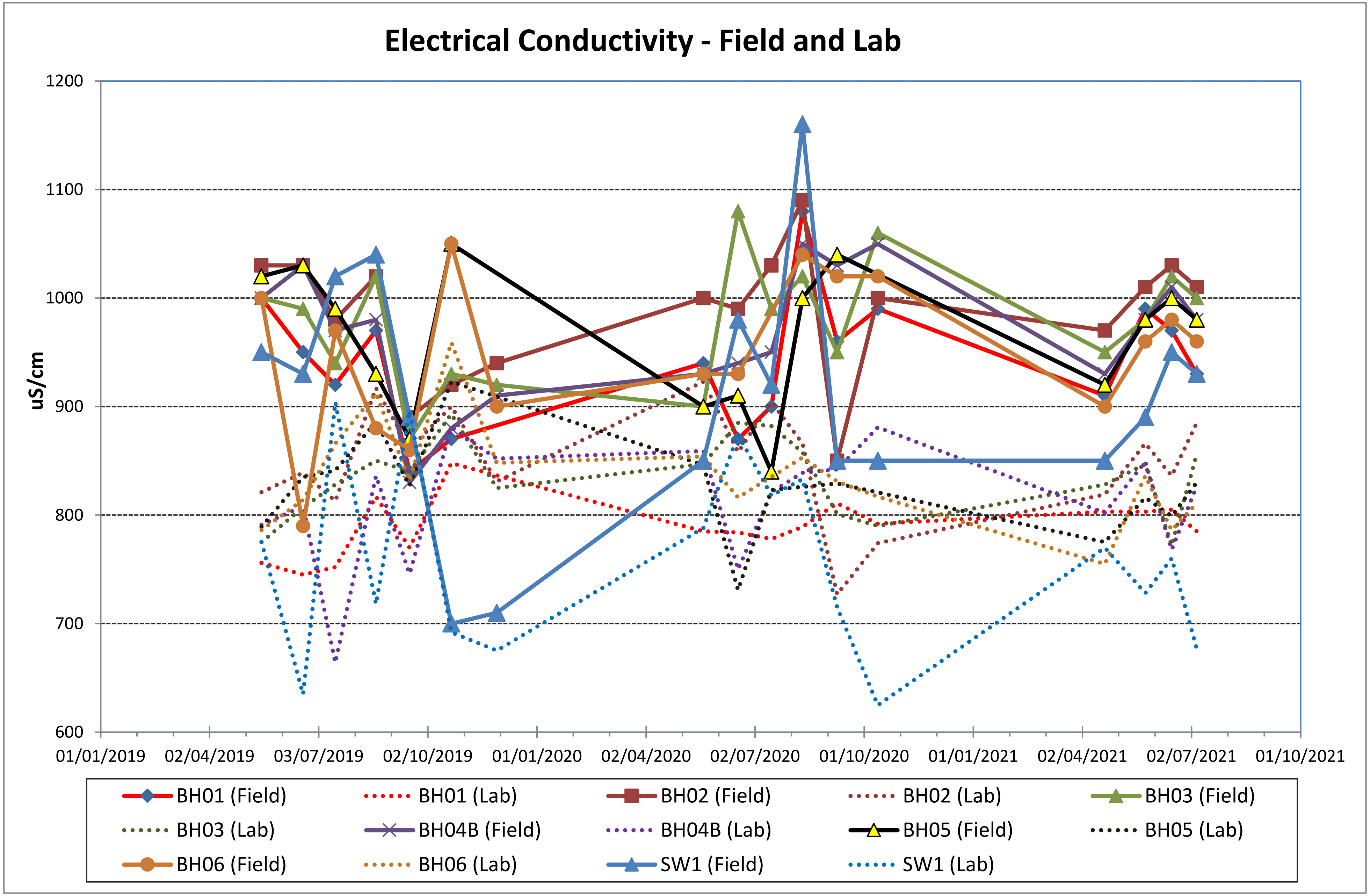

Copper (dissolved) Groundwater mg/l
mg/l
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06

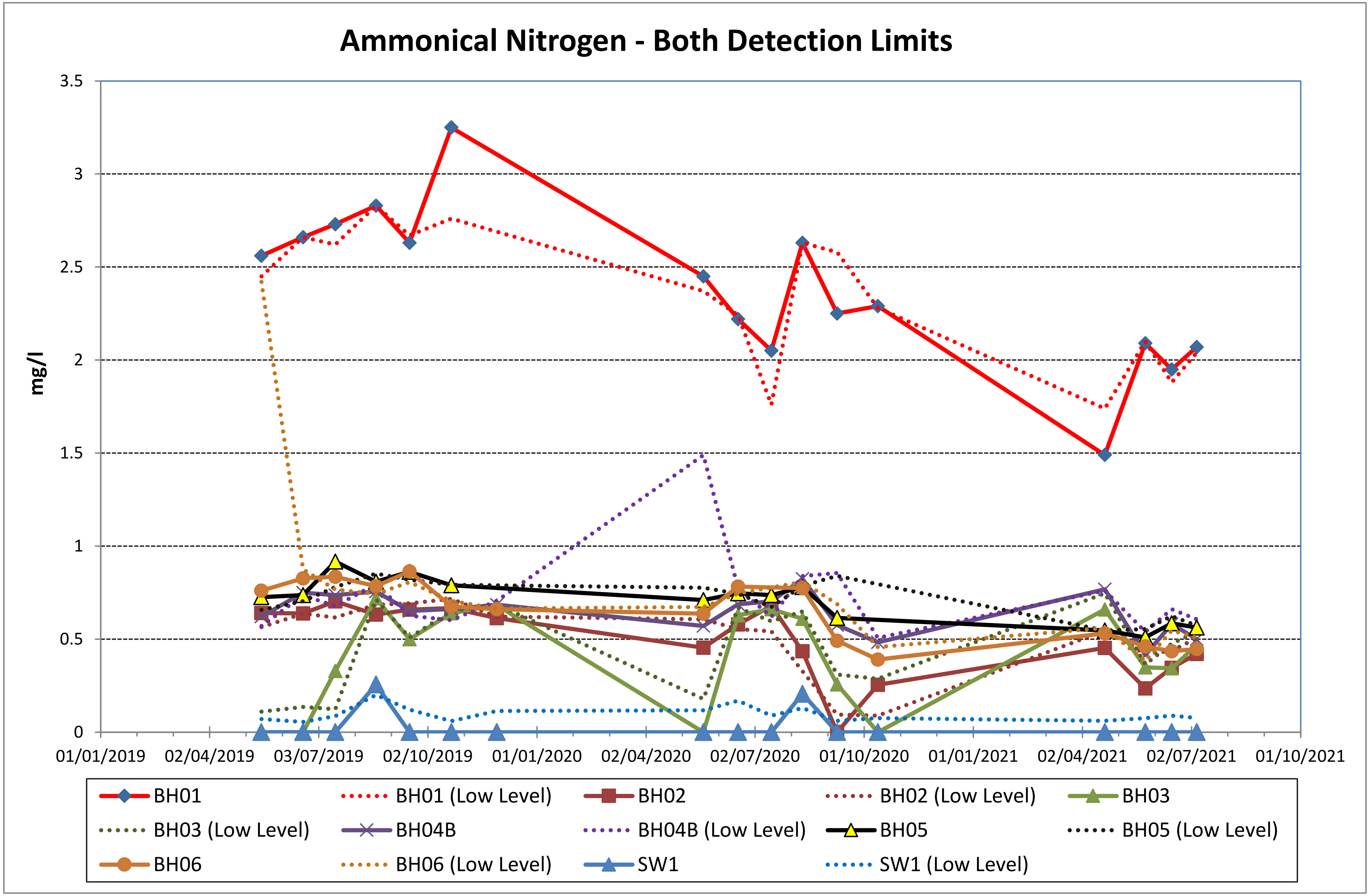

Lead (dissolved) Groundwater mg/l
mg/l
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06


Nickel (dissolved) Groundwater mg/l
mg/l
0.006
0.005
0.004
0.003
0.002
0.001
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06

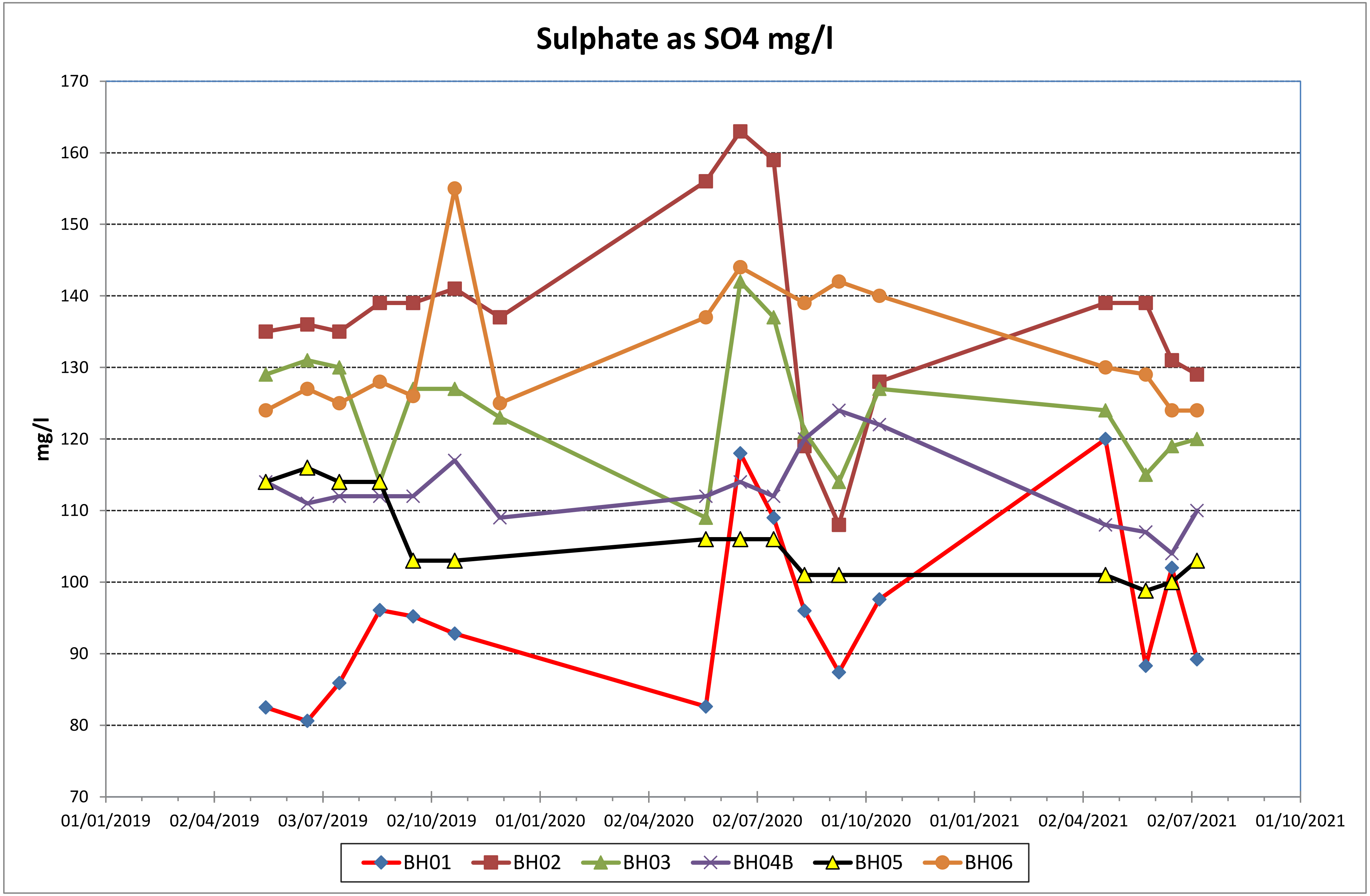

Zinc (dissolved) Groundwater mg/l
mg/l
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06

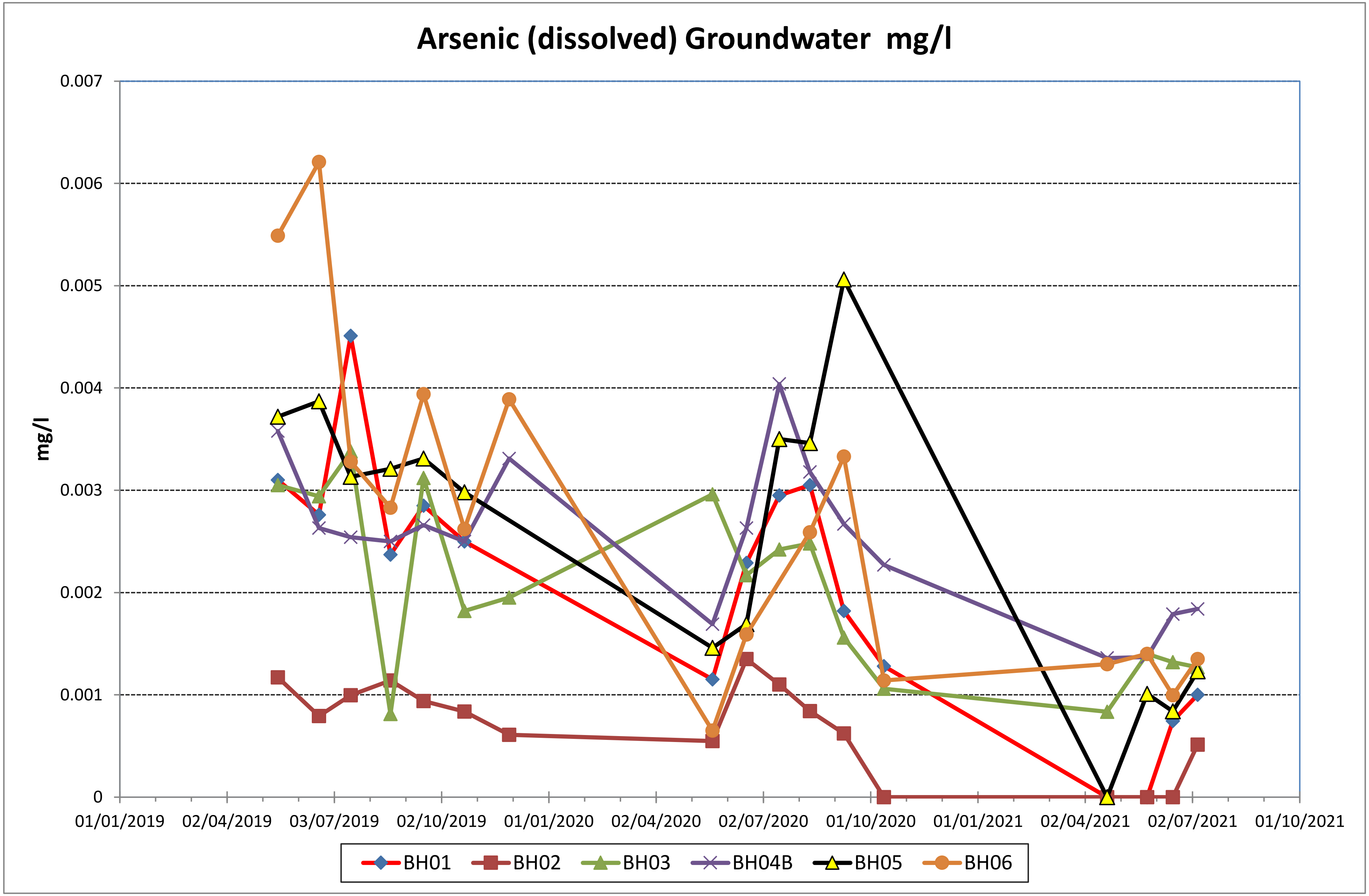

pH - Field and Lab
pH units
8.5
8
7.5
7
6.5
6
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01 (Field)
BH01 (Lab)
BH02 (Field)
BH02 (Lab)
BH03 (Field)
BH03 (Lab)
BH04B (Field)
BH04B (Lab)
BH05 (Field)
BH05 (Lab)
BH06 (Field)
BH06 (Lab)
SW1 (Field)
SW1 (Lab)

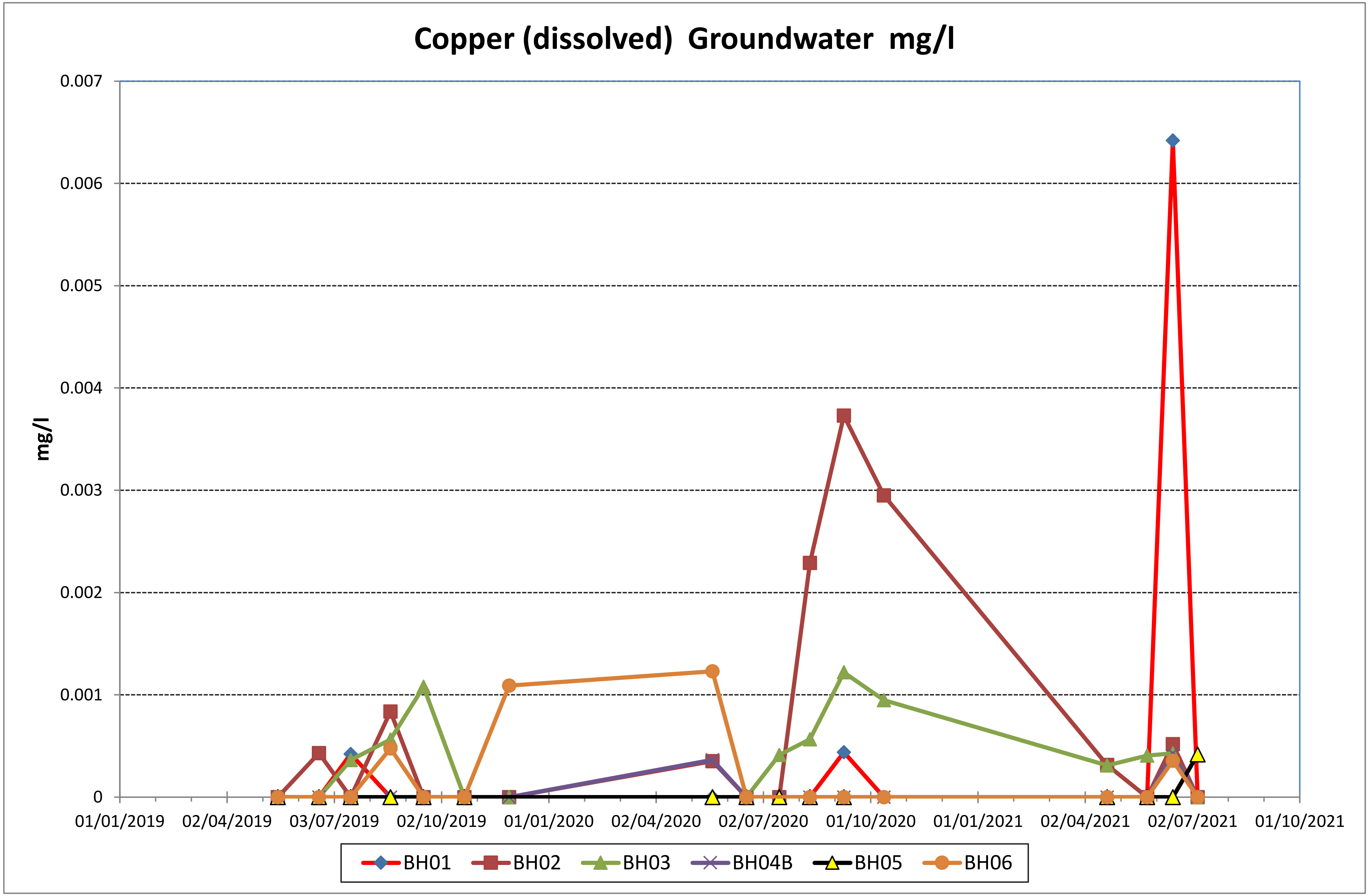

Electrical Conductivity - Field and Lab
uS/cm
1200
1100
1000
900
800
700
600
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01 (Field)
BH01 (Lab)
BH02 (Field)
BH02 (Lab)
BH03 (Field)
BH03 (Lab)
BH04B (Field)
BH04B (Lab)
BH05 (Field)
BH05 (Lab)
BH06 (Field)
BH06 (Lab)
SW1 (Field)
SW1 (Lab)

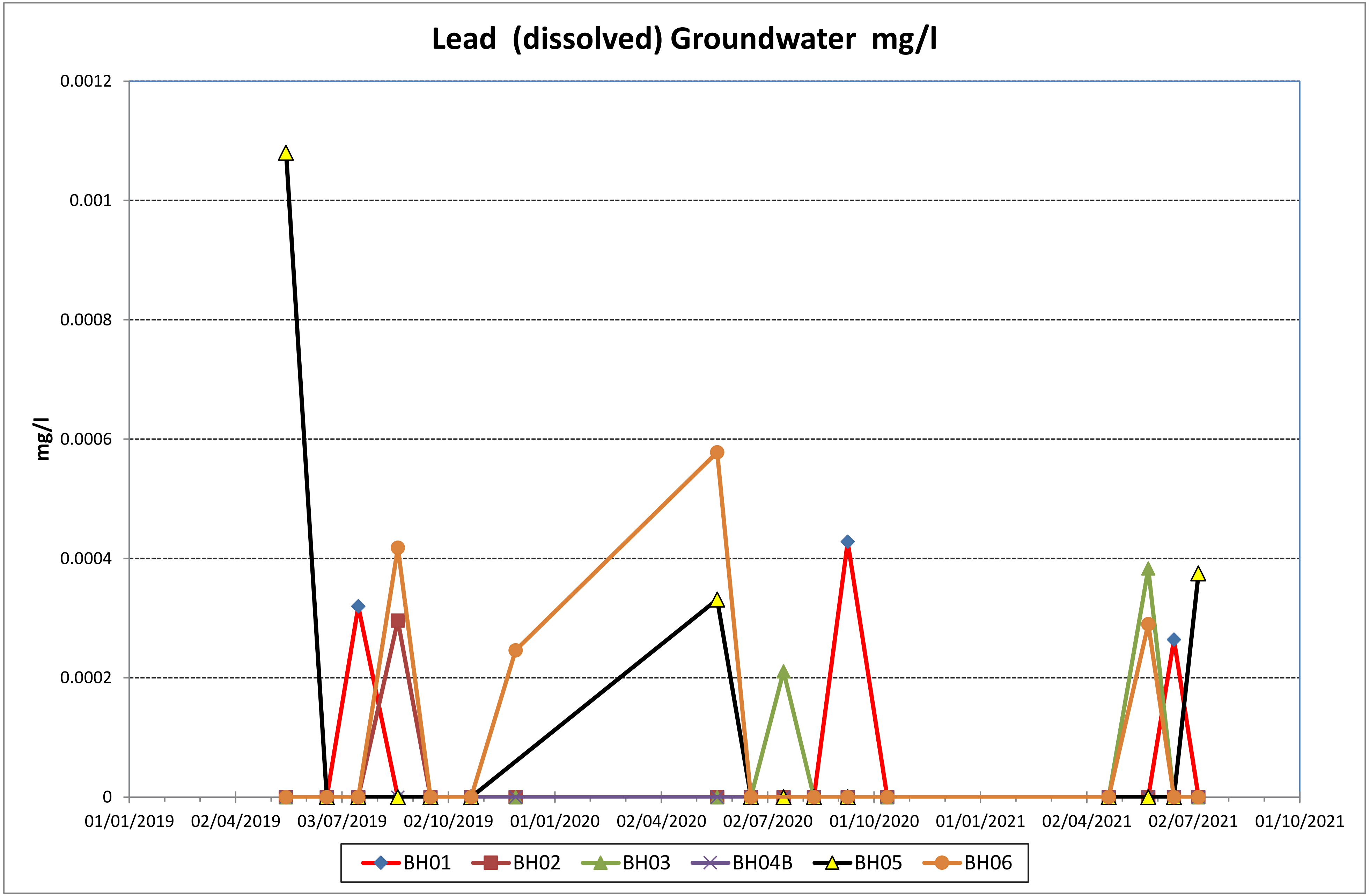


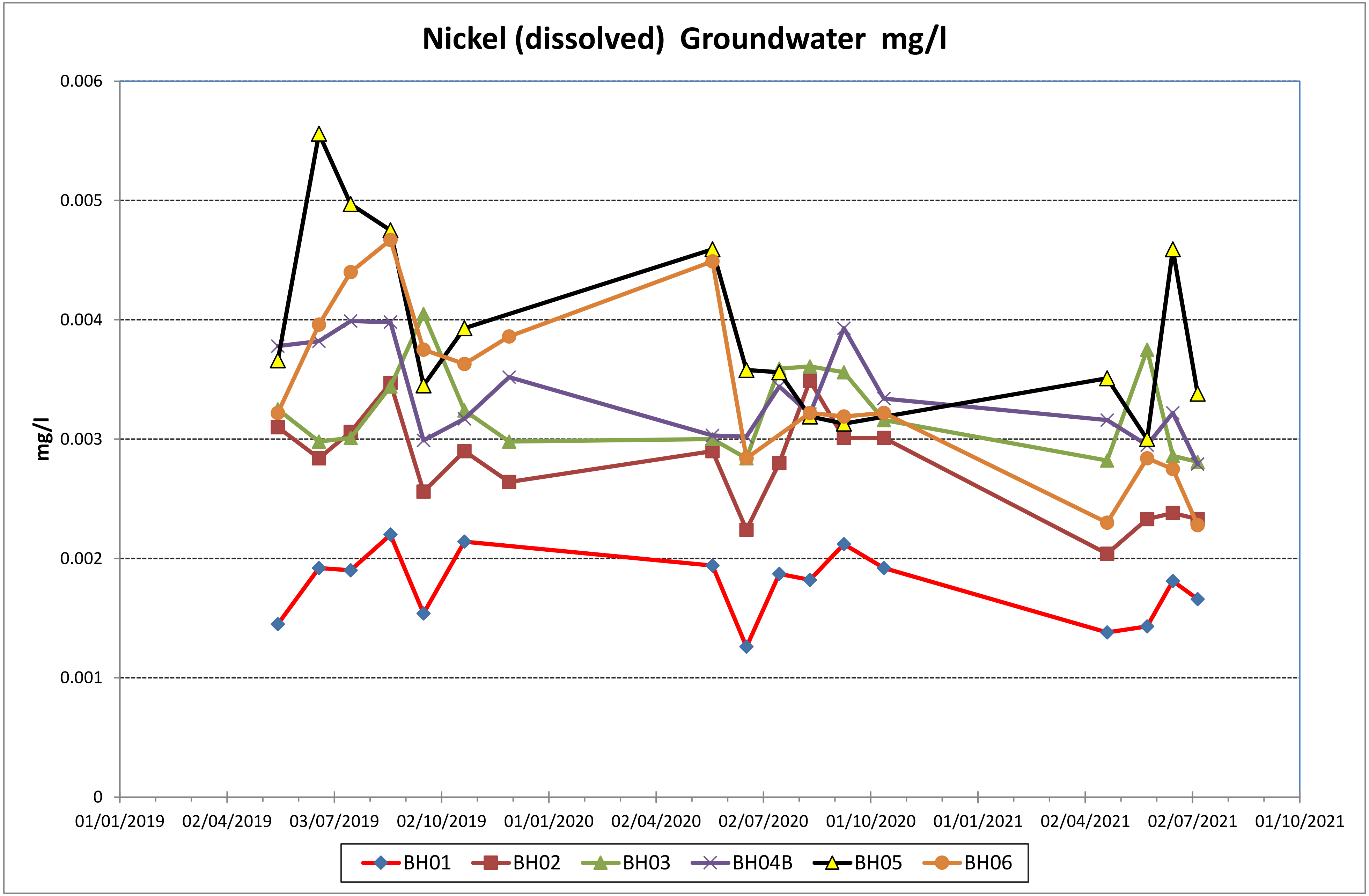
Ammonical Nitrogen - Both Detection Limits
mg/l
3.5
3
2.5
2
1.5
1
0.5
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH01 (Low Level)
BH02
BH02 (Low Level)
BH03
BH03 (Low Level)
BH04B
BH04B (Low Level)
BH05
BH05 (Low Level)
BH06
BH06 (Low Level)
SW1
SW1 (Low Level)


Sulphate as SO4 mg/l
mg/l
170
160
150
140
130
120
110
100
90
80
70
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06


Arsenic (dissolved) Groundwater mg/l
mg/l
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06


Copper (dissolved) Groundwater mg/l
mg/l
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06


Lead (dissolved) Groundwater mg/l
mg/l
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06


Nickel (dissolved) Groundwater mg/l
mg/l
0.006
0.005
0.004
0.003
0.002
0.001
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
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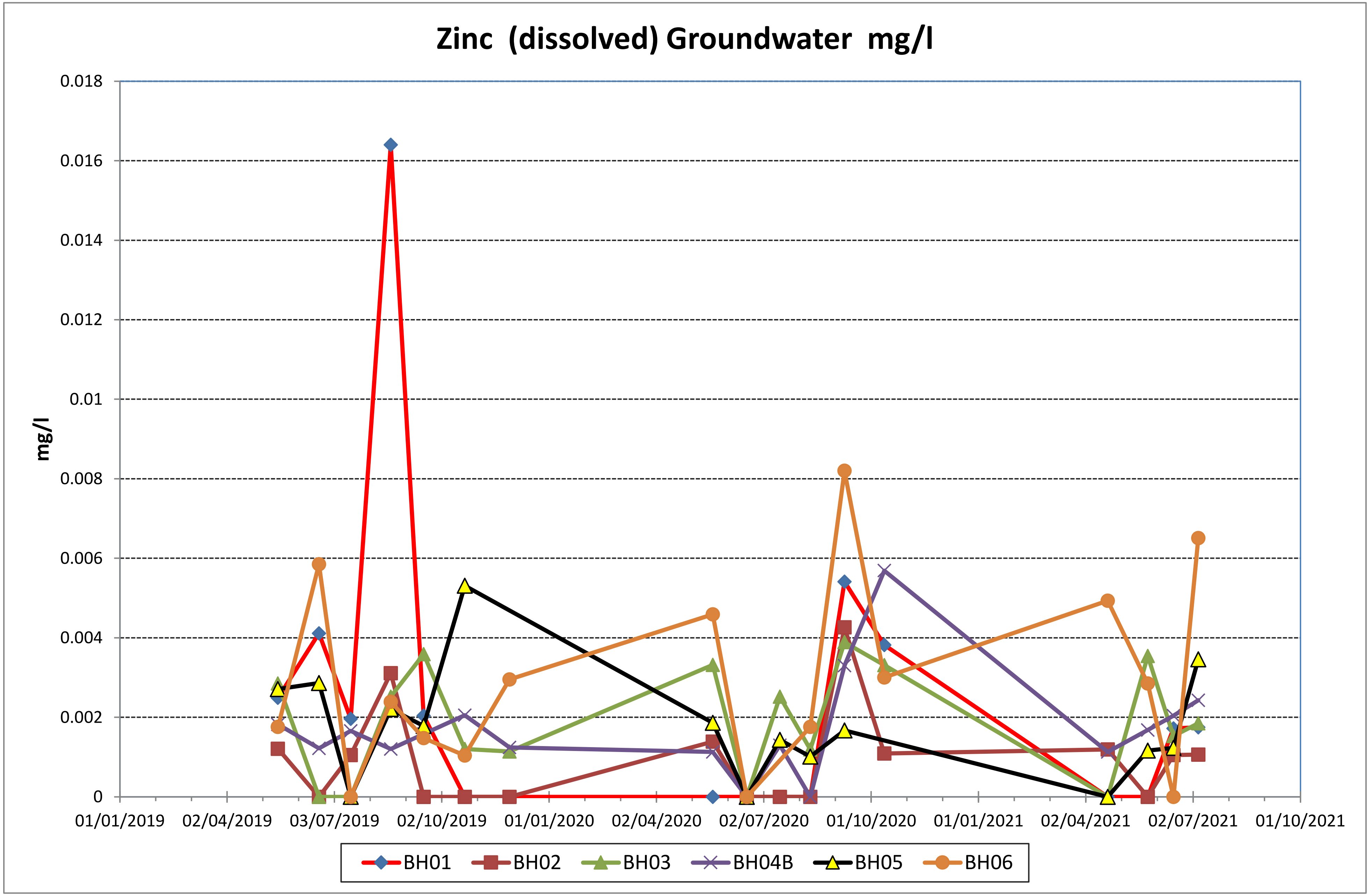
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06


Zinc (dissolved) Groundwater mg/l
mg/l
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
01/01/2019
02/04/2019
03/07/2019
02/10/2019
01/01/2020
02/04/2020
02/07/2020
01/10/2020
01/01/2021
02/04/2021
02/07/2021
01/10/2021
BH01
BH02
BH03
BH04B
BH05
BH06

APPENDIX 04

RAM Model Parameterisation Table

Table 4
Site Layout Source / Inert Waste Source

Item		Value/Description	Source of Data
Infiltration to site (mm/year)		130	MAFF Effective Rainfall as worst case
Area of Top of Waste (m^2)		146,000	Site volume calculations
Nominal Waste Thickness (m)		6	Void Volume / Area of Top of Waste (max thickness 8m)
Waste porosity		0.30	Typical values for inert waste
Waste Water filled porosity		0.05	
Waste dry bulk density (kg/m^3)		1500	
Waste FoC		0.01	
Contaminant Source	Arsenic (mg/l)	0.05	Derived in mg/l from mg/kg Inert WAC limits as outlined within the Landfill Directive council decision annex 2003/33/EC
	Fluoride (mg/l)	1	
	Copper (mg/l)	0.20	
	Lead (mg/l)	0.05	
	Mercury (mg/l)	0.001	
	Nickel (mg/l)	0.04	
	Sulphate (mg/l)	600	
	Zinc (mg/l)	0.4	
	Acenaphthene (mg/kg)	20	Assumes 20% of the total PAH WAC limit of 100mg/kg is Benzo(a)pyrene
	Benzene (mg/kg)	2	Assumes 33% of the total BTEX WAC limit of 6mg/kg is benzene
	Benzo(a)pyrene (mg/kg)	20	Assumes 20% of the total PAH WAC limit of 100mg/kg is Benzo(a)pyrene
	Aromatic C10 – C12 (mg/kg)	100	Assumes 20% of the Total Mineral Oil (C10-C40) WAC limit of 500mg/kg in Aromatic C10-C12

Item		Value/Description	Source of Data
Free Water Diffusion Coefficients (m^2/s)	Arsenic	3.52x10^{-10}	https://www.dgtresearch.com/diffusion-coefficients/
	Copper	7.14x10^{-10}	Buffle et.al
	Fluoride	1.48x10^{-9}	Buffle et.al
	Lead	9.45x10^{-10}	Buffle et.al[18]
	Mercury	2.00x10^{-09}	Supplementary information for the derivation of SGV for mercury, Science Report SC050021
	Nickel	7.05x10^{-10}	Salmon P. S., Howells W. S., Mills R. The dynamics of water molecules in ionic solution: J. Phys. C: Solid State. Phys., 1987, 20, 5727-5747.
	Sulphate	1.07x10^{-10}	Buffle et.al
	Zinc	7.03x10^{-10}	Buffle et.al
	Acenaphthene	5.16E^{-10}	Assumed similar to naphthalene
	Benzene	6.64X10^{-10}	Compilation of Data for Priority Organic pollutants for Derivation of Soil Guideline Values Science report SC050021/SR7
	Benzo(a)pyrene	3.67X10^{-10}	
	Aromatic C10 – C12	5.16E^{-10}	EA Compilation of Data for Priority Organic pollutants[19] - value for naphthalene used as representative of most conservative of Aromatic C10-C12 band
Contaminant Solubility (mg/l)	Acenaphthene	3.9	Handbook of Aqueous Solubility Data , Yalkowsky et al, 2010
	Benzene	1780	Compilation of Data for Priority Organic pollutants for Derivation of Soil Guideline Values Science report SC050021/SR7
	Benzo(a)pyrene	0.0038	

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[18] Buffle, Zhang & Startchev (1994) *Metal flux and dynamic specification at (bio)interfaces. Part I: Critical evaluation and compilation of physico-chemical parameters for complexes with simple ligands and fluvic/humic substances*

[19] Environment Agency (Nov 2008) *Compilation of Data for priority organic pollutants for derivation of soil guideline values*, Ref: SC050021/SR7

Item		Value/Description	Source of Data
	Aromatic C10 – C12	25.0	CL:AIRE Petroleum Hydrocarbons in Groundwater[20]
Henrys Law Constant (dimensionless)	Acenaphthene	0.0049	EA 2003 Review of Fate and Transport of Selected Contaminants
	Benzene	0.182	
	Benzo(a)pyrene	0.000019	
	Aromatic C10 – C12	0.14	TPHCWG 1999

Table 5
Hydrogeological Units

Item		Value	Source of Data
Attenuation Layer	Unit Thickness (m)	1.0	Based on proposed thickness
	Hydraulic Conductivity (m/s)	1×10^{-7} 1×10^{-6}	Proposed specification Sensitivity Run
	Hydraulic Gradient (m/m)	0.637– 0.0637 – Sensitivity Run	Assumes site is fully saturated as worst case. Calculated based on maximum potential head across sidewall of site given the effective rainfall of 130mm/year. $Q = KiA$ Where: K = max conductivity (1×10^{-7}m/s or 1×10^{-6} (sensitivity)) I = hydraulic gradient A = area of sidewall in contact with aquifer (9,450m^2)
	Porosity	Min: 0.34 Max: 0.61	Based on range for silt and clay from ConSIM helpfile
	Bulk Density (kg/m^3)	Min: 1800 Max: 2400	Based on typical range for clay from ConSim helpfile
	FoC	Min: 0.01 Max: 0.1	Based on typical range for clay from ConSim Helpfile
River Terrace Deposits	Unit Thickness (m)	5.0	Typical saturated thickness at site
	Aquifer Width (m)	300	Equal to width of site

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[20] CL:AIRE (2017) *Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies*

Item		Value	Source of Data
	Hydraulic Conductivity (m/s)	Min: 0.0008 Max: 0.0045	Based on minimum result derived from particle size distribution as a conservative worst case.
	Hydraulic Gradient (m/m)	0.004	Average hydraulic gradient from groundwater contours
	Porosity	Min: 0.24 Max: 0.46	Based on range for sands and gravels from ConSIM helpfile
	Bulk Density (kg/m^3)	Min: 1360 Max: 2190	Based on typical range for sands and gravels from ConSim helpfile
	FoC	Min: 0.00017 Max: 0.00125	Based on range for glacio-fluvial sands from ConSim helpfile

Table 6
Attenuation Parameters

Item		Value	Source of Data
Arsenic Partition Coefficient (l/kg)	Attenuation Layer	Min: 25 Max: 250	Based on LandSim default
	River Terrace Deposits	0	Assumed 0 as worst case
Copper Partition Coefficient (l/kg)	Attenuation Layer	126.8	ConSim Helpfile for Loam
	River Terrace Deposits	Min: 40 Max: 27500	LandSim default range
Fluoride Partition Coefficient (l/kg)	Attenuation Layer	0.8	Based on ConSim Helpfile value for glacial till as representative of clayey overburden
	River Terrace Deposits	0	Assumed 0 as worst case
Lead Partition Coefficient (l/kg)	Attenuation Layer	Min: 990 ML: 1600 Max: 27000	Based on range for Loam from ConSim helpfile
	River Terrace Deposits	0	Assumed 0 as worst case
Mercury Partition Coefficient (l/kg)	Attenuation Layer	1500	ConSim Helpfile for Loam
	River Terrace Deposits	0	Assumed 0 as worst case
Nickel Partition Coefficient (l/kg)	Attenuation Layer	300	ConSim Helpfile for Loam
	River Terrace Deposits	Min 20 Max: 800	LandSim default range
Sulphate Partition Coefficient (l/kg)	Attenuation Layer	0	Assumed 0 as worst case
	River Terrace Deposits	0	Assumed 0 as worst case

Item		Value	Source of Data
Zinc Partition Coefficient (l/kg)	Attenuation Layer	Min: 11 ML: 1300 Max: 160,000	Based on range for Loam from ConSim helpfile
	River Terrace Deposits	Min: 1.1 ML: 200 Max: 36,000	Based on range for sand from ConSim helpfile
Acenaphthene (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	7079	EA 2003 Review of Fate and Transport of Selected Contaminants
Benzene (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	68	Compilation of Data for Priority Organic pollutants SC050021/SR7
Benzo(a)pyrene (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	128,825	
Aromatic C10 – C12 (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	2510	EA R&D Report P2-228
Acenaphthene Half Life (Days)	Attenuation Layer (no halflife used in Aquifer)	Min: 12.3 Max: 102	Based on range of aerobic halflife from Howard et.al Handbook of Environmental Degradation Rates Naphthalene used as representative of Aromatic C10-C12
Benzene Half Life (Days)	Attenuation Layer (no halflife used in Aquifer)	Min: 5 Max: 15	
Benzo(a)pyrene Half Life (Days)	Attenuation Layer (no halflife used in Aquifer)	Min: 57 Max: 529.25	
Aromatic C10 – C12 Half Life (days)	Attenuation Layer (no halflife used in Aquifer)	Min: 0.5 Max: 20	

APPENDIX 05

RAM Model Results

BREAKTHROUGH Probabilistic Results **10000 Monte Carlo iterations**

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

5.000E-03	2.000E-04	1.000E-05	7.500E-01	1.100E-02	1.840E+02	2.000E-02	1.200E-02

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	7.708E-30	0.000E+00	0.000E+00	4.767E-02	0.000E+00	5.243E+01	0.000E+00	0.000E+00
5	1.634E-10	0.000E+00	0.000E+00	6.957E-02	1.007E-31	3.928E+01	0.000E+00	1.052E-21
10	2.012E-06	0.000E+00	0.000E+00	4.849E-02	1.341E-24	2.737E+01	0.000E+00	6.165E-15
25	3.126E-04	0.000E+00	1.593E-33	1.641E-02	2.897E-14	9.265E+00	0.000E+00	7.219E-07
50	6.070E-04	3.662E-32	2.738E-26	2.698E-03	2.625E-08	1.523E+00	0.000E+00	2.559E-04
75	5.096E-04	1.801E-25	1.741E-22	4.434E-04	2.172E-06	2.504E-01	0.000E+00	1.207E-03
100	4.275E-04	9.613E-23	9.288E-19	7.289E-05	1.699E-05	4.115E-02	7.157E-36	1.909E-03
150	3.213E-04	4.476E-17	6.600E-14	1.969E-06	9.315E-05	1.112E-03	3.462E-31	1.622E-03
250	1.695E-04	2.474E-11	4.059E-10	1.163E-09	1.788E-04	6.587E-07	2.459E-22	3.558E-04
500	1.408E-05	2.730E-07	1.388E-07	0.000E+00	4.846E-05	0.000E+00	8.013E-13	3.461E-06
750	9.610E-07	3.584E-06	5.686E-07	0.000E+00	7.205E-06	0.000E+00	2.422E-09	3.408E-08
1000	6.609E-08	9.209E-06	8.554E-07	0.000E+00	1.000E-06	0.000E+00	1.031E-07	3.666E-10
1500	3.301E-10	1.354E-05	7.629E-07	0.000E+00	1.961E-08	0.000E+00	3.388E-06	1.337E-12
2500	1.133E-13	1.130E-05	2.217E-07	0.000E+00	9.066E-12	0.000E+00	1.766E-05	0.000E+00
5000	0.000E+00	7.348E-06	4.644E-09	3.552E-12	0.000E+00	2.467E-09	2.529E-05	0.000E+00
7500	0.000E+00	5.309E-06	9.393E-11	4.452E-12	0.000E+00	2.828E-09	2.192E-05	0.000E+00
10000	0.000E+00	4.147E-06	2.013E-12	4.181E-12	0.000E+00	2.595E-09	1.874E-05	0.000E+00
12500	0.000E+00	3.368E-06	4.648E-14	3.755E-12	0.000E+00	2.308E-09	1.666E-05	0.000E+00
15000	1.034E-14	2.724E-06	1.525E-15	3.359E-12	0.000E+00	2.056E-09	1.460E-05	0.000E+00
20000	2.239E-14	1.751E-06	0.000E+00	2.744E-12	0.000E+00	1.669E-09	1.213E-05	0.000E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/L in Inert Waste

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	2.944E+25	1.000E+40	1.000E+40	1.573E+01	1.000E+40	2.105E+03	1.000E+40	1.000E+40
5	1.505E+06	1.000E+40	1.000E+40	1.078E+01	4.364E+27	2.810E+03	1.000E+40	2.282E+18
10	1.240E+02	1.000E+40	1.000E+40	1.547E+01	3.271E+20	4.032E+03	1.000E+40	3.888E+11
25	7.982E-01	1.000E+40	6.278E+24	4.570E+01	1.518E+10	1.191E+04	1.000E+40	3.320E+03
50	4.111E-01	2.710E+26	3.648E+17	2.780E+02	1.675E+04	7.246E+04	1.000E+40	9.373E+00
75	4.906E-01	5.473E+19	5.741E+13	1.691E+03	2.025E+02	4.408E+05	1.000E+40	1.988E+00
100	5.841E-01	1.030E+17	1.075E+10	1.029E+04	2.589E+01	2.682E+06	1.077E+33	1.257E+00
150	7.777E-01	2.200E+11	1.515E+05	3.808E+05	4.721E+00	9.925E+07	2.267E+28	1.479E+00
250	1.472E+00	4.038E+05	2.463E+01	6.448E+08	2.461E+00	1.676E+11	3.166E+19	6.741E+00
500	1.772E+01	3.643E+01	7.193E-02	1.000E+40	9.076E+00	1.000E+40	9.954E+09	6.933E+02
750	2.600E+02	2.775E+00	1.757E-02	1.000E+40	6.102E+01	1.000E+40	3.165E+06	7.037E+04
1000	3.778E+03	1.081E+00	1.169E-02	1.000E+40	4.395E+02	1.000E+40	7.592E+04	6.537E+06
1500	7.568E+05	7.379E-01	1.311E-02	1.000E+40	2.242E+04	1.000E+40	2.350E+03	1.794E+09
2500	2.206E+09	8.841E-01	4.511E-02	1.000E+40	4.848E+07	1.000E+40	4.523E+02	1.000E+40
5000	1.000E+40	1.360E+00	2.149E+00	2.111E+11	1.000E+40	4.475E+13	3.161E+02	1.000E+40
7500	1.000E+40	1.883E+00	1.064E+02	1.685E+11	1.000E+40	3.903E+13	3.645E+02	1.000E+40
10000	1.000E+40	2.411E+00	4.956E+03	1.794E+11	1.000E+40	4.254E+13	4.267E+02	1.000E+40
12500	1.000E+40	2.967E+00	2.149E+05	1.997E+11	1.000E+40	4.784E+13	4.795E+02	1.000E+40
15000	2.408E+10	3.670E+00	6.553E+06	2.231E+11	1.000E+40	5.369E+13	5.474E+02	1.000E+40
20000	1.116E+10	5.710E+00	1.000E+40	2.733E+11	1.000E+40	6.613E+13	6.595E+02	1.000E+40

Compared with source concentrations in mg/L

5.000E-02	5.000E-02	1.000E-03	1.000E+00	4.000E-02	6.000E+02	4.000E-01	2.000E-01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

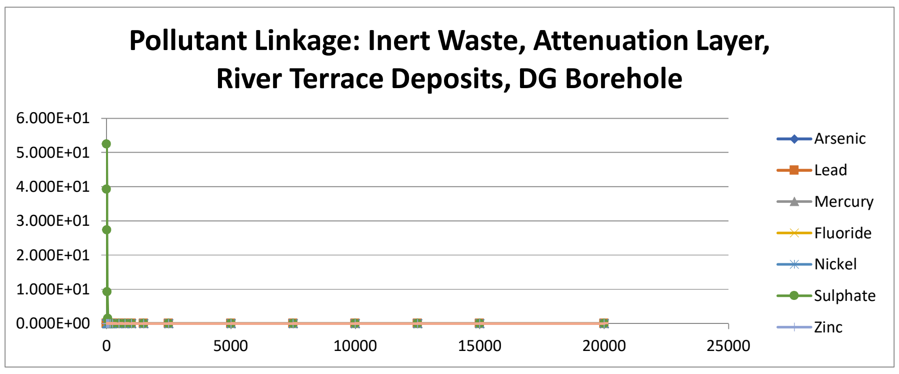
5 th Percentile Dilution Factor

1.083E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	2.330E+26	1.000E+40	1.000E+40	1.602E+00	1.000E+40	1.053E+00	1.000E+40	1.000E+40
5	1.236E+07	1.000E+40	1.000E+40	1.315E+00	1.860E+28	1.404E+00	1.000E+40	6.472E+18
10	9.720E+02	1.000E+40	1.000E+40	1.887E+00	1.607E+21	2.015E+00	1.000E+40	1.132E+12
25	6.110E+00	1.000E+40	2.727E+28	5.574E+00	5.710E+10	5.954E+00	1.000E+40	1.097E+04
50	3.946E+00	4.979E+28	2.176E+21	3.391E+01	7.172E+04	3.622E+01	1.000E+40	4.219E+01
75	5.563E+00	1.140E+22	3.079E+17	2.063E+02	9.558E+02	2.203E+02	1.000E+40	1.083E+01
100	7.343E+00	2.018E+19	4.433E+13	1.255E+03	1.335E+02	1.340E+03	1.920E+33	8.046E+00
150	1.107E+01	4.377E+13	6.453E+08	4.644E+04	2.768E+01	4.961E+04	7.332E+28	1.094E+01
250	1.889E+01	7.909E+07	1.172E+05	7.859E+07	1.894E+01	8.383E+07	5.462E+19	3.917E+01
500	1.594E+02	7.577E+03	4.163E+02	1.000E+40	5.936E+01	1.000E+40	2.550E+10	3.212E+03
750	2.209E+03	5.777E+02	1.166E+02	1.000E+40	3.457E+02	1.000E+40	7.851E+06	2.936E+05
1000	3.195E+04	2.150E+02	8.903E+01	1.000E+40	2.293E+03	1.000E+40	1.773E+05	2.549E+07
1500	6.413E+06	1.350E+02	1.182E+02	1.000E+40	1.054E+05	1.000E+40	5.394E+03	1.103E+10
2500	2.003E+10	2.054E+02	3.207E+02	1.000E+40	2.009E+08	1.000E+40	8.534E+02	1.000E+40
5000	1.000E+40	4.007E+02	1.230E+04	2.538E+10	1.000E+40	2.221E+10	5.627E+02	1.000E+40
7500	1.000E+40	5.974E+02	5.509E+05	2.055E+10	1.000E+40	1.950E+10	6.947E+02	1.000E+40
10000	1.000E+40	7.958E+02	2.388E+07	2.199E+10	1.000E+40	2.128E+10	8.630E+02	1.000E+40
12500	1.000E+40	9.946E+02	9.870E+08	2.452E+10	1.000E+40	2.396E+10	1.054E+03	1.000E+40
15000	1.754E+11	1.193E+03	3.114E+10	2.741E+10	1.000E+40	2.691E+10	1.243E+03	1.000E+40
20000	8.317E+10	1.603E+03	1.000E+40	3.360E+10	1.000E+40	3.316E+10	1.622E+03	1.000E+40



BREAKTHROUGH Probabilistic Results

10000 Monte Carlo iterations

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

	5.000E-06	1.000E-03	1.000E-05	1.000E-02

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	0.000E+00	4.725E-08	0.000E+00	0.000E+00
5	8.319E-36	4.654E-08	0.000E+00	5.268E-40
10	6.571E-30	4.579E-08	0.000E+00	5.265E-40
25	1.474E-29	4.297E-08	0.000E+00	5.258E-40
50	1.473E-29	3.914E-08	0.000E+00	5.245E-40
100	1.471E-29	3.166E-08	0.000E+00	5.220E-40
250	1.467E-29	1.815E-08	0.000E+00	5.145E-40
500	1.461E-29	7.370E-09	0.000E+00	5.022E-40
1000	1.448E-29	1.460E-09	0.000E+00	4.836E-40
2000	1.410E-29	1.159E-10	0.000E+00	4.313E-40
5000	1.273E-29	1.660E-13	0.000E+00	3.055E-40
7500	1.195E-29	1.188E-15	0.000E+00	2.297E-40
10000	1.143E-29	3.159E-18	0.000E+00	1.759E-40
15000	1.045E-29	0.000E+00	0.000E+00	0.000E+00
20000	8.762E-30	0.000E+00	0.000E+00	0.000E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/kg in Inert Waste

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10	1.000E+40	1.000E+40	1.000E+40	1.000E+40
25	1.000E+40	1.000E+40	1.000E+40	1.000E+40
50	1.000E+40	1.000E+40	1.000E+40	1.000E+40
100	1.000E+40	1.000E+40	1.000E+40	1.000E+40
250	1.000E+40	1.000E+40	1.000E+40	1.000E+40
500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
2000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
7500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
15000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
20000	1.000E+40	1.000E+40	1.000E+40	1.000E+40

Compared with source concentrations in mg/kg

	2.000E+01	2.000E+00	2.000E+01	1.000E+02

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

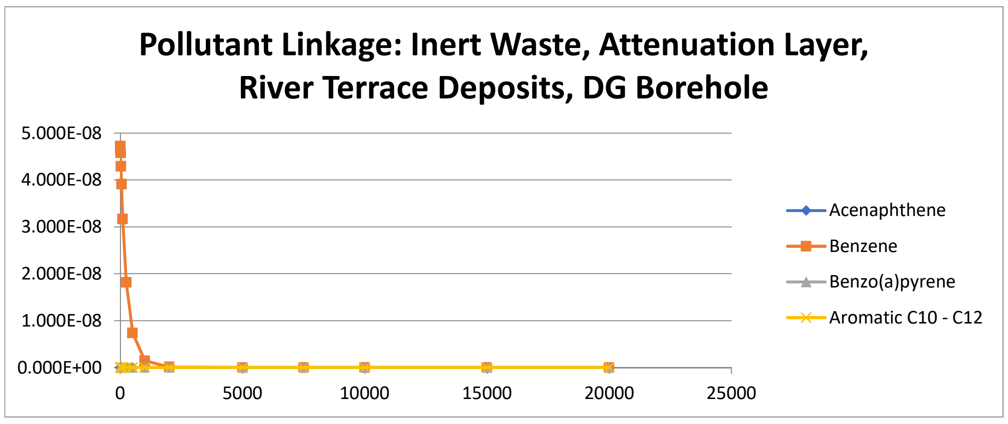
5 th Percentile Dilution Factor

1.096E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	5.019E+05	1.000E+40	1.000E+40
5	2.702E+32	5.066E+05	1.000E+40	6.262E+37
10	3.263E+26	5.194E+05	1.000E+40	6.264E+37
25	1.168E+26	5.467E+05	1.000E+40	6.270E+37
50	1.169E+26	6.047E+05	1.000E+40	6.281E+37
100	1.172E+26	7.286E+05	1.000E+40	6.302E+37
250	1.179E+26	1.299E+06	1.000E+40	6.367E+37
500	1.199E+26	3.082E+06	1.000E+40	6.475E+37
1000	1.230E+26	1.211E+07	1.000E+40	6.879E+37
2000	1.261E+26	1.451E+08	1.000E+40	7.277E+37
5000	1.402E+26	9.607E+10	1.000E+40	1.076E+38
7500	1.559E+26	1.323E+13	1.000E+40	1.789E+38
10000	1.694E+26	4.686E+15	1.000E+40	2.509E+38
15000	1.982E+26	1.000E+40	1.000E+40	7.151E+38
20000	2.348E+26	1.000E+40	1.000E+40	1.000E+40



BREAKTHROUGH Probabilistic Results

10000 Monte Carlo iterations

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

	5.000E-03	2.000E-04	1.000E-05	7.500E-01	1.100E-02	1.840E+02	2.000E-02	1.200E-02

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	9.201E-29	0.000E+00	0.000E+00	1.412E-01	0.000E+00	1.564E+02	0.000E+00	0.000E+00
5	3.792E-10	0.000E+00	0.000E+00	2.075E-01	2.932E-31	1.172E+02	0.000E+00	3.272E-21
10	5.738E-06	0.000E+00	0.000E+00	1.446E-01	3.855E-24	8.169E+01	0.000E+00	1.834E-14
20	4.801E-04	0.000E+00	5.752E-36	7.024E-02	8.542E-17	3.967E+01	0.000E+00	1.009E-07
30	1.336E-03	2.829E-36	8.871E-30	3.411E-02	7.995E-12	1.927E+01	0.000E+00	1.601E-05
50	1.817E-03	1.454E-31	8.364E-26	8.047E-03	7.584E-08	4.545E+00	0.000E+00	7.553E-04
75	1.517E-03	5.275E-25	5.114E-22	1.323E-03	6.341E-06	7.471E-01	0.000E+00	3.536E-03
100	1.297E-03	3.069E-22	2.606E-18	2.174E-04	4.935E-05	1.228E-01	5.432E-34	5.633E-03
150	9.667E-04	1.885E-16	1.858E-13	5.875E-06	2.735E-04	3.318E-03	1.044E-27	4.875E-03
200	7.228E-04	6.944E-13	4.654E-11	1.579E-07	4.695E-04	8.918E-05	5.604E-24	2.475E-03
300	3.278E-04	2.311E-09	9.280E-09	0.000E+00	4.781E-04	0.000E+00	1.642E-18	4.420E-04
500	4.202E-05	8.691E-07	4.055E-07	0.000E+00	1.459E-04	0.000E+00	1.106E-11	1.064E-05
750	2.864E-06	1.084E-05	1.671E-06	0.000E+00	2.195E-05	0.000E+00	1.866E-08	1.046E-07
1000	2.026E-07	2.723E-05	2.511E-06	0.000E+00	3.062E-06	0.000E+00	6.439E-07	1.115E-09
1500	1.034E-09	4.074E-05	2.286E-06	0.000E+00	5.992E-08	0.000E+00	1.254E-05	4.057E-12
2500	3.425E-13	3.468E-05	6.689E-07	0.000E+00	2.764E-11	0.000E+00	6.951E-05	0.000E+00
5000	0.000E+00	2.123E-05	1.421E-08	1.062E-11	0.000E+00	7.393E-09	7.600E-05	0.000E+00
10000	0.000E+00	1.237E-05	6.159E-12	1.249E-11	0.000E+00	7.748E-09	5.600E-05	0.000E+00
15000	3.061E-14	8.230E-06	4.602E-15	1.003E-11	0.000E+00	6.138E-09	4.565E-05	0.000E+00
20000	6.793E-14	5.291E-06	0.000E+00	8.191E-12	0.000E+00	4.982E-09	3.768E-05	0.000E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/L in Inert Waste

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	7.026E+24	1.000E+40	1.000E+40	1.593E+01	1.000E+40	2.117E+03	1.000E+40	1.000E+40
5	1.941E+06	1.000E+40	1.000E+40	1.084E+01	4.497E+27	2.824E+03	1.000E+40	2.193E+18
10	1.304E+02	1.000E+40	1.000E+40	1.556E+01	3.420E+20	4.053E+03	1.000E+40	3.924E+11
20	1.557E+00	1.000E+40	5.215E+27	3.203E+01	1.543E+13	8.345E+03	1.000E+40	7.137E+04
30	5.590E-01	1.034E+31	3.378E+21	6.595E+01	1.650E+08	1.718E+04	1.000E+40	4.493E+02
50	4.126E-01	2.055E+26	3.583E+17	2.796E+02	1.740E+04	7.284E+04	1.000E+40	9.530E+00
75	4.944E-01	5.653E+19	5.857E+13	1.701E+03	2.082E+02	4.431E+05	1.000E+40	2.036E+00
100	5.783E-01	9.748E+16	1.151E+10	1.035E+04	2.674E+01	2.696E+06	4.153E+31	1.276E+00
150	7.753E-01	1.548E+11	1.612E+05	3.830E+05	4.821E+00	9.978E+07	2.204E+25	1.476E+00
200	1.037E+00	4.060E+07	6.444E+02	1.425E+07	2.811E+00	3.712E+09	4.190E+21	2.907E+00
300	2.287E+00	1.298E+04	3.233E+00	1.000E+40	2.761E+00	1.000E+40	1.255E+16	1.629E+01
500	1.781E+01	3.441E+01	7.392E-02	1.000E+40	9.042E+00	1.000E+40	2.033E+09	6.755E+02
750	2.617E+02	2.765E+00	1.795E-02	1.000E+40	6.013E+01	1.000E+40	1.258E+06	6.877E+04
1000	3.698E+03	1.101E+00	1.195E-02	1.000E+40	4.305E+02	1.000E+40	3.685E+04	6.452E+06
1500	7.253E+05	7.354E-01	1.311E-02	1.000E+40	2.199E+04	1.000E+40	1.887E+03	1.773E+09
2500	2.189E+09	8.645E-01	4.484E-02	1.000E+40	4.776E+07	1.000E+40	3.400E+02	1.000E+40
5000	1.000E+40	1.412E+00	2.108E+00	2.117E+11	1.000E+40	4.480E+13	3.157E+02	1.000E+40
10000	1.000E+40	2.422E+00	4.870E+03	1.801E+11	1.000E+40	4.270E+13	4.282E+02	1.000E+40
15000	2.449E+10	3.645E+00	6.513E+06	2.242E+11	1.000E+40	5.394E+13	5.254E+02	1.000E+40
20000	1.104E+10	5.669E+00	1.000E+40	2.746E+11	1.000E+40	6.648E+13	6.364E+02	1.000E+40

Compared with source concentrations in mg/L

	1.500E-01	1.500E-01	3.000E-03	3.000E+00	1.200E-01	1.800E+03	1.200E+00	6.000E-01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

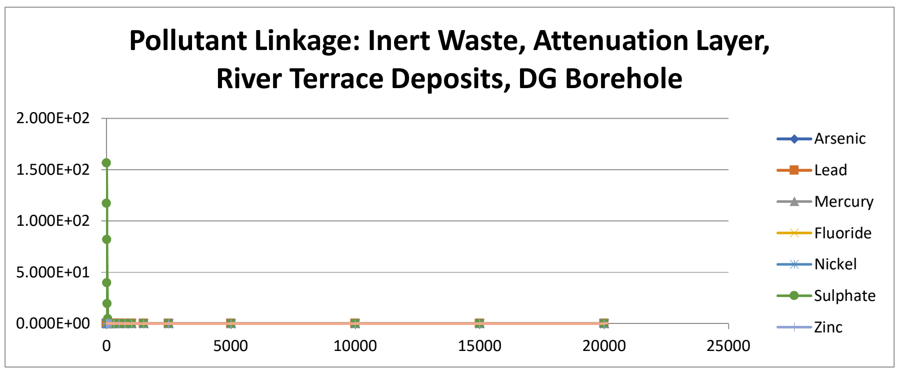
5 th Percentile Dilution Factor

1.087E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	7.493E+25	1.000E+40	1.000E+40	1.608E+00	1.000E+40	1.053E+00	1.000E+40	1.000E+40
5	1.567E+07	1.000E+40	1.000E+40	1.315E+00	1.874E+28	1.404E+00	1.000E+40	6.342E+18
10	1.090E+03	1.000E+40	1.000E+40	1.886E+00	1.614E+21	2.015E+00	1.000E+40	1.117E+12
20	1.295E+01	1.000E+40	2.033E+31	3.883E+00	5.512E+13	4.149E+00	1.000E+40	2.200E+05
30	4.331E+00	1.926E+33	1.276E+25	7.996E+00	6.031E+08	8.544E+00	1.000E+40	1.558E+03
50	3.947E+00	3.710E+28	2.180E+21	3.390E+01	7.202E+04	3.622E+01	1.000E+40	4.200E+01
75	5.571E+00	9.933E+21	3.092E+17	2.062E+02	9.580E+02	2.203E+02	1.000E+40	1.082E+01
100	7.349E+00	1.916E+19	4.481E+13	1.255E+03	1.338E+02	1.340E+03	8.838E+31	8.045E+00
150	1.107E+01	3.374E+13	6.518E+08	4.643E+04	2.773E+01	4.961E+04	4.969E+25	1.094E+01
200	1.493E+01	8.848E+09	2.795E+06	1.728E+06	1.839E+01	1.846E+06	7.857E+21	1.859E+01
300	2.529E+01	2.828E+06	1.552E+04	1.000E+40	2.276E+01	1.000E+40	3.754E+16	8.990E+01
500	1.553E+02	7.069E+03	4.169E+02	1.000E+40	5.925E+01	1.000E+40	5.125E+09	3.191E+03
750	2.112E+03	5.546E+02	1.167E+02	1.000E+40	3.442E+02	1.000E+40	2.685E+06	2.904E+05
1000	3.003E+04	2.097E+02	8.907E+01	1.000E+40	2.279E+03	1.000E+40	7.712E+04	2.510E+07
1500	5.823E+06	1.358E+02	1.181E+02	1.000E+40	1.045E+05	1.000E+40	3.454E+03	1.101E+10
2500	1.946E+10	2.041E+02	3.201E+02	1.000E+40	1.979E+08	1.000E+40	6.983E+02	1.000E+40
5000	1.000E+40	4.000E+02	1.223E+04	2.539E+10	1.000E+40	2.221E+10	5.619E+02	1.000E+40
10000	1.000E+40	7.960E+02	2.348E+07	2.198E+10	1.000E+40	2.128E+10	8.846E+02	1.000E+40
15000	1.870E+11	1.195E+03	3.058E+10	2.741E+10	1.000E+40	2.691E+10	1.239E+03	1.000E+40
20000	8.445E+10	1.601E+03	1.000E+40	3.360E+10	1.000E+40	3.317E+10	1.628E+03	1.000E+40



BREAKTHROUGH Probabilistic Results **10000 Monte Carlo iterations**

Site Name: "Elton II"
Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

5.000E-06	1.000E-03	1.000E-05	1.000E-02

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	0.000E+00	1.472E-07	0.000E+00	0.000E+00
5	5.465E-35	1.456E-07	0.000E+00	1.516E-38
10	1.384E-29	1.408E-07	0.000E+00	1.514E-38
25	3.693E-29	1.341E-07	0.000E+00	1.508E-38
50	3.691E-29	1.186E-07	0.000E+00	1.497E-38
100	3.687E-29	9.634E-08	0.000E+00	1.475E-38
200	3.679E-29	6.499E-08	0.000E+00	1.434E-38
500	3.655E-29	2.397E-08	0.000E+00	1.375E-38
1000	3.616E-29	5.284E-09	0.000E+00	1.329E-38
2000	3.534E-29	3.784E-10	0.000E+00	1.241E-38
5000	3.187E-29	5.118E-13	0.000E+00	9.466E-39
7500	2.898E-29	2.920E-15	0.000E+00	6.614E-39
10000	2.474E-29	7.736E-18	0.000E+00	4.741E-39
15000	1.883E-29	0.000E+00	0.000E+00	2.765E-39
20000	1.682E-29	0.000E+00	0.000E+00	1.434E-39

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/kg in Inert Waste

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10	1.000E+40	1.000E+40	1.000E+40	1.000E+40
25	1.000E+40	1.000E+40	1.000E+40	1.000E+40
50	1.000E+40	1.000E+40	1.000E+40	1.000E+40
100	1.000E+40	1.000E+40	1.000E+40	1.000E+40
200	1.000E+40	1.000E+40	1.000E+40	1.000E+40
500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
2000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
7500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
15000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
20000	1.000E+40	1.000E+40	1.000E+40	1.000E+40

Compared with source concentrations in mg/kg

6.000E+01	6.000E+00	6.000E+01	3.000E+02

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

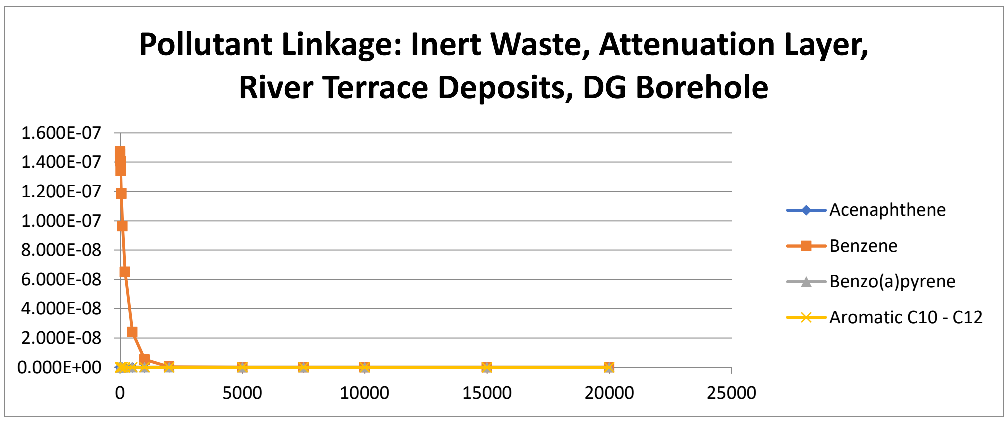
5 th Percentile Dilution Factor

1.078E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	5.393E+05	1.000E+40	1.000E+40
5	1.341E+32	5.460E+05	1.000E+40	8.306E+36
10	5.903E+26	5.573E+05	1.000E+40	8.309E+36
25	1.596E+26	5.888E+05	1.000E+40	8.320E+36
50	1.596E+26	6.453E+05	1.000E+40	8.338E+36
100	1.598E+26	7.746E+05	1.000E+40	8.375E+36
200	1.602E+26	1.047E+06	1.000E+40	8.598E+36
500	1.612E+26	2.735E+06	1.000E+40	8.819E+36
1000	1.633E+26	1.125E+07	1.000E+40	9.064E+36
2000	1.666E+26	1.344E+08	1.000E+40	9.907E+36
5000	1.870E+26	8.415E+10	1.000E+40	1.304E+37
7500	2.244E+26	1.448E+13	1.000E+40	1.684E+37
10000	2.443E+26	5.045E+15	1.000E+40	2.245E+37
15000	3.042E+26	1.000E+40	1.000E+40	4.553E+37
20000	3.619E+26	1.000E+40	1.000E+40	6.578E+37


Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

BREAKTHROUGH Probabilistic Results **10000 Monte Carlo iterations**

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

	5.000E-03	2.000E-04	1.000E-05	7.500E-01	1.100E-02	1.840E+02	2.000E-02	1.200E-02

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	1.631E-31	0.000E+00	0.000E+00	4.774E-02	0.000E+00	5.219E+01	0.000E+00	0.000E+00
5	1.375E-10	0.000E+00	0.000E+00	6.910E-02	9.856E-32	3.910E+01	0.000E+00	1.129E-21
10	1.908E-06	0.000E+00	0.000E+00	4.816E-02	1.317E-24	2.725E+01	0.000E+00	6.464E-15
25	3.198E-04	7.646E-40	1.640E-33	1.630E-02	2.829E-14	9.224E+00	0.000E+00	7.272E-07
50	6.306E-04	6.356E-32	2.711E-26	2.679E-03	2.628E-08	1.516E+00	0.000E+00	2.592E-04
75	5.159E-04	2.398E-25	1.758E-22	4.405E-04	2.175E-06	2.492E-01	0.000E+00	1.210E-03
100	4.232E-04	1.134E-22	8.944E-19	7.240E-05	1.679E-05	4.097E-02	2.850E-35	1.905E-03
150	3.159E-04	1.448E-16	6.574E-14	1.956E-06	9.337E-05	1.107E-03	5.845E-28	1.618E-03
250	1.666E-04	5.232E-11	4.060E-10	1.155E-09	1.781E-04	6.556E-07	3.577E-22	3.507E-04
500	1.376E-05	3.574E-07	1.379E-07	0.000E+00	4.743E-05	0.000E+00	1.523E-12	3.418E-06
750	8.973E-07	3.788E-06	5.678E-07	0.000E+00	7.125E-06	0.000E+00	3.454E-09	3.320E-08
1000	5.979E-08	9.147E-06	8.526E-07	0.000E+00	9.857E-07	0.000E+00	1.249E-07	3.574E-10
1500	2.750E-10	1.319E-05	7.621E-07	0.000E+00	1.908E-08	0.000E+00	3.377E-06	1.322E-12
2500	1.093E-13	1.158E-05	2.180E-07	0.000E+00	8.902E-12	0.000E+00	2.001E-05	0.000E+00
5000	0.000E+00	7.452E-06	4.588E-09	3.533E-12	0.000E+00	2.457E-09	2.522E-05	0.000E+00
7500	0.000E+00	5.355E-06	9.149E-11	4.428E-12	0.000E+00	2.811E-09	2.067E-05	0.000E+00
10000	0.000E+00	4.144E-06	1.977E-12	4.151E-12	0.000E+00	2.580E-09	1.802E-05	0.000E+00
12500	0.000E+00	3.315E-06	4.541E-14	3.727E-12	0.000E+00	2.294E-09	1.610E-05	0.000E+00
15000	1.039E-14	2.681E-06	1.481E-15	3.338E-12	0.000E+00	2.043E-09	1.452E-05	0.000E+00
20000	2.234E-14	1.706E-06	0.000E+00	2.726E-12	0.000E+00	1.659E-09	1.221E-05	0.000E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/L in Inert Waste

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	1.530E+27	1.000E+40	1.000E+40	1.571E+01	1.000E+40	2.115E+03	1.000E+40	1.000E+40
5	1.795E+06	1.000E+40	1.000E+40	1.085E+01	4.463E+27	2.821E+03	1.000E+40	2.123E+18
10	1.306E+02	1.000E+40	1.000E+40	1.557E+01	3.332E+20	4.048E+03	1.000E+40	3.713E+11
25	7.805E-01	1.230E+34	6.093E+24	4.599E+01	1.554E+10	1.196E+04	1.000E+40	3.300E+03
50	3.962E-01	1.487E+26	3.688E+17	2.798E+02	1.672E+04	7.276E+04	1.000E+40	9.255E+00
75	4.843E-01	4.148E+19	5.668E+13	1.702E+03	2.022E+02	4.426E+05	1.000E+40	1.983E+00
100	5.907E-01	8.600E+16	1.115E+10	1.035E+04	2.617E+01	2.693E+06	2.778E+32	1.259E+00
150	7.913E-01	6.314E+10	1.520E+05	3.832E+05	4.710E+00	9.966E+07	1.326E+25	1.483E+00
250	1.500E+00	1.906E+05	2.459E+01	6.491E+08	2.467E+00	1.683E+11	2.209E+19	6.841E+00
500	1.811E+01	2.792E+01	7.247E-02	1.000E+40	9.273E+00	1.000E+40	4.817E+09	7.010E+02
750	2.785E+02	2.637E+00	1.761E-02	1.000E+40	6.175E+01	1.000E+40	2.303E+06	7.206E+04
1000	4.176E+03	1.090E+00	1.172E-02	1.000E+40	4.461E+02	1.000E+40	6.295E+04	6.704E+06
1500	9.080E+05	7.577E-01	1.312E-02	1.000E+40	2.305E+04	1.000E+40	2.363E+03	1.814E+09
2500	2.281E+09	8.631E-01	4.581E-02	1.000E+40	4.939E+07	1.000E+40	3.952E+02	1.000E+40
5000	1.000E+40	1.341E+00	2.179E+00	2.121E+11	1.000E+40	4.492E+13	3.164E+02	1.000E+40
7500	1.000E+40	1.867E+00	1.092E+02	1.693E+11	1.000E+40	3.925E+13	3.866E+02	1.000E+40
10000	1.000E+40	2.413E+00	5.056E+03	1.807E+11	1.000E+40	4.277E+13	4.430E+02	1.000E+40
12500	1.000E+40	3.016E+00	2.196E+05	2.012E+11	1.000E+40	4.812E+13	4.962E+02	1.000E+40
15000	2.400E+10	3.727E+00	6.750E+06	2.246E+11	1.000E+40	5.400E+13	5.493E+02	1.000E+40
20000	1.116E+10	5.845E+00	1.000E+40	2.751E+11	1.000E+40	6.653E+13	6.551E+02	1.000E+40

Compared with source concentrations in mg/L

	5.000E-02	5.000E-02	1.000E-03	1.000E+00	4.000E-02	6.000E+02	4.000E-01	2.000E-01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

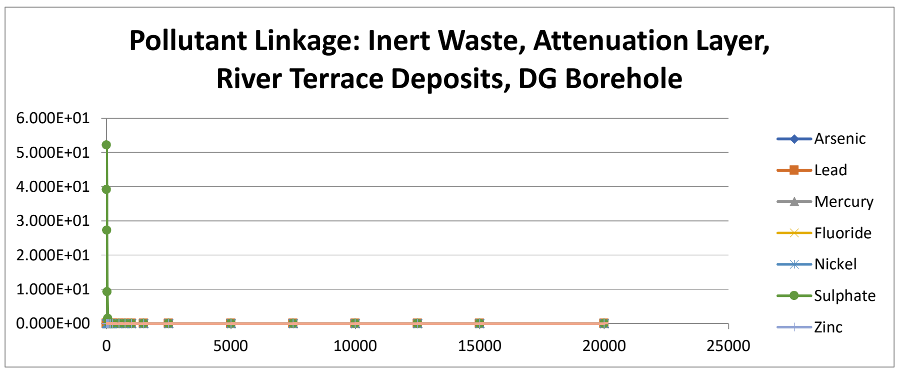
5 th Percentile Dilution Factor

1.089E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	1.766E+28	1.000E+40	1.000E+40	1.601E+00	1.000E+40	1.053E+00	1.000E+40	1.000E+40
5	1.323E+07	1.000E+40	1.000E+40	1.315E+00	1.871E+28	1.404E+00	1.000E+40	6.072E+18
10	1.004E+03	1.000E+40	1.000E+40	1.887E+00	1.608E+21	2.015E+00	1.000E+40	1.068E+12
25	6.166E+00	2.167E+36	2.715E+28	5.574E+00	5.694E+10	5.954E+00	1.000E+40	1.075E+04
50	3.935E+00	3.438E+28	2.178E+21	3.391E+01	7.158E+04	3.622E+01	1.000E+40	4.186E+01
75	5.555E+00	8.306E+21	3.084E+17	2.063E+02	9.542E+02	2.203E+02	1.000E+40	1.080E+01
100	7.337E+00	1.859E+19	4.377E+13	1.255E+03	1.333E+02	1.340E+03	7.256E+32	8.041E+00
150	1.107E+01	1.075E+13	6.408E+08	4.645E+04	2.766E+01	4.961E+04	2.387E+25	1.094E+01
250	1.894E+01	3.456E+07	1.168E+05	7.860E+07	1.894E+01	8.383E+07	4.225E+19	3.928E+01
500	1.651E+02	5.185E+03	4.157E+02	1.000E+40	5.944E+01	1.000E+40	1.128E+10	3.245E+03
750	2.349E+03	4.631E+02	1.165E+02	1.000E+40	3.467E+02	1.000E+40	4.504E+06	2.982E+05
1000	3.476E+04	1.876E+02	8.900E+01	1.000E+40	2.303E+03	1.000E+40	1.248E+05	2.595E+07
1500	7.288E+06	1.331E+02	1.182E+02	1.000E+40	1.063E+05	1.000E+40	4.824E+03	1.103E+10
2500	2.073E+10	2.045E+02	3.211E+02	1.000E+40	2.037E+08	1.000E+40	7.973E+02	1.000E+40
5000	1.000E+40	3.996E+02	1.237E+04	2.538E+10	1.000E+40	2.221E+10	5.611E+02	1.000E+40
7500	1.000E+40	5.975E+02	5.551E+05	2.054E+10	1.000E+40	1.950E+10	6.993E+02	1.000E+40
10000	1.000E+40	7.955E+02	2.413E+07	2.198E+10	1.000E+40	2.128E+10	8.834E+02	1.000E+40
12500	1.000E+40	9.947E+02	9.998E+08	2.452E+10	1.000E+40	2.396E+10	1.051E+03	1.000E+40
15000	1.785E+11	1.194E+03	3.154E+10	2.741E+10	1.000E+40	2.691E+10	1.241E+03	1.000E+40
20000	8.352E+10	1.601E+03	1.000E+40	3.360E+10	1.000E+40	3.316E+10	1.622E+03	1.000E+40



BREAKTHROUGH Probabilistic Results **10000 Monte Carlo iterations**

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

	5.000E-06	1.000E-03	1.000E-05	1.000E-02

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	0.000E+00	4.344E-08	0.000E+00	0.000E+00
5	1.326E-36	4.311E-08	0.000E+00	1.937E-39
10	2.676E-30	4.271E-08	0.000E+00	1.935E-39
25	9.012E-30	3.943E-08	0.000E+00	1.928E-39
50	9.008E-30	3.651E-08	0.000E+00	1.915E-39
100	9.002E-30	3.091E-08	0.000E+00	1.891E-39
200	8.989E-30	2.091E-08	0.000E+00	1.843E-39
500	8.949E-30	7.254E-09	0.000E+00	1.707E-39
1000	8.884E-30	1.513E-09	0.000E+00	1.502E-39
2000	8.696E-30	1.159E-10	0.000E+00	1.213E-39
5000	8.128E-30	2.073E-13	0.000E+00	8.721E-40
7500	6.944E-30	1.291E-15	0.000E+00	6.996E-40
10000	6.133E-30	5.038E-18	0.000E+00	5.273E-40
15000	5.135E-30	0.000E+00	0.000E+00	3.379E-40
20000	4.564E-30	0.000E+00	0.000E+00	2.110E-40

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/kg in Inert Waste

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10	1.000E+40	1.000E+40	1.000E+40	1.000E+40
25	1.000E+40	1.000E+40	1.000E+40	1.000E+40
50	1.000E+40	1.000E+40	1.000E+40	1.000E+40
100	1.000E+40	1.000E+40	1.000E+40	1.000E+40
200	1.000E+40	1.000E+40	1.000E+40	1.000E+40
500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
2000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
7500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
15000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
20000	1.000E+40	1.000E+40	1.000E+40	1.000E+40

Compared with source concentrations in mg/kg

	2.000E+01	2.000E+00	2.000E+01	1.000E+02

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

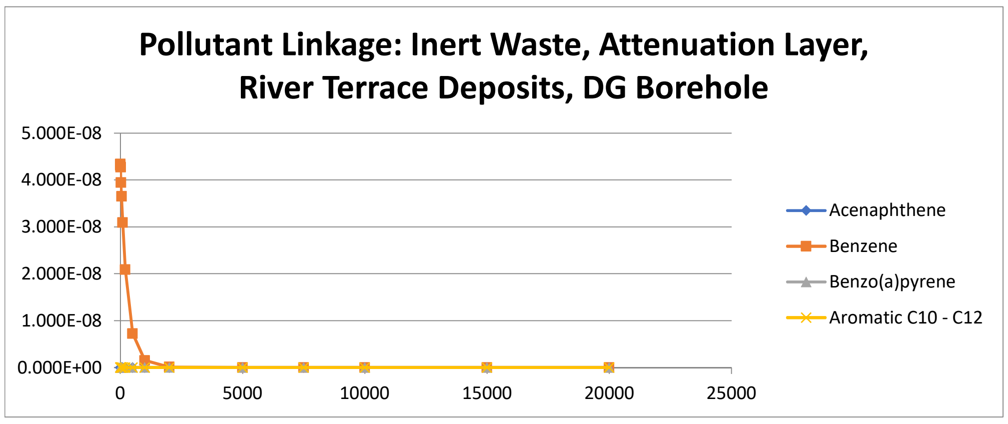
5 th Percentile Dilution Factor

	1.075E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	5.212E+05	1.000E+40	1.000E+40
5	1.863E+33	5.244E+05	1.000E+40	1.780E+37
10	8.024E+26	5.364E+05	1.000E+40	1.781E+37
25	2.826E+26	5.605E+05	1.000E+40	1.783E+37
50	2.828E+26	6.097E+05	1.000E+40	1.785E+37
100	2.832E+26	7.319E+05	1.000E+40	1.791E+37
200	2.842E+26	1.062E+06	1.000E+40	1.803E+37
500	2.869E+26	2.978E+06	1.000E+40	1.839E+37
1000	2.915E+26	1.263E+07	1.000E+40	1.901E+37
2000	3.010E+26	1.459E+08	1.000E+40	2.030E+37
5000	3.312E+26	8.198E+10	1.000E+40	2.584E+37
7500	3.529E+26	1.070E+13	1.000E+40	3.412E+37
10000	3.660E+26	2.485E+15	1.000E+40	3.852E+37
15000	4.559E+26	1.000E+40	1.000E+40	7.505E+37
20000	5.273E+26	1.000E+40	1.000E+40	1.291E+38



BREAKTHROUGH Probabilistic Results

10000 Monte Carlo iterations

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

	5.000E-03	2.000E-04	1.000E-05	7.500E-01	1.100E-02	1.840E+02	2.000E-02	1.200E-02

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	8.681E-29	0.000E+00	0.000E+00	1.432E-01	0.000E+00	1.567E+02	0.000E+00	0.000E+00
5	7.122E-10	0.000E+00	0.000E+00	2.075E-01	3.043E-31	1.174E+02	0.000E+00	3.297E-21
10	7.177E-06	0.000E+00	0.000E+00	1.446E-01	3.801E-24	8.181E+01	0.000E+00	1.944E-14
20	5.288E-04	0.000E+00	6.237E-36	7.023E-02	9.053E-17	3.973E+01	0.000E+00	1.030E-07
30	1.408E-03	8.396E-37	9.626E-30	3.411E-02	8.409E-12	1.930E+01	0.000E+00	1.647E-05
50	1.876E-03	1.388E-31	8.240E-26	8.045E-03	7.647E-08	4.551E+00	0.000E+00	7.694E-04
75	1.565E-03	4.224E-25	5.289E-22	1.323E-03	6.472E-06	7.482E-01	0.000E+00	3.594E-03
100	1.288E-03	2.339E-22	2.780E-18	2.174E-04	5.057E-05	1.230E-01	4.368E-34	5.686E-03
150	9.493E-04	7.768E-17	1.948E-13	5.874E-06	2.794E-04	3.323E-03	1.270E-27	4.857E-03
200	7.306E-04	3.467E-13	4.806E-11	1.579E-07	4.801E-04	8.931E-05	5.452E-24	2.465E-03
300	3.283E-04	1.366E-09	9.489E-09	0.000E+00	4.773E-04	0.000E+00	3.978E-18	4.357E-04
500	4.293E-05	6.946E-07	4.125E-07	0.000E+00	1.448E-04	0.000E+00	1.562E-11	1.048E-05
750	2.909E-06	9.843E-06	1.696E-06	0.000E+00	2.168E-05	0.000E+00	2.401E-08	1.023E-07
1000	1.974E-07	2.699E-05	2.547E-06	0.000E+00	3.012E-06	0.000E+00	7.078E-07	1.107E-09
1500	9.606E-10	4.187E-05	2.275E-06	0.000E+00	5.876E-08	0.000E+00	1.445E-05	4.023E-12
2500	3.498E-13	3.429E-05	6.646E-07	0.000E+00	2.753E-11	0.000E+00	6.788E-05	0.000E+00
5000	0.000E+00	2.204E-05	1.404E-08	1.062E-11	0.000E+00	7.386E-09	7.433E-05	0.000E+00
10000	0.000E+00	1.228E-05	6.124E-12	1.250E-11	0.000E+00	7.756E-09	5.788E-05	0.000E+00
15000	3.526E-14	8.193E-06	4.607E-15	1.005E-11	0.000E+00	6.142E-09	4.558E-05	0.000E+00
20000	7.108E-14	5.199E-06	0.000E+00	8.204E-12	0.000E+00	4.989E-09	3.685E-05	0.000E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/L in Inert Waste

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	8.119E+24	1.000E+40	1.000E+40	1.570E+01	1.000E+40	2.113E+03	1.000E+40	1.000E+40
5	1.031E+06	1.000E+40	1.000E+40	1.082E+01	4.338E+27	2.821E+03	1.000E+40	2.182E+18
10	1.041E+02	1.000E+40	1.000E+40	1.552E+01	3.471E+20	4.047E+03	1.000E+40	3.696E+11
20	1.415E+00	1.000E+40	4.744E+27	3.196E+01	1.456E+13	8.334E+03	1.000E+40	6.984E+04
30	5.317E-01	3.465E+31	3.112E+21	6.581E+01	1.567E+08	1.716E+04	1.000E+40	4.370E+02
50	3.997E-01	2.108E+26	3.634E+17	2.790E+02	1.724E+04	7.275E+04	1.000E+40	9.358E+00
75	4.788E-01	7.061E+19	5.665E+13	1.697E+03	2.037E+02	4.425E+05	1.000E+40	2.003E+00
100	5.810E-01	1.274E+17	1.078E+10	1.033E+04	2.604E+01	2.692E+06	5.458E+31	1.266E+00
150	7.900E-01	3.378E+11	1.538E+05	3.822E+05	4.722E+00	9.964E+07	1.765E+25	1.482E+00
200	1.026E+00	8.175E+07	6.238E+02	1.422E+07	2.749E+00	3.707E+09	4.210E+21	2.920E+00
300	2.283E+00	2.083E+04	3.152E+00	1.000E+40	2.764E+00	1.000E+40	5.243E+15	1.650E+01
500	1.745E+01	4.318E+01	7.266E-02	1.000E+40	9.118E+00	1.000E+40	1.506E+09	6.869E+02
750	2.577E+02	3.043E+00	1.768E-02	1.000E+40	6.088E+01	1.000E+40	9.964E+05	7.032E+04
1000	3.790E+03	1.107E+00	1.178E-02	1.000E+40	4.380E+02	1.000E+40	3.391E+04	6.501E+06
1500	7.796E+05	7.161E-01	1.318E-02	1.000E+40	2.244E+04	1.000E+40	1.661E+03	1.787E+09
2500	2.143E+09	8.739E-01	4.508E-02	1.000E+40	4.794E+07	1.000E+40	3.490E+02	1.000E+40
5000	1.000E+40	1.360E+00	2.136E+00	2.119E+11	1.000E+40	4.475E+13	3.227E+02	1.000E+40
10000	1.000E+40	2.440E+00	4.890E+03	1.800E+11	1.000E+40	4.270E+13	4.146E+02	1.000E+40
15000	2.126E+10	3.659E+00	6.510E+06	2.239E+11	1.000E+40	5.391E+13	5.262E+02	1.000E+40
20000	1.055E+10	5.754E+00	1.000E+40	2.741E+11	1.000E+40	6.636E+13	6.508E+02	1.000E+40

Compared with source concentrations in mg/L

	1.500E-01	1.500E-01	3.000E-03	3.000E+00	1.200E-01	1.800E+03	1.200E+00	6.000E-01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

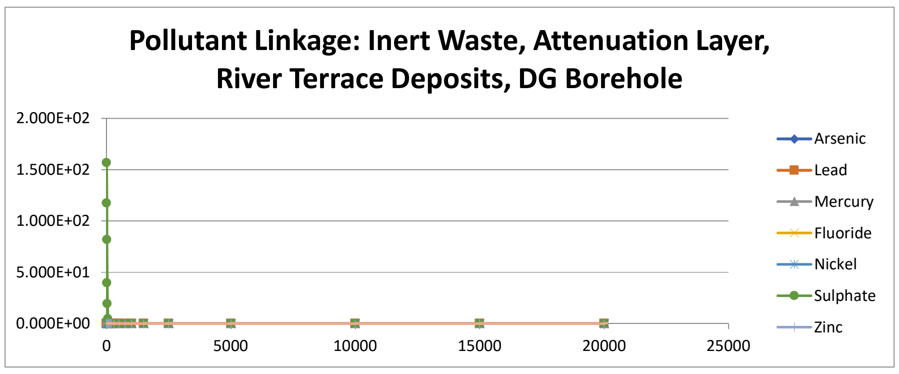
5 th Percentile Dilution Factor

1.085E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4	Species5	Species6	Species7	Species8
	Arsenic	**Lead**	**Mercury**	**Fluoride**	**Nickel**	**Sulphate**	**Zinc**	**Copper**
1	6.684E+25	1.000E+40	1.000E+40	1.600E+00	1.000E+40	1.053E+00	1.000E+40	1.000E+40
5	8.530E+06	1.000E+40	1.000E+40	1.315E+00	1.869E+28	1.404E+00	1.000E+40	6.250E+18
10	8.103E+02	1.000E+40	1.000E+40	1.887E+00	1.611E+21	2.015E+00	1.000E+40	1.043E+12
20	1.140E+01	1.000E+40	1.883E+31	3.884E+00	5.253E+13	4.149E+00	1.000E+40	2.151E+05
30	4.075E+00	6.917E+33	1.186E+25	7.998E+00	5.860E+08	8.544E+00	1.000E+40	1.549E+03
50	3.932E+00	4.203E+28	2.175E+21	3.391E+01	7.090E+04	3.622E+01	1.000E+40	4.193E+01
75	5.570E+00	1.267E+22	3.088E+17	2.063E+02	9.484E+02	2.203E+02	1.000E+40	1.079E+01
100	7.340E+00	2.227E+19	4.281E+13	1.255E+03	1.328E+02	1.340E+03	1.019E+32	8.036E+00
150	1.107E+01	7.179E+13	6.316E+08	4.644E+04	2.760E+01	4.961E+04	3.171E+25	1.094E+01
200	1.493E+01	1.559E+10	2.731E+06	1.728E+06	1.835E+01	1.846E+06	7.025E+21	1.859E+01
300	2.552E+01	4.102E+06	1.529E+04	1.000E+40	2.276E+01	1.000E+40	1.174E+16	9.009E+01
500	1.607E+02	8.740E+03	4.141E+02	1.000E+40	5.932E+01	1.000E+40	2.855E+09	3.211E+03
750	2.239E+03	6.290E+02	1.163E+02	1.000E+40	3.452E+02	1.000E+40	1.886E+06	2.931E+05
1000	3.253E+04	2.269E+02	8.894E+01	1.000E+40	2.288E+03	1.000E+40	6.515E+04	2.544E+07
1500	6.597E+06	1.387E+02	1.181E+02	1.000E+40	1.051E+05	1.000E+40	3.412E+03	1.100E+10
2500	2.020E+10	2.049E+02	3.205E+02	1.000E+40	2.005E+08	1.000E+40	6.556E+02	1.000E+40
5000	1.000E+40	4.006E+02	1.229E+04	2.537E+10	1.000E+40	2.221E+10	5.762E+02	1.000E+40
10000	1.000E+40	7.961E+02	2.374E+07	2.198E+10	1.000E+40	2.128E+10	8.611E+02	1.000E+40
15000	1.591E+11	1.195E+03	3.100E+10	2.741E+10	1.000E+40	2.691E+10	1.247E+03	1.000E+40
20000	8.077E+10	1.602E+03	1.000E+40	3.360E+10	1.000E+40	3.316E+10	1.635E+03	1.000E+40



BREAKTHROUGH Probabilistic Results **10000 Monte Carlo iterations**

Site Name: "Elton II"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

95 th Percentile Concentrations in mg/L in DG Borehole

Compared with EAL target concentration in mg/L

5.000E-06	1.000E-03	1.000E-05	1.000E-02

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	0.000E+00	1.421E-07	0.000E+00	0.000E+00
5	8.895E-36	1.409E-07	0.000E+00	1.598E-39
10	8.491E-30	1.386E-07	0.000E+00	1.597E-39
25	2.716E-29	1.289E-07	0.000E+00	1.595E-39
50	2.715E-29	1.166E-07	0.000E+00	1.592E-39
100	2.713E-29	9.356E-08	0.000E+00	1.585E-39
200	2.709E-29	6.293E-08	0.000E+00	1.572E-39
500	2.697E-29	2.194E-08	0.000E+00	1.533E-39
1000	2.677E-29	5.269E-09	0.000E+00	1.471E-39
2000	2.637E-29	3.896E-10	0.000E+00	1.353E-39
5000	2.452E-29	4.743E-13	0.000E+00	1.054E-39
7500	2.298E-29	3.250E-15	0.000E+00	8.717E-40
10000	2.075E-29	8.068E-18	0.000E+00	6.794E-40
15000	1.798E-29	0.000E+00	0.000E+00	4.685E-40
20000	1.449E-29	0.000E+00	0.000E+00	2.783E-40

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Remedial Target Concentrations in mg/kg in Inert Waste

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10	1.000E+40	1.000E+40	1.000E+40	1.000E+40
25	1.000E+40	1.000E+40	1.000E+40	1.000E+40
50	1.000E+40	1.000E+40	1.000E+40	1.000E+40
100	1.000E+40	1.000E+40	1.000E+40	1.000E+40
200	1.000E+40	1.000E+40	1.000E+40	1.000E+40
500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
2000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
7500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
15000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
20000	1.000E+40	1.000E+40	1.000E+40	1.000E+40

Compared with source concentrations in mg/kg

6.000E+01	6.000E+00	6.000E+01	3.000E+02

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

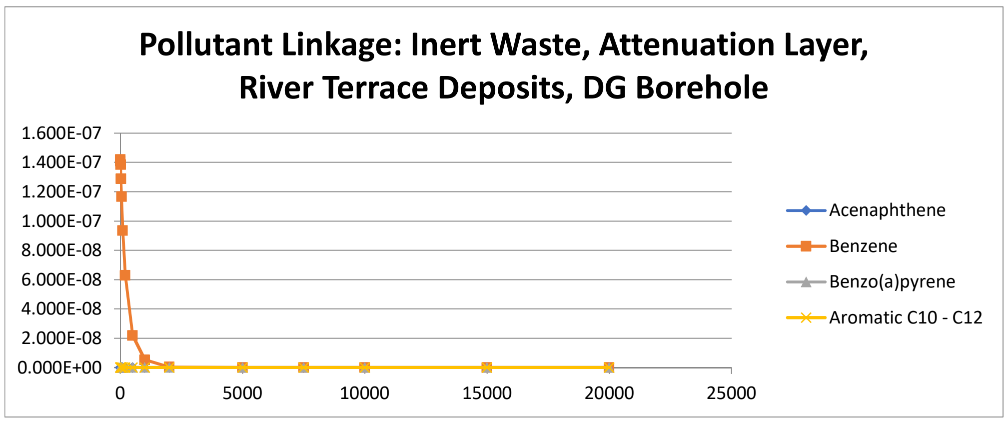
5 th Percentile Dilution Factor

1.067E+01

Pollutant Linkage: Inert Waste, Attenuation Layer, River Terrace Deposits, DG Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyren**	**Aromatic C10 - C12**
1	1.000E+40	5.387E+05	1.000E+40	1.000E+40
5	6.641E+32	5.569E+05	1.000E+40	5.406E+37
10	8.747E+26	5.775E+05	1.000E+40	5.407E+37
25	2.032E+26	6.041E+05	1.000E+40	5.412E+37
50	2.033E+26	6.508E+05	1.000E+40	5.419E+37
100	2.035E+26	7.729E+05	1.000E+40	5.434E+37
200	2.038E+26	1.096E+06	1.000E+40	5.465E+37
500	2.092E+26	2.776E+06	1.000E+40	5.644E+37
1000	2.139E+26	1.177E+07	1.000E+40	5.774E+37
2000	2.281E+26	1.384E+08	1.000E+40	6.127E+37
5000	2.708E+26	9.706E+10	1.000E+40	7.729E+37
7500	2.949E+26	1.238E+13	1.000E+40	9.409E+37
10000	3.138E+26	5.202E+15	1.000E+40	1.229E+38
15000	4.040E+26	1.000E+40	1.000E+40	1.774E+38
20000	4.533E+26	1.000E+40	1.000E+40	3.060E+38



APPENDIX 06

Electronic Copy of RAM Model
(spreadsheet enclosed separately)

APPENDIX 07

Memo: Requirement for Artificial Attenuation Barrier

Technical Memorandum

To: James Sutton **At:** Ingrebourne Valley Limited

From: Geoff Keenan **At:** SLR Consulting Limited

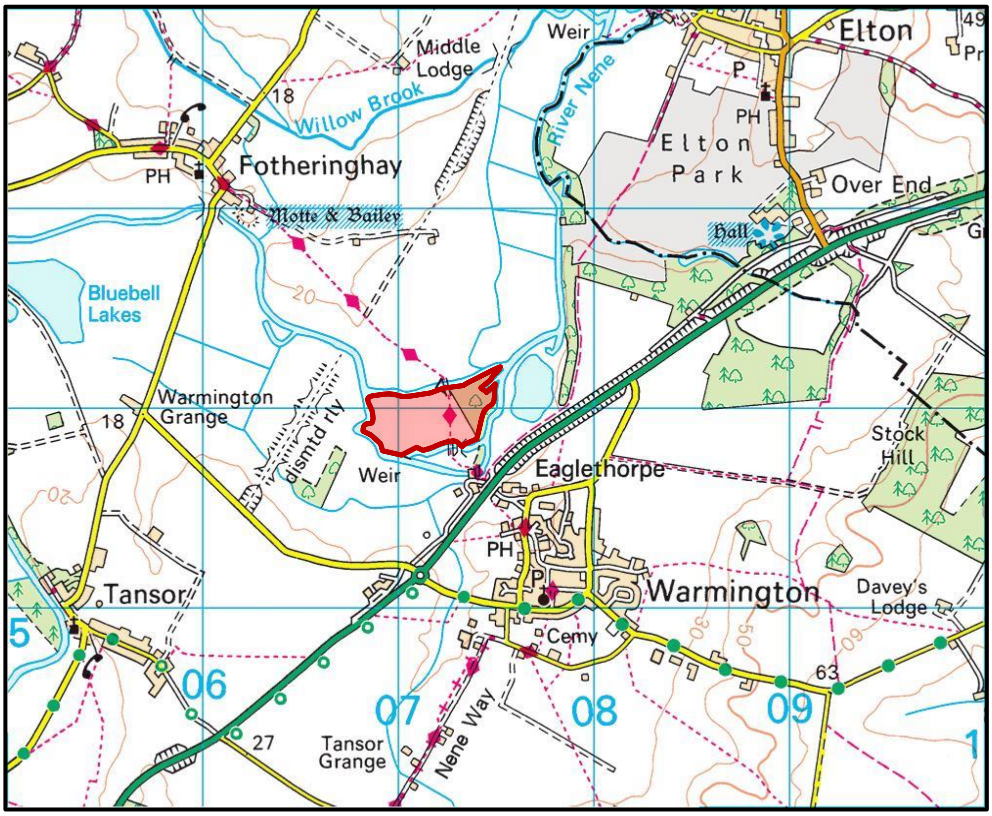
Date: 14/07/2021 **Ref:** 210721_01526_00029_Elton_II_ AGB_Requirements_Draft_Rev_0

Subject: ELTON 2 – REQUIREMENT FOR ARTIFICIAL ATTENUATION BARRIER

1.0 BACKGROUND

Ingrebourne Valley Limited (IV) has retained SLR Consulting Limited (SLR) to prepare an Environmental Permit (EP) application to authorise the deposit of waste for recovery for the restoration of Elton 2 Quarry (the site), located near Warmington, Northants as a waste recovery operation. The site lies to the north of the A605 and the village of Warmington, approximately 17 miles to the south-west of Peterborough at National Grid Reference TL 070 919. The location of the site is shown on Figure 1-1

Figure 1-1
Location of Site



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The site benefits from planning permission (planning application, reference 19/00033/MINFUL). The site is approximately 20 hectares in size and consists mainly of agricultural pasture currently used for livestock grazing, with a commercial poplar plantation near the eastern boundary. Approximately 850 – 900,000 tonnes of sand and gravel will be extracted and the site will be restored using a combination of site-won overburden, silt from the processing of the mineral and imported inert wastes, with a final layer comprising replacement of the site-derived topsoil.

The EA has approved a waste recovery plan and the permit application will be for a waste recovery operation. As such, is it not mandatory for the site to comply with the Landfill Directive requirement for a geological barrier. However, IV wish to consider restoration of the void using wastes which meet iWAC, and therefore have requested an opinion on the potential need for an artificial attenuation barrier to protect groundwater and surface water from pollution with non-hazardous substances and from the emission of hazardous substances. The purpose of this note is to provide that opinion based on an assessment of the geological and hydrogeological setting.

2.0 GEOLOGY AND HYDROGEOLOGY

A summary of the regional geological sequence is provided in Table 2-1.

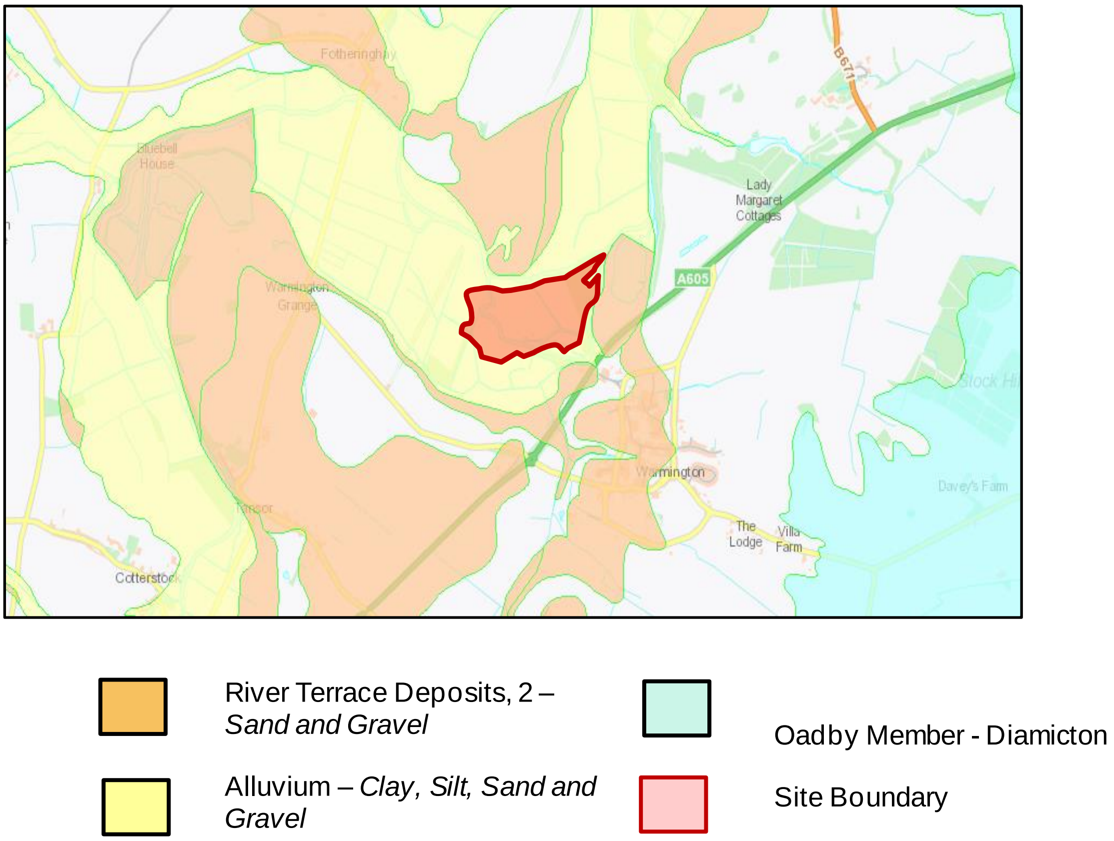
Table 2-1
Summary of Regional Geology

Parent Group	Geological Strata	Lithological Description	Approx. Thickness (m)
Quaternary Superficial	Topsoil	Loamy and clayey floodplain soils with naturally high groundwater.	0.1 – 0.2
	Alluvium	Brown, sandy, silty-clay to gravelly-sand.	1.7 – 2.5
	River Terrace Deposits	Orange, very sandy gravels with infrequent, non-continuous clay bands.	3.1 – 7.2
Ancholme Group	Oxford Clay Fm.	Grey, generally smooth to slightly silty silicate-mudstone, with sporadic beds of argillaceous limestone nodules.	20+
	Kellaways Sand Member	Pale-grey, calcareous cemented silicate sandstone and silicate siltstone, with interbeds of sandy and silty mudstone.	2 – 3
	Kellaways Clay Member	Grey, silicate mudstone.	2 – 3
Great Oolite Group	Cornbrash Fm.	Blue grey to yellowish-brown, medium- to fine-grained Limestone. Predominantly bioclastic wackestone and packstone with sporadic peloids.	2
	Blisworth Clay Fm.	Silicate-mudstone, grey, commonly variegated purplish red, yellow and green, poorly bedded to blocky.	3

Parent Group	Geological Strata	Lithological Description	Approx. Thickness (m)
	Blisworth Limestone Fm.	Pale grey to off-white or yellowish limestones with thin marls and mudstones.	6
Upper Lias	Rutland Fm.	Grey marine mudstone passing into non-marine mudstone and siltstone. Subordinate sandstone beds occur higher in the sequence as well as marine limestones and calcareous mudstones.	8 – 12
	Lincolnshire Limestone Fm.	Limestone - typically calcilutites, peloidal wackestones and packstones in lower part (Lower Lincolnshire Limestone) and ooidal and shell fragmental grainstones in upper part (Upper Lincolnshire Limestone).	1.5
Lower Lias	Grantham Fm.	Mudstones, sandy mudstones and argillaceous siltstone-sandstone.	7
	Whitby Mudstone Fm.	Medium, dark-grey, fossiliferous mudstone and siltstone, laminated and bituminous in part, with thin siltstone or silty mudstone beds and rare fine-grained calcareous sandstone beds.	120+

The site is underlain by superficial strata comprising alluvial deposits over river terrace deposits. This was confirmed by site investigation undertaken in June 2015 which encountered alluvial deposits comprising brown, sandy, silty clay to depths ranging from 1.5m to 2.3m below ground level (BGL). The underlying River Terrace Deposits outcrop to the north, south and east of the site. The 2015 site investigation described these as very sandy gravels with infrequent, non-continuous clay bands at thicknesses from 3.1m to 7.2m. A geological map showing the regional superficial geology is provided in Figure 2-1.

Figure 2-1
Map Showing Regional Superficial Geology

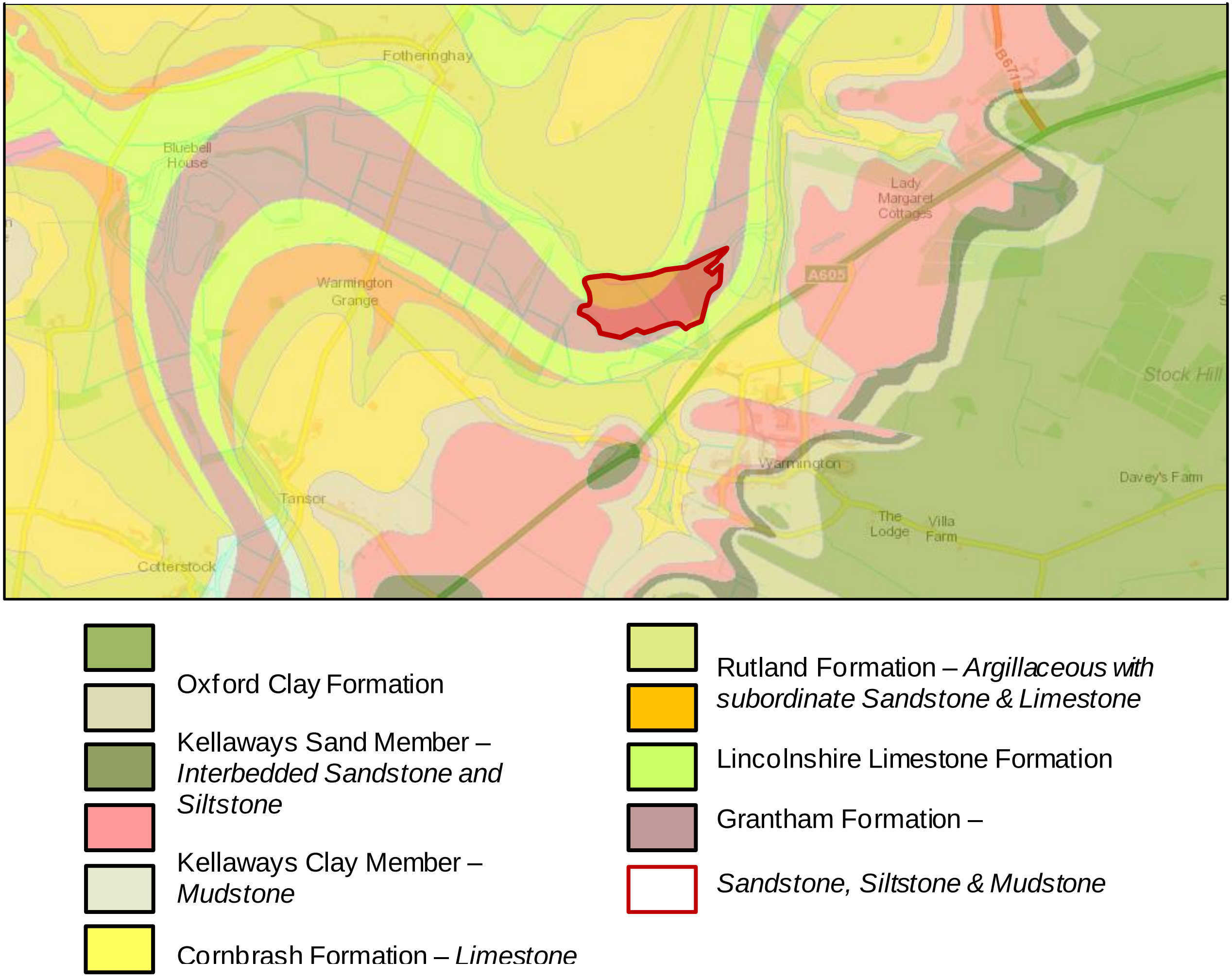


The bedrock geology comprises sandstone, mudstone and limestone strata of the Lias Group which have been exposed by the course of the River Nene. These units are overlain by limestone formations of the Great Oolite Group to the south-west, which are in-turn unconformably overlain by the Ancholme Group.

Underlying the base of the site's eastern and southern areas is the Whitby Mudstone Formation. This stratum is lithologically described by the BGS as 'medium, dark-grey, fossiliferous mudstone and siltstone' and is present in thicknesses upwards of 120m. The Grantham Formation, comprising 'mudstones, sandy mudstones and argillaceous siltstone-sandstone' overlie the Whitby Mudstone Formation and outcropping in the base of the north-western area of the site only.

A summary of the regional bedrock geological sequence is given in Figure 2-3

Figure 2-2
Map showing Regional Bedrock Geology



The Environment Agency (EA) online mapping service classifies the River Terrace Deposits as a Secondary A Aquifer, described as:

"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers"

The Whitby Mudstone Formation is classified as Un-Productive Strata, described as:

"rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow"

The Grantham Formation is classified as a Secondary (Undifferentiated) Aquifer, described as:

"rock layers where it has not been possible to attribute either category A or B. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type"

3.0 DISCUSSION

Based on the BGS mapping of the geological succession and hydrogeological characteristics of the strata beneath the site there are the following two designated aquifers at the site:

- The River Terrace Deposits (Secondary A Aquifer) – that will be left in place and form the sidewalls of the mineral void.
- The Grantham Formation (Secondary, Undifferentiated, Aquifer) – that will form the base of the site in the northern part only.

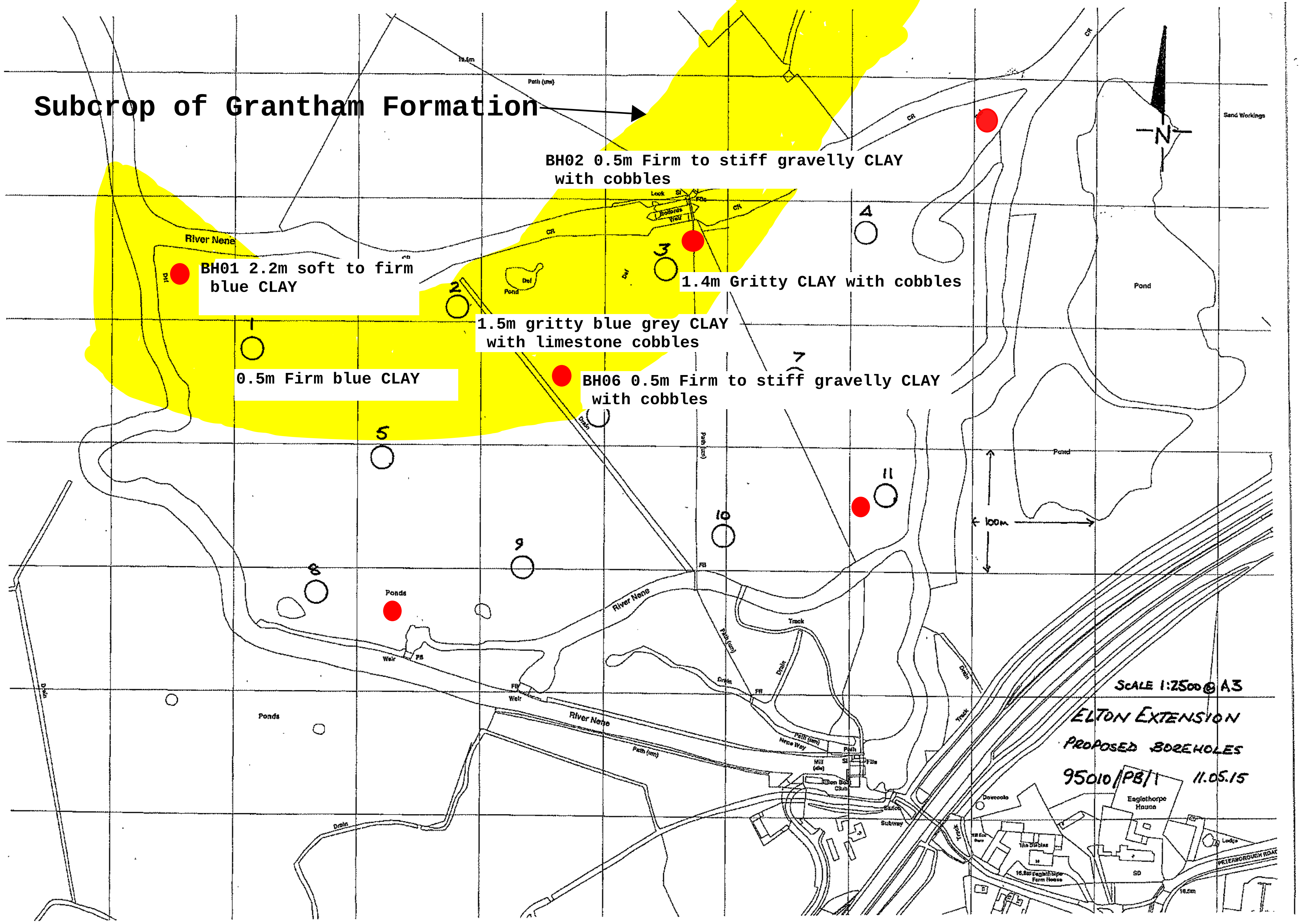
Subject to the nature of the materials used to restore the site and the hydrogeological risk assessment it may be necessary to install an artificial geological barrier (AGB) to protect groundwater in the River Terrace Deposits and the Grantham Formation. Whilst the aquifer status of the River Terrace Deposits is clear, the characteristics of the Grantham Formation deposits are variable and therefore additional analysis of data from borehole logs drilled at the site has been undertaken to assess the actual strata present within the proposed quarry restoration area.

Details of the strata from boreholes drilled into the Grantham Formation in the base of the site are provided in Annex A. Six boreholes (BH 01, 02, 06 and BH 1 to 3) penetrate the Grantham Formation and all of these locations indicate that it comprises CLAY with a minimum thickness of 0.5 to 2.2m. Therefore this strata will have a low permeability and negligible significance for water supply or river base flow. It is also underlain by over 100m of Whitby Mudstone Formation which is designated as 'unproductive strata' by the Environment Agency. For this reason, it is suggested that the Grantham Formation should be considered as 'unproductive strata' at the Elton 2 site and together with the Whitby Mudstone Formation (which also underlies the Grantham Formation in the Northern part of the site), would act as a natural basal attenuation barrier across the whole of the quarry restoration area.

4.0 CONCLUSION

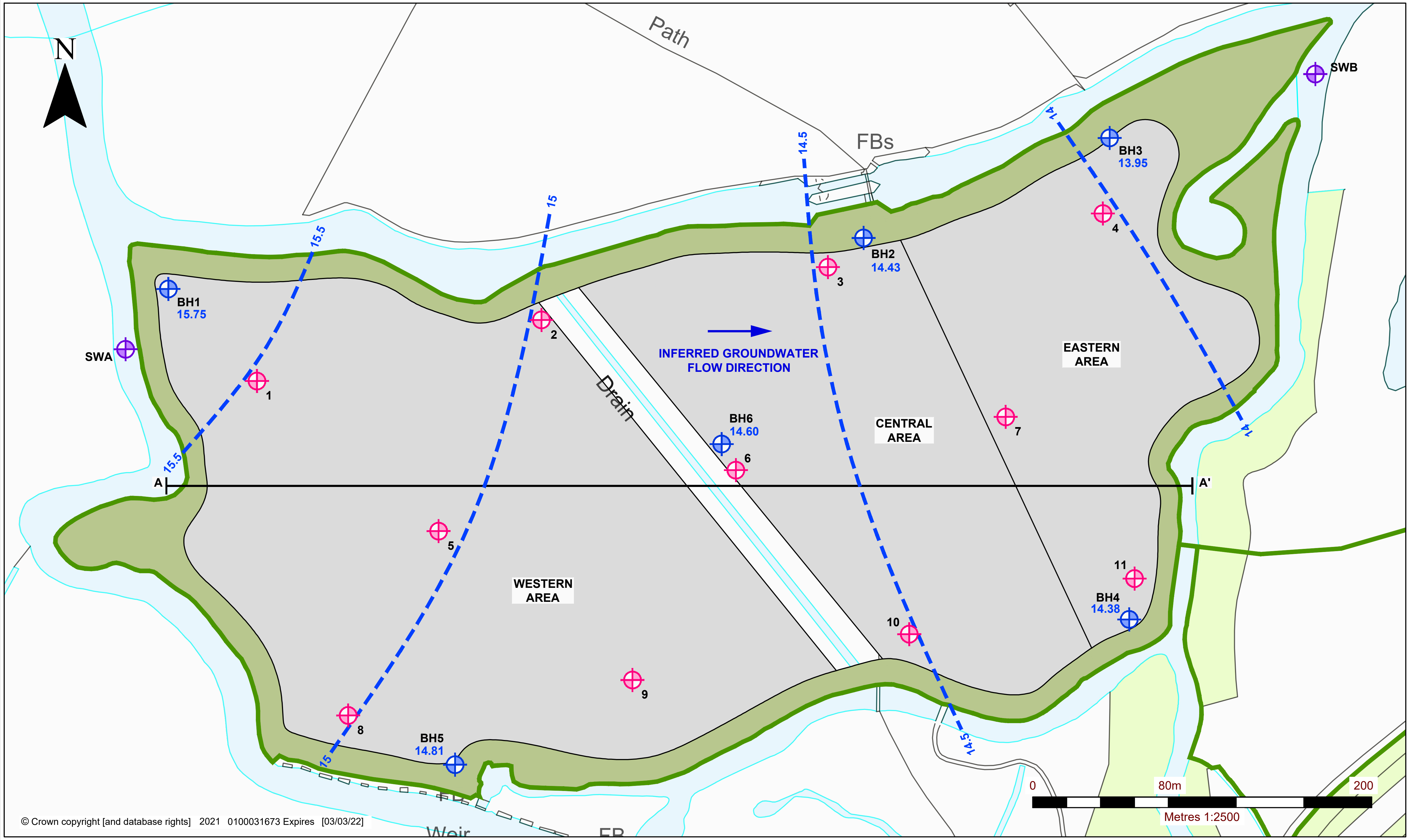
Based on the information presented in this technical note and subject to the nature of the materials used to restore the site and the conclusion of a hydrogeological risk assessment, it will only be necessary to install an artificial attenuation barrier to protect groundwater in the River Terrace Deposits. This will mean that an artificial attenuation barrier will be required around the perimeter of the site but not on the base.

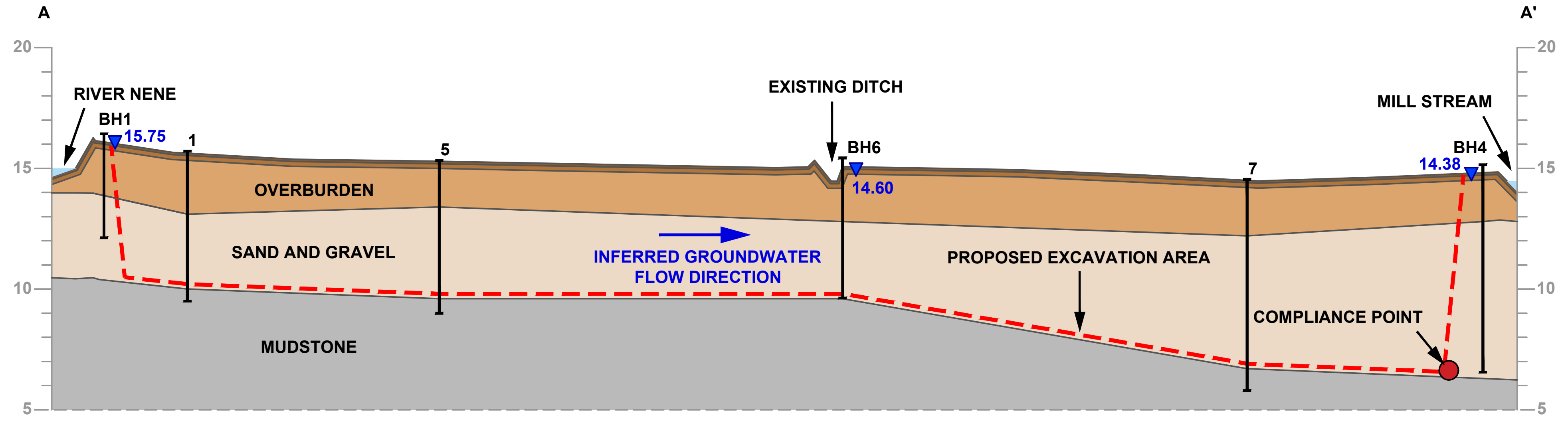
Annex A – Details of Grantham Strata at Base of the Site


Subcrop of Grantham Formation
BH02 0.5m Firm to stiff gravelly CLAY with cobbles
1.4m Gritty CLAY with cobbles
1.5m gritty blue grey CLAY with limestone cobbles
BH06 0.5m Firm to stiff gravelly CLAY with cobbles
BH01 2.2m soft to firm blue CLAY
0.5m Firm blue CLAY
1
2
3
4
5
7
8
9
10
11
N
Sand Workings
Pond
Pond
Ponds
Ponds
River Nene
River Nene
River Nene
Lock
Weir
Weir
Weir
Drain
Drain
Drain
Track
Track
Path (um)
Nene Way
Mill
Subway
Dovecote
Eaglethorpe House
The Stables
Farm House
Lodge
PETERBOROUGH ROAD
100m
SCALE 1:2500 @ A3
ELTON EXTENSION
PROPOSED BOREHOLES
95010/PB/1
11.05.15

DRAWING 09

Local Hydrogeology and Conceptual Site Model Cross-Section





ILLUSTRATIVE CROSS SECTION A - A'

NOTES

1. DRAWING CROSS SECTIONS SUPPLIED BY D.K. SYMES ASSOCIATES, DRAWING: COMPOSITE OPERATIONS PLAN, REF: 95010/E2/CO/1, DATED: 15.04.2019.

LEGEND

🟩	ENVIRONMENTAL PERMIT BOUNDARY
14.43	MAY 2021 GROUNDWATER LEVELS (mAOD)
14.5	MAY 2021 INFERRED GROUNDWATER CONTOURS (mAOD)
⊕	GROUNDWATER MONITORING WELL
⊕	EXPLORATION BOREHOLE LOCATION

CROSS SECTION LEGEND

■	TOPSOIL
■	SUBSOIL
■	OVERBURDEN
■	SAND AND GRAVEL
■	MUDSTONE
▼	INFERRED GROUNDWATER LEVEL MAY 2021

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ELTON 2 QUARRY RESTORATION

ENVIRONMENTAL PERMIT APPLICATION

HYDROGEOLOGICAL CONCEPTUAL MODEL

DRAWING 09

Scale
1:2500 @ A3

Date
DECEMBER 2021

01526.00029.001.18.009.2_HYDRO_CONCEPTUAL_MODEL.dwg

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