McDonnell Cole

March 2022
Ref: 1714-HRA-R2.1

Hydrogeological Risk Assessment for Milton Landfill

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Disclaimer

1. Introduction

1.1. Report Context

Milton Landfill Site is operated by FCC Environment (FCC), under environmental permit number BV4584IU, issued in 2005. A Hydrogeological Risk Assessment (HRA) of the site was carried out during 2015. FCC has requested an early review of the HRA to further conceptualise the site and assess the potential for raising leachate level limits above the base of the landfill.
Documents referenced in preparing this report are as follows:

- Golder Associates : 2003 : Environmental Setting and Installation Design. Milton Landfill Site
- Golder Associates : 2003 : Hydrogeological Risk Assessment. Milton Landfill Site
- Golder Associates : 2008 : Milton Landfill Site, Four Year Review of Hydrogeological Risk Assessment
- Wardell Armstrong : 2015 : Milton Landfill. Hydrogeological Risk Assessment Review

A draft of this HRA has been reviewed by the Environment Agency at the pre-application stage and a meeting was held on 28/9/2020. Following the written response to the meeting, this report has been updated and changes are highlighted in green.

1.2. Conceptual Hydrogeological Site Model

1.2.1. The Site

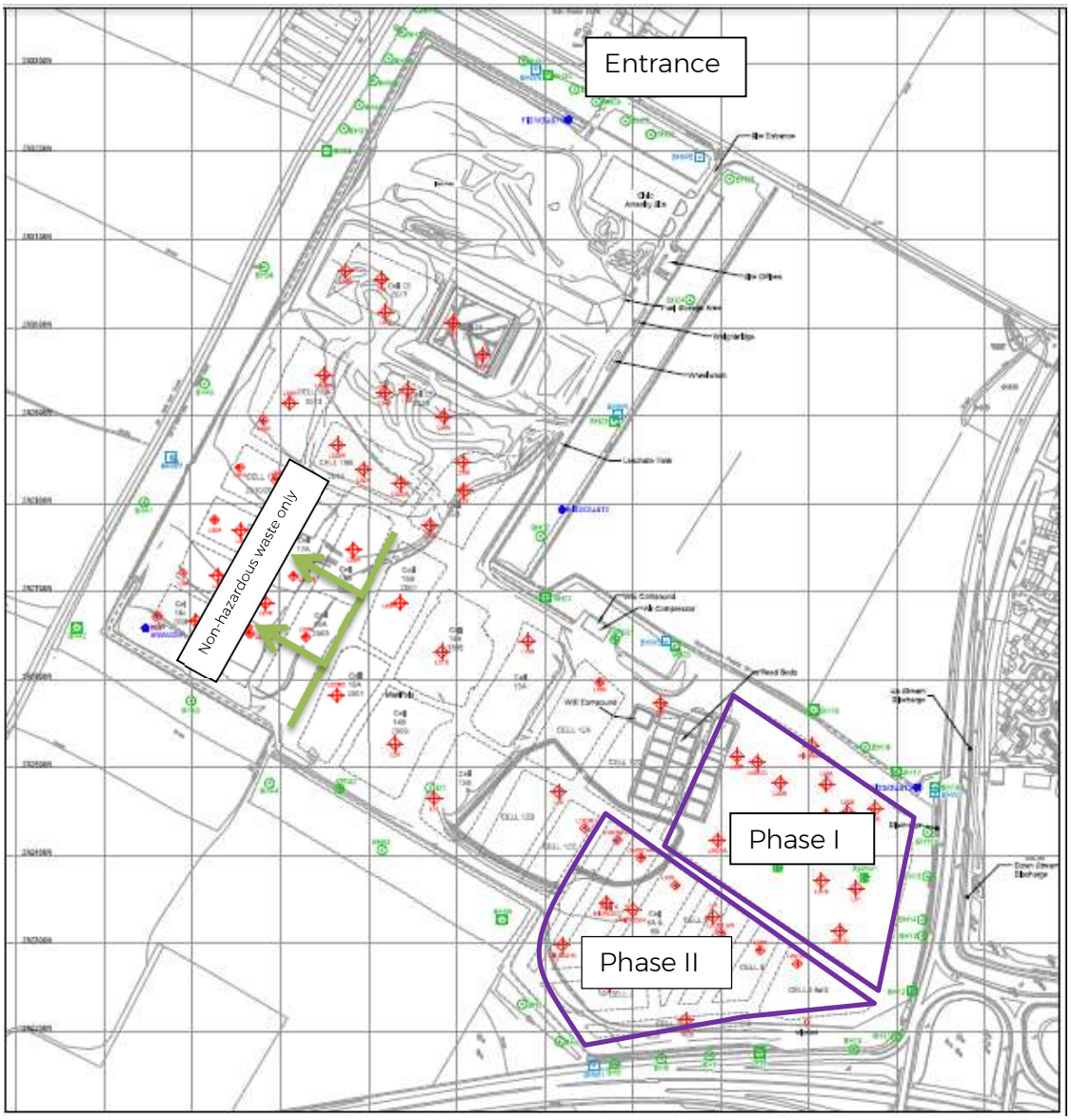
Milton Landfill is a non-hazardous landfill, located on Butt Lane, Milton, Cambridgeshire, CB24 6DQ, approximately 4km north of Cambridge city centre. The site can be located by National Grid Reference TL 465 632. The site occupies an area of approximately 48 hectares and is roughly L-shaped, refer to Figure 1.

The land surrounding the site is relatively low lying, agricultural land, with elevations of approximately 13m AOD on the western boundary and 10m AOD on the eastern boundary. Milton Park and Ride is adjacent to the northeastern boundary of the site. There is a farm directly opposite the northern boundary of the site and a small business park adjoining the northwestern boundary.

Milton Landfill was initially operated by Cambridgeshire County Council and accepted hazardous waste until 2005. Filling in Phase I is understood to have begun in 1980. The site is divided into three phases. Phase II is divided in to Phase IIa: Cells 1 to 5 and Phase IIb: Cells 6 – 11. Wardell Armstrong report that Phases I, II and Phase III cells 12 to 15B accepted both hazardous and non-hazardous waste. It is understood the remaining cells have only accepted non-hazardous waste. Cell 16A and Cell 16B are recorded as having been built in 2003, but are understood to only have received non-hazardous waste once filling began in those cells.

The site has been progressively capped. The site closed in April 2020 due to the coronavirus pandemic. Cells 22, 23 and 24 are temporarily capped. It is planned to re-open the site in 2022/2023 to bring the site to final levels.

Figure 1 Site Plan



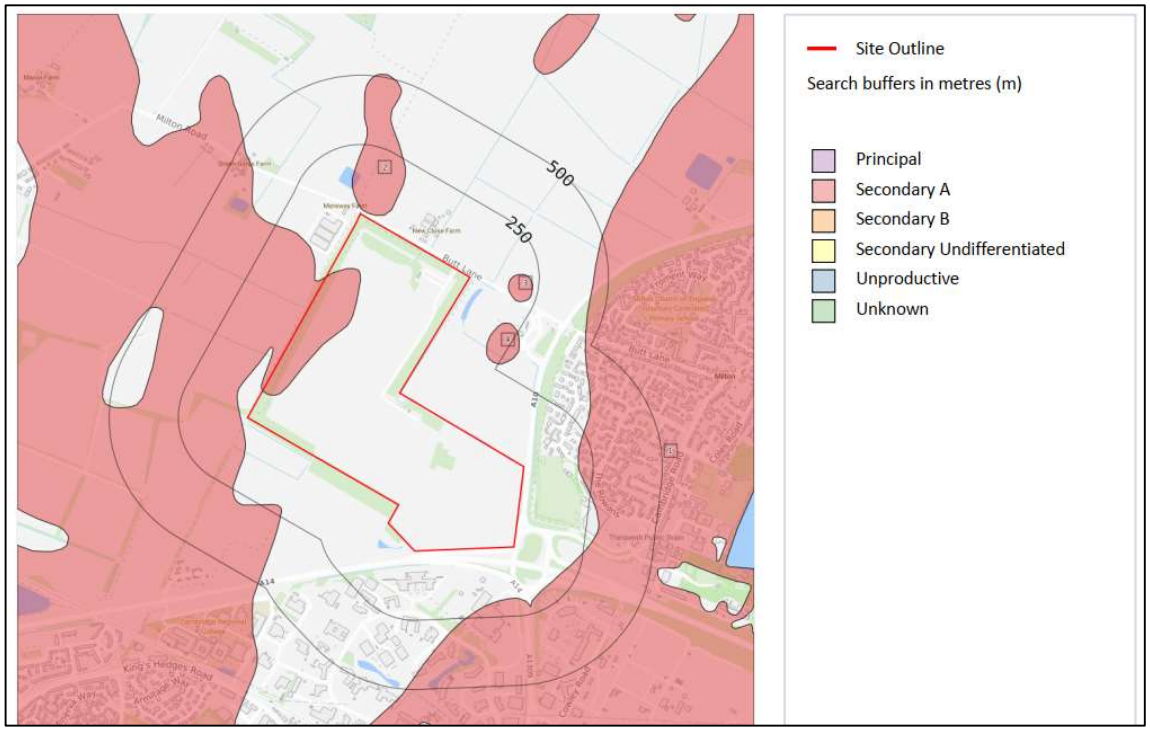
1.2.2. Geology and Hydrogeology

The geology of the site can be viewed on the British Geological Survey (BGS) Geology of Britain Viewer. This shows the site to be underlain by Gault Clay. There are superficial River Terrace deposits indicated as occurring along the middle part of the western boundary, however, on the remainder of the site there are no superficial deposits indicated. The Gault Clay is

underlain by Greensand and in turn by Kimmeridge Clay.

The previous hydrogeological risk assessments of the site describe the principles of site leachate management in relation to the groundwater confined within the Greensand at depth, but also in relation to the River Terrace deposits, which are understood to be present across the whole site, in contrast to the published information available from the BGS. An extract of a recent Groundsure report illustrates the distribution of the River Terrace deposits (Secondary A aquifer) in relation to the boundary of the site, refer to Figure 2.

Figure 2: River Terrace deposits/ superficial aquifer (taken from Groundsure report GS-7383761)



The 2003 permit application contained copies of the available borehole logs at that time. The borehole logs for the current monitoring boreholes are presented in Appendix 1. Table 1 presents a summary of the geological information obtained from the available logs for the existing perimeter monitoring boreholes.

Table 1: Geological Sequence on Site

Name	Description	Thickness (m)
Topsoil	Topsoil	Mostly absent to 0.4
Made ground	Medium dense light brown light brown slightly clayey SAND and sandy silty CLAY with fine and	0 to 2.4 5.3m in BH14

	medium gravel including brick and ash. Rootlets.	
River Terrace deposits / Sand and Gravel / Drift	Medium dense yellowish/orange brown clayey SAND and fine to medium GRAVEL including chalk. Occasional thin laminae of shelly sand. Termed RIVER TERRACE DEPOSITS, or POCKETY DRIFT. Includes layers of firm slightly sandy silty CLAY. In parts of the site becoming mostly silty CLAY with gravel of chalk.	Absent to 2.8
Gault Clay	Firm to stiff grey / brown mottled finely laminated silty MARL. Occasional shell fragments and phosphatic nodules.	24.4 - 28.75
Lower Greensand	Greenish grey glauconitic SAND with clay and gravel layers.	4.5 to 6.25
Kimmeridge Clay	Light grey silty CLAY	2.55 penetrated

River Terrace Deposits / Drift

Table 1 indicates that the maximum thickness of River Terrace/Drift deposits at the site perimeter is 2.8m. In places the River Terrace/Drift is absent (BH7); in places it is interbedded with clays (BHs 28, 37, 42, 46) and in places it is predominantly clayey (BHs 21 and 38).

Figures 2 to 5 present cross sections of the site. It has been stated in previous reports that the thickness of River Terrace deposits reached 6.7m. This appears to be based on the borehole log for BH14, where the base of the River Terrace is 6.7m below ground level (bgl), however, the borehole encounters a 5.3m thickness of fill and the ground level recorded for the borehole is elevated more than 3m above surrounding ground level. The base of the River Terrace/Drift is at a similar level relative to Ordnance Datum as seen in nearby BH12, where only a maximum of 2.8m of River Terrace/Drift was present.

The River Terrace Gravels are classified as a Secondary A aquifer. Seepages were recorded from these deposits during boring. Where installation details are available (these appear only to be available for the 1990 boreholes: BH1 to BH8) they indicate the BH series boreholes were installed with 50mm, or 100mm diameter standpipe to the full depth of the borehole, which was 13m, or more. Therefore, water levels measured in these boreholes represent the combined monitoring of River Terrace/Drift and Gault Clay. The River Terrace deposits have been previously modelled as a groundwater receptor.

Gault Clay

The Gault Clay is a non-aquifer / unproductive strata. Rising and falling head tests are reported to have been carried out on the in situ clay at the base of Phase II and report permeabilities of

3×10^{-10} to 4×10^{-7} m/s. The BGS, 1995, references the Milton area in Technical report WN/94/31 on the Gault Clay. The depth to the Gault is recorded as 2.8m, which ties in with the thickness of River Terrace/Drift given in the section above. The BGS records the permeability of the Gault Clay at Harwell to be 8.3×10^{-12} m/s.

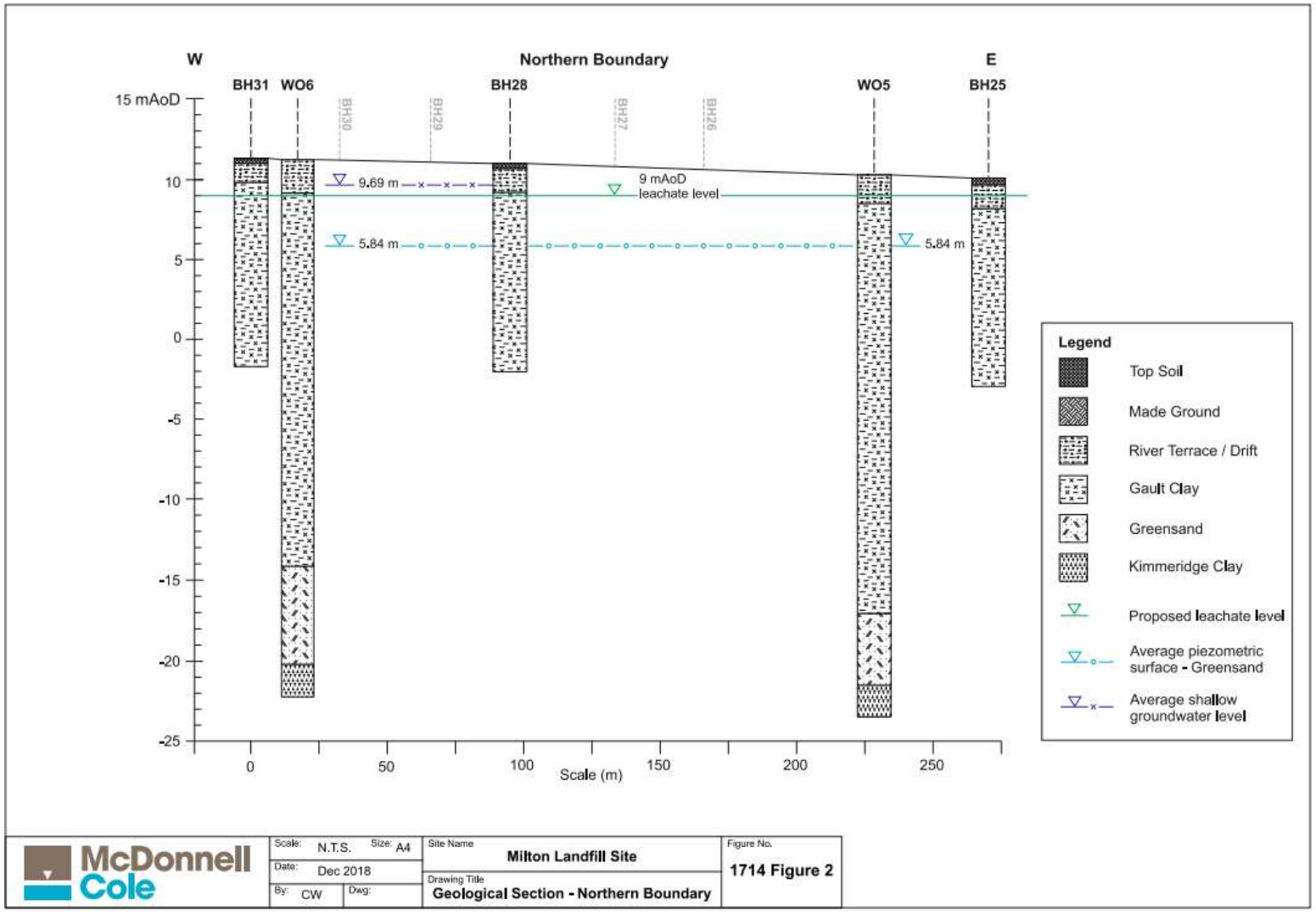
The site has been excavated to variable depths. The 2003 ESID reports cell bases of between 6 and -1.18m AOD. Recent retro-drilled wells in Phase I indicate the base may reach -3.5 m AOD in places. The base of the Gault Clay is between -14.4 (Borehole W7) and -19.7m AOD (Borehole W3). Depth to the Gault is deeper on the east where the waste is deeper. The likely minimum thickness of Gault remaining below Phase I would be 16.2m. Available data for the base of Phase II suggests lowest bases are around 0m AOD. The underlying thickness of Gault will be at least the same as for Phase I, but potentially 3m thicker. The majority of cell bases in Phase III are recorded to be around 4m AOD, with Cells 15A and 15B at around 2m AOD. This would leave a minimum thickness of approximately 16.5 m of Gault Clay on the west of the site, but over 25m towards the centre.

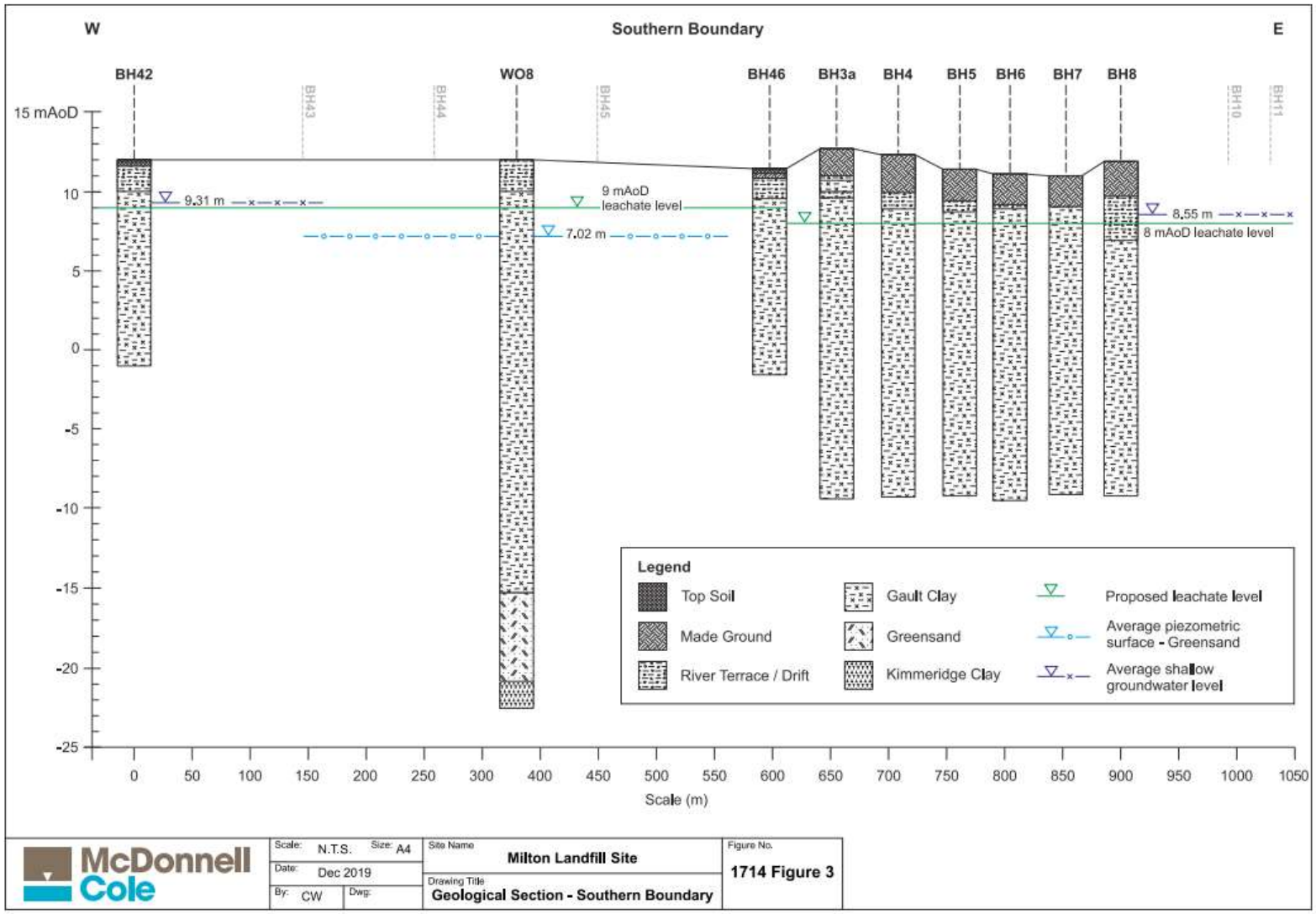
Lower Greensand

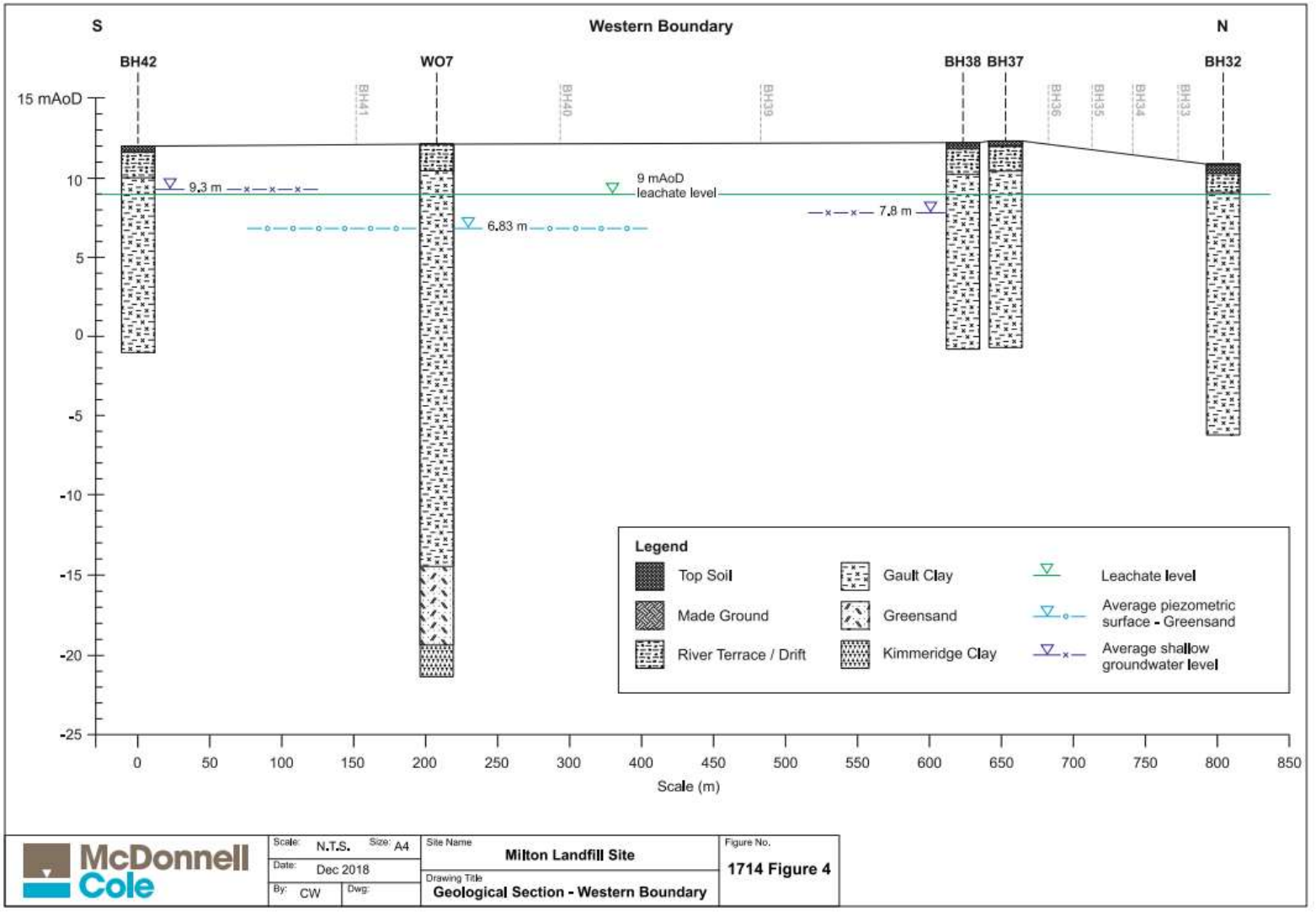
The borehole logs record that the W series boreholes encountered the Greensand, but installation details are not provided. The groundwater within the Greensand, which is designated as a principal aquifer, is confined by the overlying thickness of Gault Clay and major water strikes are recorded when boreholes reach the top of the horizon. The aquifer is 4.5 to 6.25m thick in the location of the site. BGS boreholes indicate a thickness of 9m downgradient of the site. The BGS, 1997, describes the reduced thickness of Lower Greensand in the Cambridge area. Here transmissivities are thought to be of the order of $100m^2$/day. With an aquifer thickness of 5m, this would give a hydraulic conductivity of 2.3×10^{-4} m/s and a thickness of 9m would give a hydraulic conductivity of 1.3×10^{-4} m/s.

Aquifer Properties

The hydraulic gradient within the River Terrace/Drift has been reported in earlier revisions of the HRA to be eastwards at approximately a gradient of 0.001 to 0.005. Due to its relatively shallow thickness the horizon can become dewatered as a result of landfill construction activities and therefore, the hydraulic gradient can be affected. The hydraulic gradient in the Greensand has been reported in earlier versions of the HRA to be northeastwards at a gradient of 0.001 to 0.003. The piezometric surface of the Greensand has been reported in earlier versions of the HRA to be approximately 1 to 4m below that of the groundwater levels recorded in shallower site boreholes. Groundwater level data reviewed since boreholes were installed in the early 1990s indicate the average groundwater level in the River Terrace/Drift varies between 7.8 and 9.9m AOD. Data for the same period for the Greensand shows average levels between 5.8 and 7m AOD. Average groundwater levels are indicated on the cross sections presented as Figures 2 to 5. It is clear that in places on the west of the site the shallow groundwater level is below the base of the River Terrace/Drift and the water level recorded represents pore water within the Gault Clay.


W
Northern Boundary
E
BH31
WO6
BH30
BH29
BH28
BH27
BH26
WO5
BH25
15 mAoD
10
5
0
-5
-10
-15
-20
-25
9.69 m
9 mAoD
leachate level
5.84 m
5.84 m
0
50
100
150
200
250
Scale (m)
Legend
Top Soil
Made Ground
River Terrace / Drift
Gault Clay
Greensand
Kimmeridge Clay
Proposed leachate level
Average piezometric surface - Greensand
Average shallow groundwater level
McDonnell Cole
Scale: N.T.S.
Size: A4
Date: Dec 2018
By: CW
Dwg:
Site Name
Milton Landfill Site
Drawing Title
Geological Section - Northern Boundary
Figure No.
1714 Figure 2


W
Southern Boundary
E
BH42
BH43
BH44
WO8
BH45
BH46
BH3a
BH4
BH5
BH6
BH7
BH8
BH10
BH11
15 mAoD
10
5
0
-5
-10
-15
-20
-25
9.31 m
9 mAoD
leachate level
7.02 m
8.55 m
8 mAoD leachate level
0
50
100
150
200
250
300
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
Scale (m)
Legend
Top Soil
Made Ground
River Terrace / Drift
Gault Clay
Greensand
Kimmeridge Clay
Proposed leachate level
Average piezometric surface - Greensand
Average shallow groundwater level
McDonnell Cole
Scale: N.T.S.
Size: A4
Date: Dec 2019
By: CW
Dwg:
Site Name
Milton Landfill Site
Drawing Title
Geological Section - Southern Boundary
Figure No.
1714 Figure 3


S
Western Boundary
N
BH42
WO7
BH38
BH37
BH32
BH41
BH40
BH39
BH36
BH35
BH34
BH33
15 mAoD
10
5
0
-5
-10
-15
-20
-25
9.3 m
9 mAoD
leachate level
6.83 m
7.8 m
0
50
100
150
200
250
300
400
450
500
550
600
650
700
750
800
850
Scale (m)
Legend
Top Soil
Made Ground
River Terrace / Drift
Gault Clay
Greensand
Kimmeridge Clay
Leachate level
Average piezometric surface - Greensand
Average shallow groundwater level
McDonnell Cole
Scale: N.T.S.
Size: A4
Date: Dec 2018
By: CW
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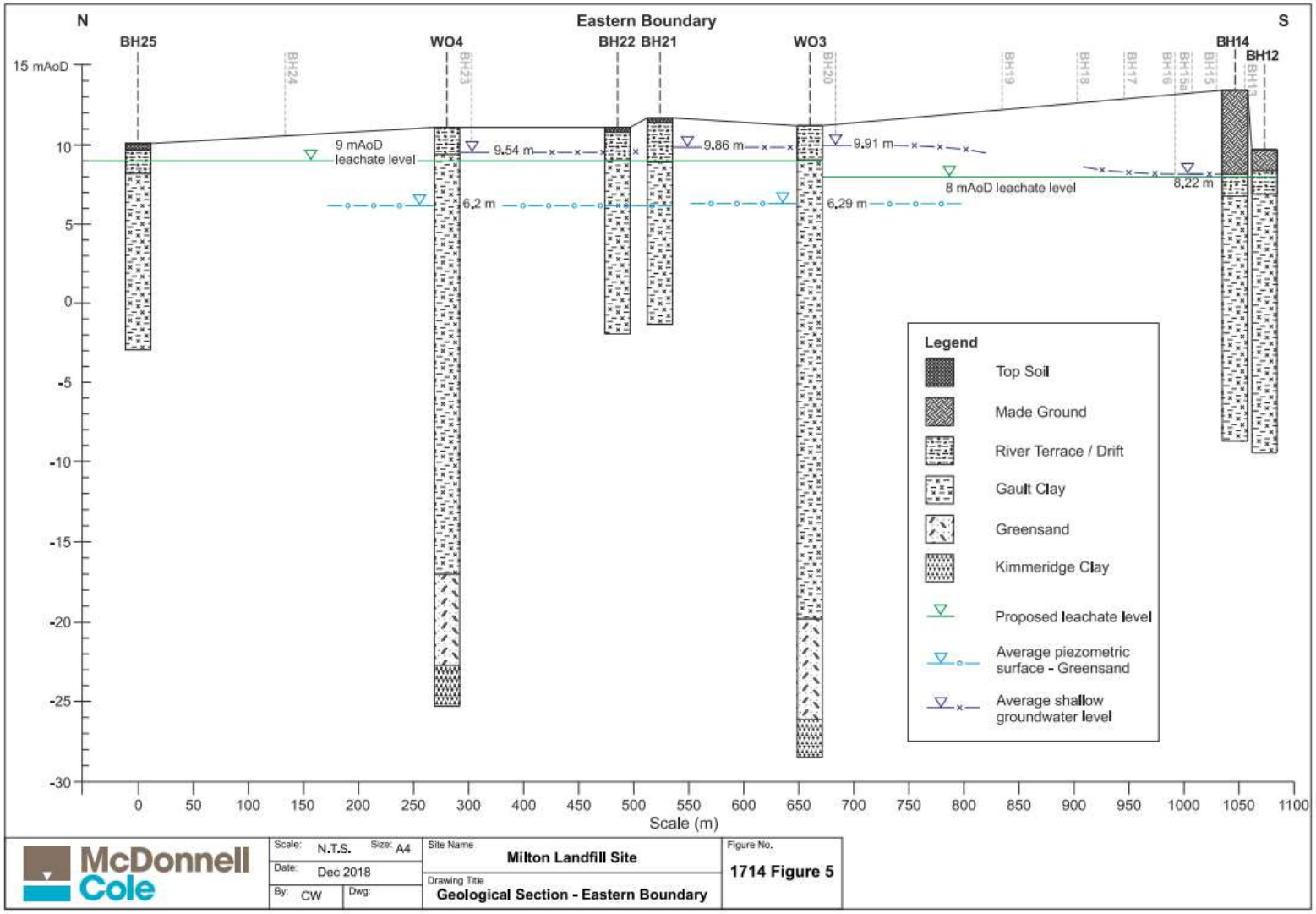
Site Name
Milton Landfill Site
Drawing Title
Geological Section - Western Boundary
Figure No.
1714 Figure 4


N
Eastern Boundary
S
BH25
WO4
BH22 BH21
WO3
BH14
BH12
BH24
BH23
BH20
BH19
BH18
BH17
BH16
BH15a
BH15
BH13
15 mAoD
10
5
0
-5
-10
-15
-20
-25
-30
9 mAoD
leachate level
9.54 m
9.86 m
9.91 m
6.2 m
6.29 m
8 mAoD leachate level
8.22 m
0
50
100
150
200
250
300
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
Scale (m)
Legend
Top Soil
Made Ground
River Terrace / Drift
Gault Clay
Greensand
Kimmeridge Clay
Proposed leachate level
Average piezometric surface - Greensand
Average shallow groundwater level
McDonnell Cole
Scale: N.T.S.
Size: A4
Date: Dec 2018
By: CW
Dwg:
Site Name
Milton Landfill Site
Drawing Title
Geological Section - Eastern Boundary
Figure No.
1714 Figure 5

Aquifer Usage

The site does not lie within a groundwater source protection zone. The 2003 ESID reported the following groundwater abstractions within 2 km of the site, as shown in Table 2. Reference to a recent Groundsure report indicates that the majority of these abstractions are no longer in use.

Table 2: Groundwater Abstractions

National grid reference	Distance from site centre (km)	Licensed quantity (m3)	Purpose	Current status	Distance from boundary (km)
TL 463 634	0.3	5000	Spray irrigation	historical	
TL 476 634	1.1	25000	General agriculture	not listed	
TL 468 619	1.3	2655	General agriculture	historical	
TL 468 618	1.4	6588	General agriculture	historical	
TL 466 617	1.5	1520	General agriculture	historical	
TL 458 617	1.7	2000	Industrial/commercial/ energy/public services	historical	
TL 449 621	1.9	22725	General agriculture	Active	1.1 km SW

Hydrology

The site is within the catchment of the River Cam, which flows south to north approximately 1.5km east of the site. The closest surface water feature to the site is Thirteenth Public Drain, which flows west to east along the northern boundary of Phase I, although this is commonly dry. From there it crosses below the A10, passes a superstore and flows through Milton Country Park to reach the River Cam. There are smaller drains along the eastern and southern boundary of the site.

1.2.3. Source

The source in this hydrogeological risk assessment is the leachate held within the wastes. This was characterised in the 2003 HRA and has been most recently reviewed in the 2015 HRA. The key determinands considered to present a risk to the hydrogeological regime in 2003 were

- m,p xylene, cadmium, mecoprop, ammonical nitrogen, chloride and zinc.

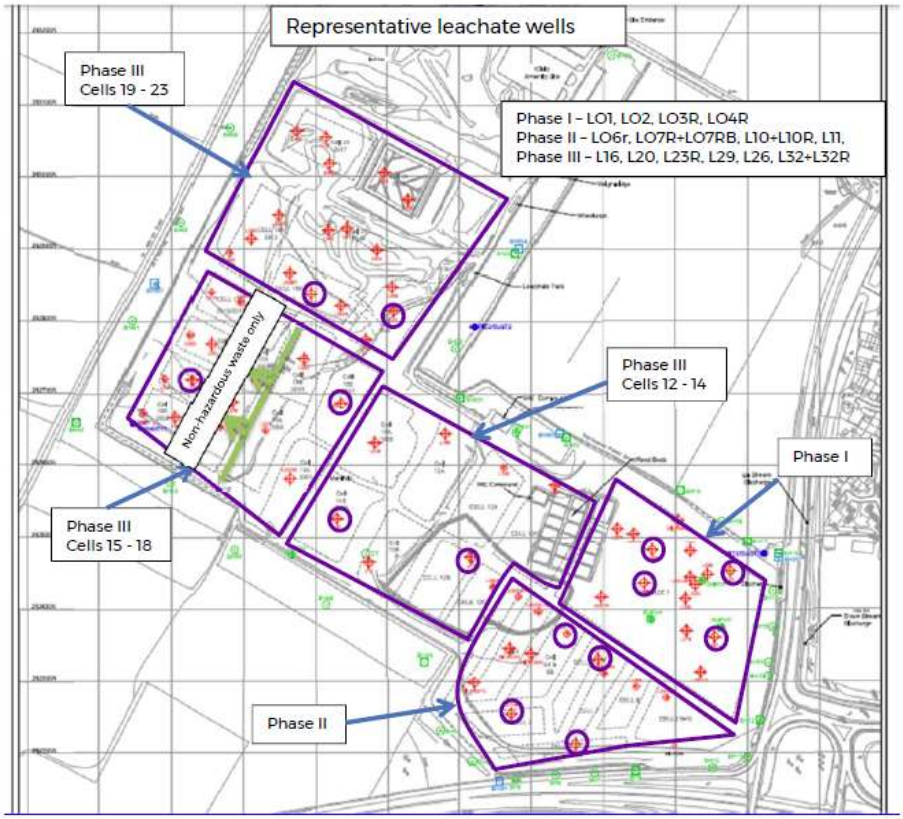
In 2015 it was reported that cadmium did not have a detection rate of more than 50% and therefore, was not considered to present a significant risk. Since the 2003 HRA there have been changes to the classification of hazardous substances, most recently by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG), 2018. Based on the 2018 classification the key determinands can be grouped as follows:

- **Hazardous substances**: m,p xylene
- **Non-hazardous pollutants**: mecoprop, ammoniacal nitrogen, chloride, cadmium and zinc.

The 2015 review of leachate chemistry determined that the concentrations of key substances

remained broadly in line with the 2003 leachate chemistry. Some maximum values were found to have risen and as a result the source term distribution was amended. Leachate chemistry is monitored in each individual cell: 68 wells are dipped monthly, 6 are sampled quarterly and 36 are sampled annually. 19 wells are sampled on a four-yearly basis. There is a very big dataset and in order to determine whether leachate chemistry has changed over time, or differs between the earlier cells, which may have included some hazardous waste and non-hazardous areas of the site, the site has been divided as shown in Figure 6, with a number of representative wells from each area. Representative wells have been selected partly based on location and partly based on length of record. A number of wells have ceased to be used and have been replaced by retro-drilled wells. In the case of L10 and L32 the original and retro-drilled records have been combined for this assessment.

Figure 6: Zoning of site for leachate



Graphs of the key determinands for each phase are presented below, to determine whether areas of the site are showing declining, or increasing concentrations and what differences in chemistry there may be between the phases. Refer to figures 7.1 to 7.18.

Figure 7.1 Ammoniacal nitrogen Phase I

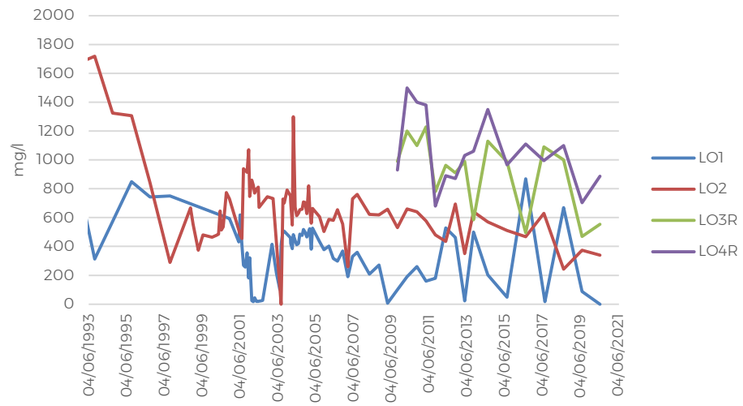


Figure 7.2 Ammoniacal Nitrogen Phase II

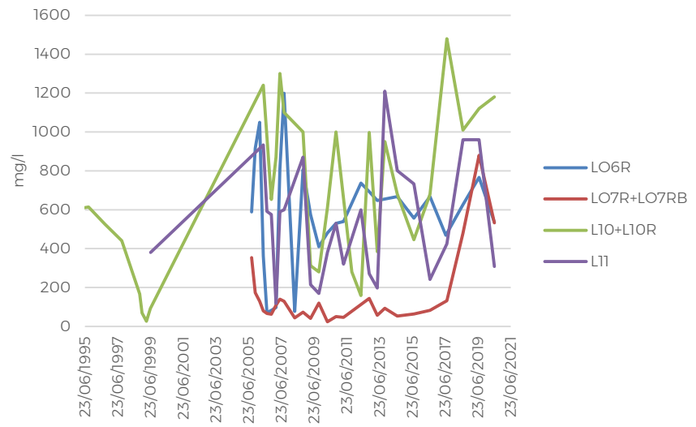


Figure 7.3 Ammoniacal Nitrogen Phase III

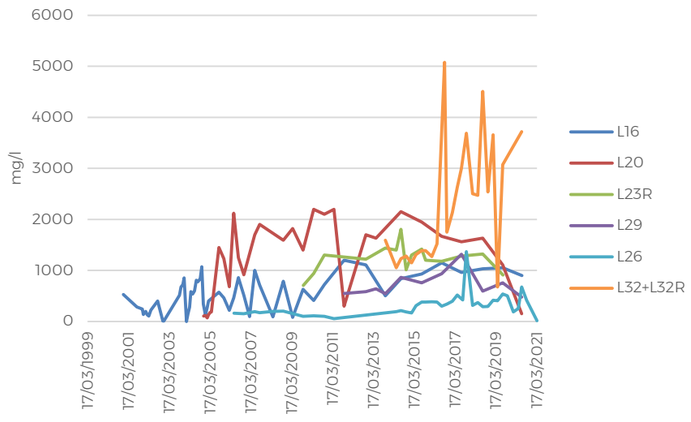


Figure 7.4 Chloride Phase I

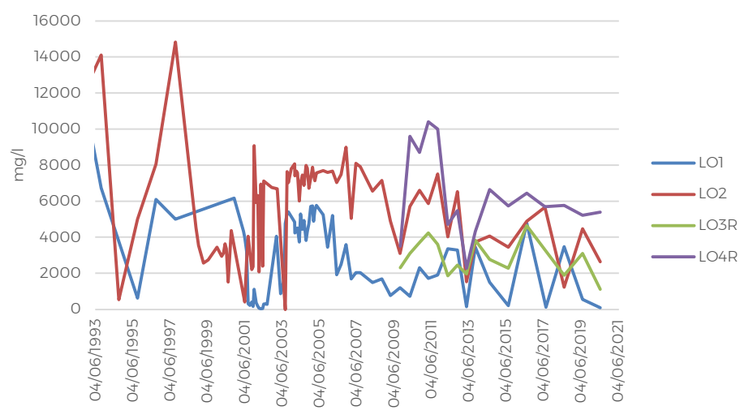


Figure 7.5 Chloride Phase II

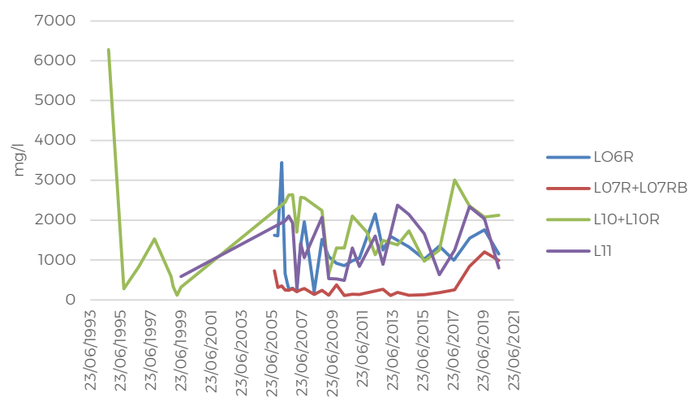


Figure 7.6 Chloride Phase III

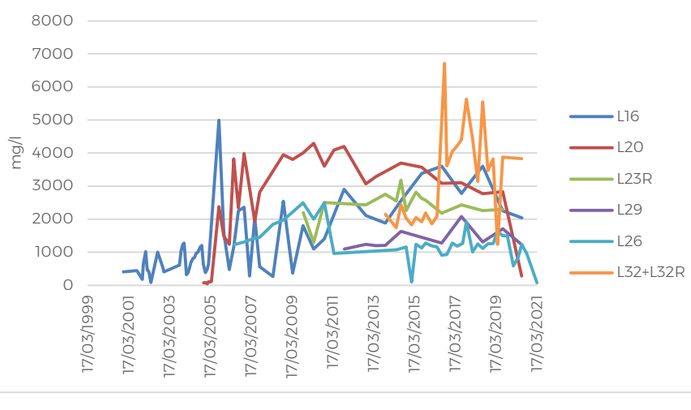


Figure 7.7 m p xylene Phase I

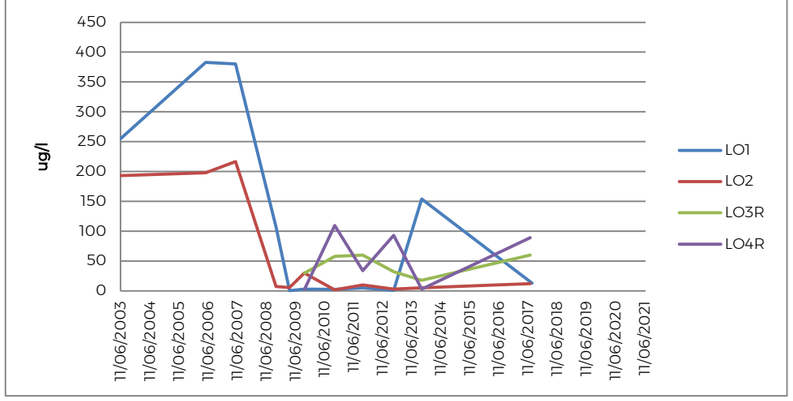


Figure 7.8 m p xylene Phase II

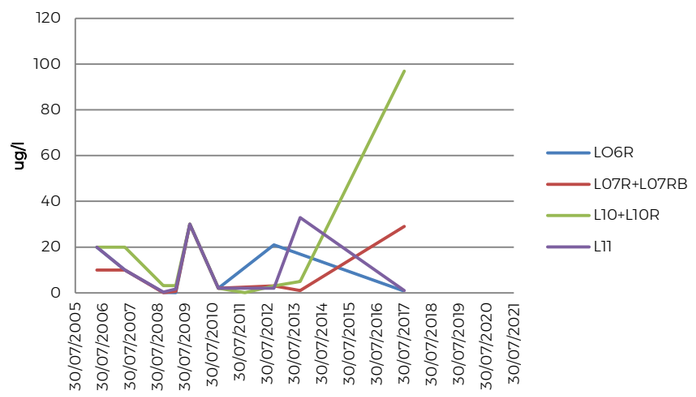


Figure 7.9 m p xylene Phase III

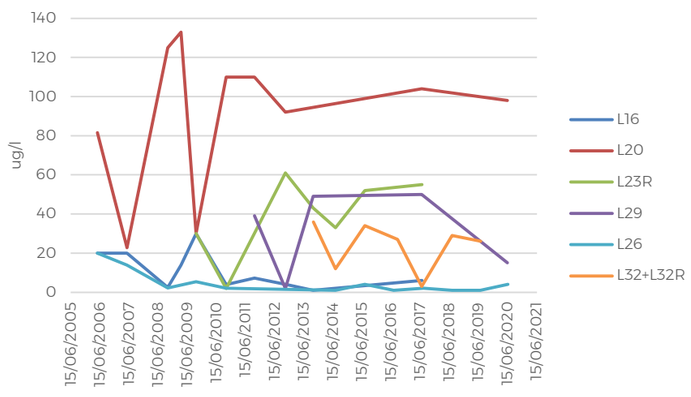


Figure 7.10 Mecoprop Phase I (mg/l)

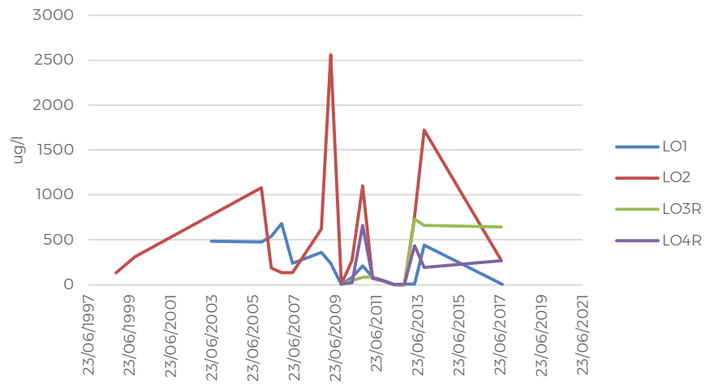


Figure 7.11 Mecoprop Phase II

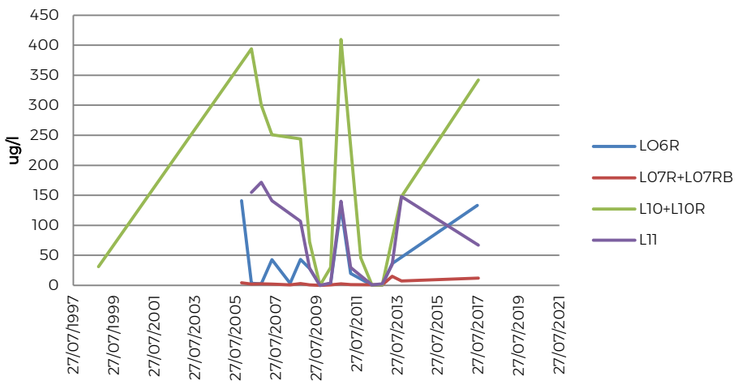


Figure 7.12 Mecoprop Phase III

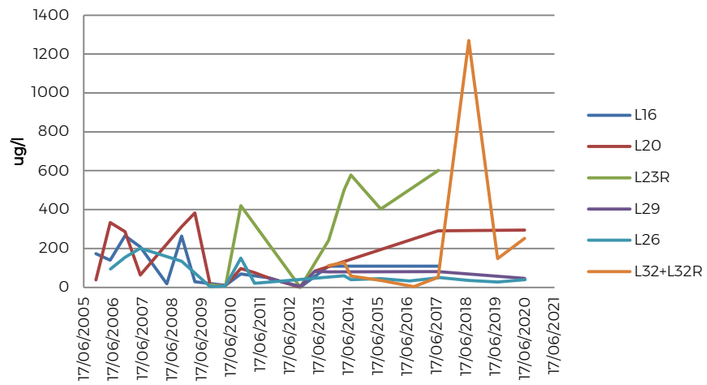


Figure 7.13 Cadmium Phase I

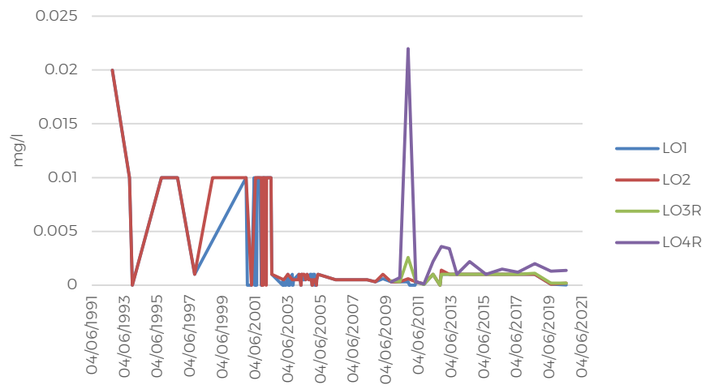


Figure 7.14 Cadmium Phase II

Figure 7.15 Cadmium Phase III

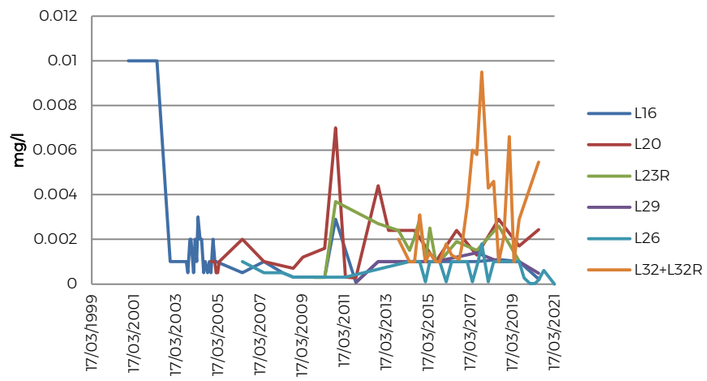


Figure 7.16 Zinc Phase 1

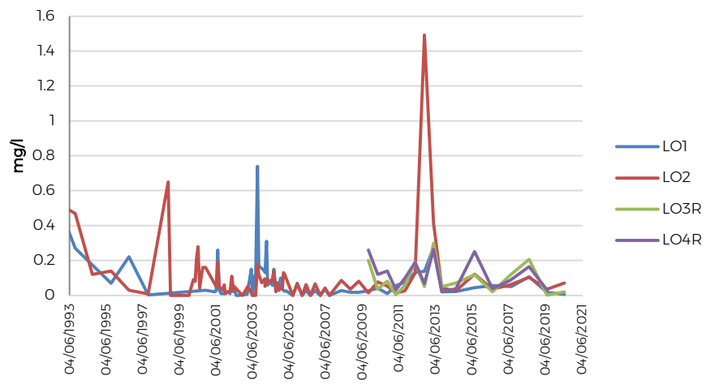


Figure 7.17 Zinc Phase II

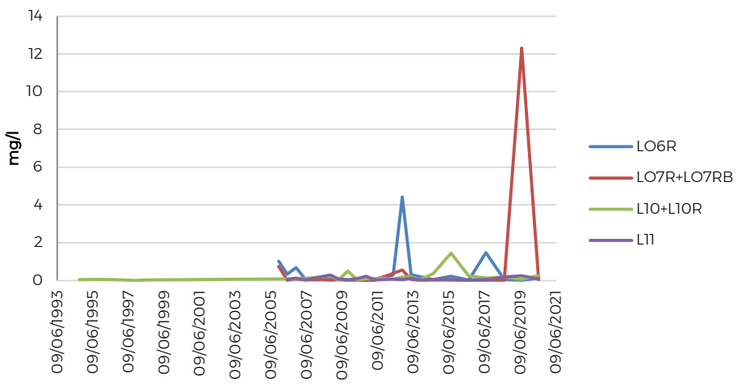
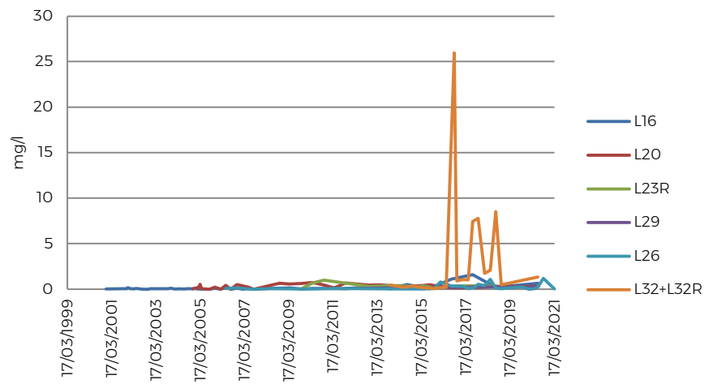


Figure 7.18 Zinc Phase III



The graphs above show data from selected cells in the different phase of the site to establish

1. Whether leachate sources are beginning to decrease with time;
2. Whether there are significant differences between the phases and the hazardous and non-hazardous waste and
3. Where there is a significant change in chemistry since the 2015 HRA.

The summary of the data reviewed for the 2015 HRA (2000 to 2015) is presented in Table 3.

Table 3: Summary of leachate chemistry from 2015 HRA

Determinand	Phase I		Phase II		Phase III	
	Min	Max	Min	Max	Min	Max
Ammoniacal nitrogen (mg/l)	0.1	1500	3.9	1330	0.3	2200
Chloride (mg/l)	2	14400	30	3450	5	5600
m,p xylene (ug/l)	<0.1	383	<0.1	33	<0.1	133
Mecoprop (ug/l)	<0.04	3990	<0.04	410	<0.4	650
Cadmium (mg/l)	<0.00008	0.022	<0.0003	0.0031	<0.00008	0.016
Zinc (mg/l)	<0.004	1.493	0.013	4.424	0.002	2.7

A review of the above data and graphs indicates that in Phase I the concentrations of ammoniacal nitrogen, chloride, m,p xylene and cadmium have decreased with time. In Phase II this is less apparent. In Phase III there are still concentration increases in the fresher waste. The ammoniacal nitrogen concentrations are highest in this phase.

Based on the key determinands, the chemistry of Phase I remains higher in chloride, m,p xylene and mecoprop than other phases, although concentrations generally show a decreasing trend. Phase II, although it took some hazardous waste, does not appear to have concentrations significantly different to those in Phase III, which is predominantly non-hazardous.

Leachate levels are discussed in section 2.4.4. This indicates that current permitted leachate levels are not contained within individual cells. In places the permitted level is higher than the intercell bund. The data above still shows a difference in chemistry between Phase I and the other phases. The decrease in concentration with time is likely due to degradation. It is possible there is some dilution from the adjacent cells. However, the trends observed are not unexpected: old wastes in Phase I showing a declining source and the newer cells in Phase III showing an increase as wastes begin to degrade.

In terms of changes to the leachate chemistry since 2015 there is no general increase in concentrations of the key determinands except in retro drilled wells, for example L10R and more distinctly L32R. These appear to suggest the retro-drilled wells have encountered concentrated leachate. Cadmium and zinc concentrations drop noticeably after a few monitoring rounds. Further monitoring will determine whether concentrations fall in line with those of the wells they have replaced.

The volume of the leachate source is governed by the prevailing leachate level. A review of technical precautions and leachate level is given in section 2.4.4. The current permitted leachate levels are given in Table 4.

Table 4: Leachate compliance levels

Phase / Cell	Leachate Well	Limit (mAOD)	Cell base (mAOD)
Phase III - operational	L26, L26A, L28B, L32R2, L32AR, L32BR2, L33R, L33A, L33BR	6.5	3.01 – 4.9
Phase I	All cells	6.5	-3.68 – 5.69
Phase II Cell 3	L03/2014R	8.1	4.9
Phase II Cell 2	L07RB	8	5.35
Phase II Cell 6	L11	8.4	6.38
Phase III Cell 12C	L12DR2	9.5	5.36
Phase III Cell 12A	L15R	8	6.01
All remaining cells*		6.5	

'* Cells 22, 23, 24A and 24B, the newer cells, do not have a designated leachate compliance level written in to the current version of the permit

It is understood that the level of 6.5m AOD has been set based largely on a level below the lowest recorded level of the River Terrace/Drift deposits. Where a higher level has been set this is understood to be because the base of the cells are higher than elsewhere on site.

1.2.4. Pathway

Based on the geology of the site there are considered to be two main pathways for leachate migration:

1. Lateral migration to the River Terrace/Drift deposits
2. Vertical migration through the Gault Clay to the Greensand at depth.

Lateral Migration to River Terrace / Drift Deposits

Migration of leachate in to the shallow groundwater of the River Terrace/Drift deposits can take place where the prevailing leachate level is higher than the prevailing shallow groundwater level. With a leachate head controlled to 6.5m AOD any groundwater held within the River Terrace / Drift will be higher than the leachate and the site will hydraulically contained, giving no pathway. A review of the geological sections presented as Figures 2 to 5, it can be seen that in most areas of the site leachate levels could rise to between 8.7 and 10m AOD before the base of the River Terrace / Drift deposits is encountered. It is only along the eastern boundary of the site where the base of the River Terrace/Drift is as low as 6.7m AOD.

The nature and level of the groundwater within the River Terrace / Drift deposits is discussed further in section 1.2.5. It is notable that these deposits are variable in sand, gravel and clay content and do not always contain water. However, the site has been engineered with a low permeability side wall liner between the wastes and the River Terrace / Drift deposits. The pathway between the leachate and the River Terrace / Drift differs between the phases of

landfilling.

- Phase II and much of Phase III have a 1m thick engineered clay sidewall liner of maximum permeability 1 x 10^{-9} m/s. From Cell 17 onwards the sidewall liner was changed to 3m in thickness. In the most northerly, final cells, the sidewall liner is continued at 1m thickness above original ground level, where fill will be against an inert stockpile.
- Phase I had no original sidewall liner. It is reported that in 1996 a retrospective side wall liner / cut off wall was installed along the northern, eastern and southern boundaries. The wall was engineered to a maximum permeability of 1 x 10^{-9} m/s and a thickness of 1m against the Gault Clay and 3m against the River Terrace / Drift deposits.
- Evidence for the retrospective sidewall is provided in Mitcham drawings from 1999 MIL/70/99, MIL/72/99 and MIL/73/99 and from information contained in the original 2003 ESID and HRA reports. The ESID indicates that CQA was in place during the construction of the sidewall. The HRA selected a permeability of 1 x 10^{-9} m/s for the sidewall based on CQA data. The permit for the site was granted by the EA on the basis that it was compliant with requirements at the time the data was submitted.

Vertical migration to Lower Greensand

Vertical migration of leachate to the Lower Greensand can occur if the leachate head is higher than the piezometric surface of the Lower Greensand aquifer. Groundwater levels in the Lower Greensand are discussed in the sections below. Tabulated data in the 2015 HRA gives groundwater levels with the Greensand of between 5.13 and 7.86m AOD. This indicates that the site, with leachate levels generally controlled to 6.5m AOD, is likely to be hydraulically contained during part of the year, but leachate has the potential to rise above the piezometric surface at other times of the year, potentially giving rise to vertical migration.

The pathway comprises a likely minimum thickness of Gault Clay of 16.5m below Phase I. Below the eastern side of Phase III the thickness may be greater than 25m. The Gault has permeabilities of 3 x 10^{-10} to 4 x 10^{-7} m/s, based on site data and effectively confines the Greensand. Studies of the characteristics of Gault Clay elsewhere in the country give permeabilities of the order of 8 x 10^{-12} m/s.

1.2.5. Groundwater Levels

Groundwater levels are measured in a series of perimeter boreholes. Available borehole logs, as summarised in Figures 2 to 5 indicate that the W series boreholes were drilled to the Kimmeridge Clay and are understood to be installed within the Lower Greensand.

Shallow BH Series Boreholes

The BH series boreholes were not drilled as deep as the Greensand. Available borehole logs indicate depths of 13 to 20m and where installation details are given this includes slotted 50mm or 100mm diameter pipe for the full depth of the borehole. This means that groundwater level readings are not restricted to the River Terrace / Drift deposits. The base of the River Terrace / Drift deposits is around 10 m AOD on the west of the site and 6.7 to 6.9 m AOD on the east. Figures 8A and 8B present groundwater levels in the BH series boreholes

with the minimum basal elevation of the River Terrace Deposits also indicated (RT MIN base). The figures indicate that in parts of the site the River Terrace / Drift deposits are dewatered. This is particularly noticeable in boreholes BH38 and BH42 on the west of the site. Borehole BH38 shows the most marked reduction in levels and this is closest to the area of new cell development. Excavation below the level of the River Terrace Deposits will have reduced the area contributing to groundwater recharge in this borehole location. Elsewhere the groundwater levels generally remain higher than the permitted leachate limit of 6.5m AOD.

Figure 8A: Groundwater levels BH series shallow boreholes (mAOD)

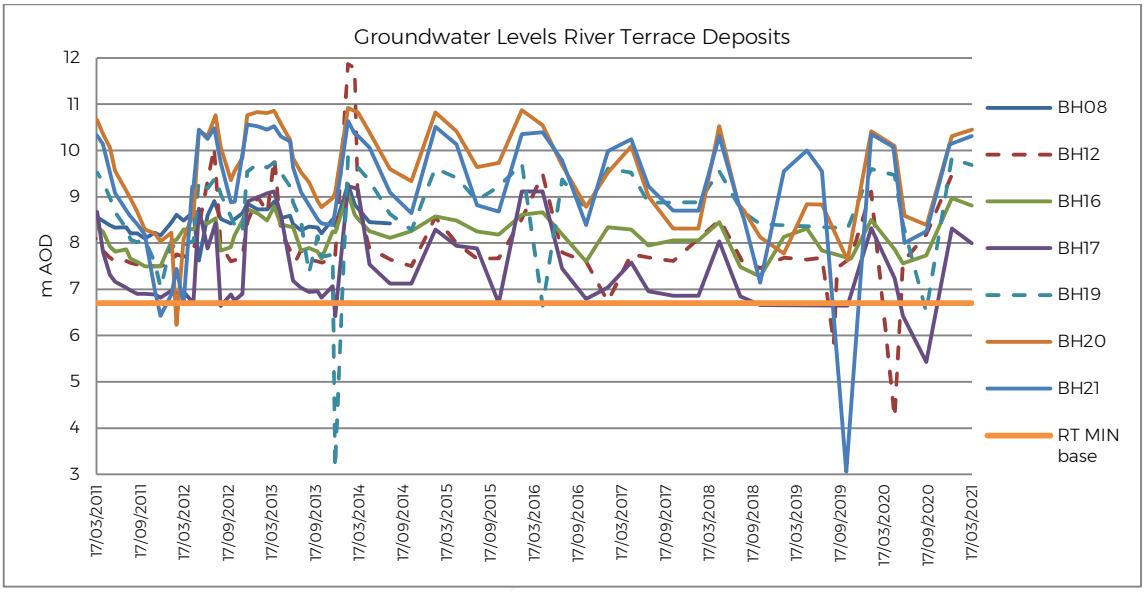
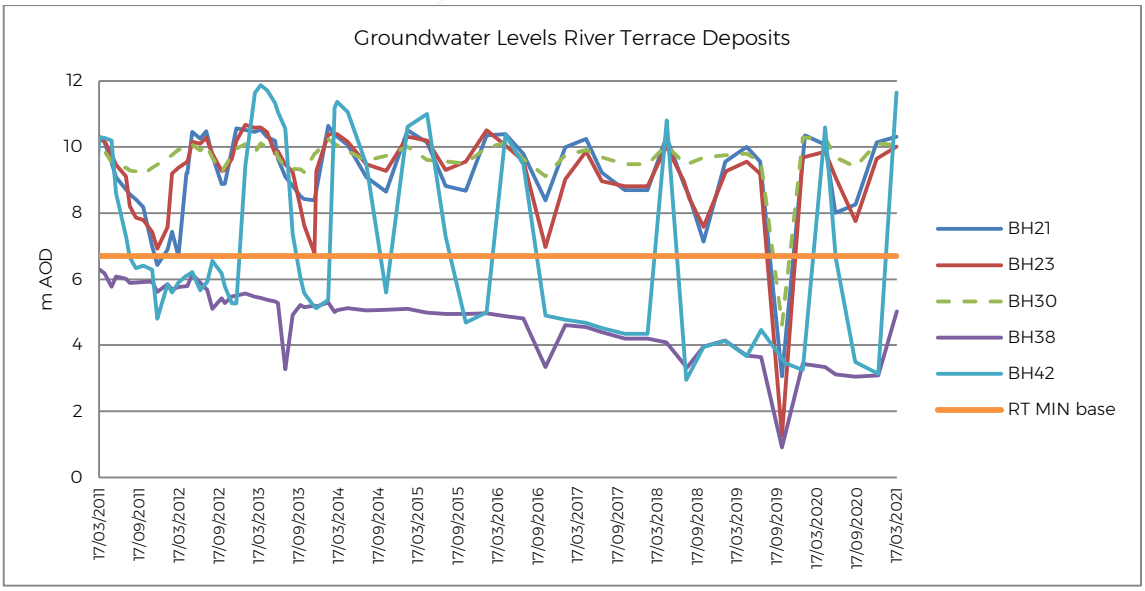


Figure 8B: Groundwater levels BH series shallow boreholes (mAOD)



The potential for leachate seepage to the River Terrace / Drift occurs on the east of the site where the base of the River Terrace / Drift is lower (minimum 6.7m AOD). The shallow groundwater on the east of the site is measured in boreholes BH8, BH12 and BH16. The table below shows water level data since the boreholes were first installed. The average groundwater level on the east of the site is approximately 8m AOD. Minimum groundwater levels on the east indicate the River Terrace / Drift deposits are dry at certain times of the year.

Table 5: Groundwater levels BH series boreholes

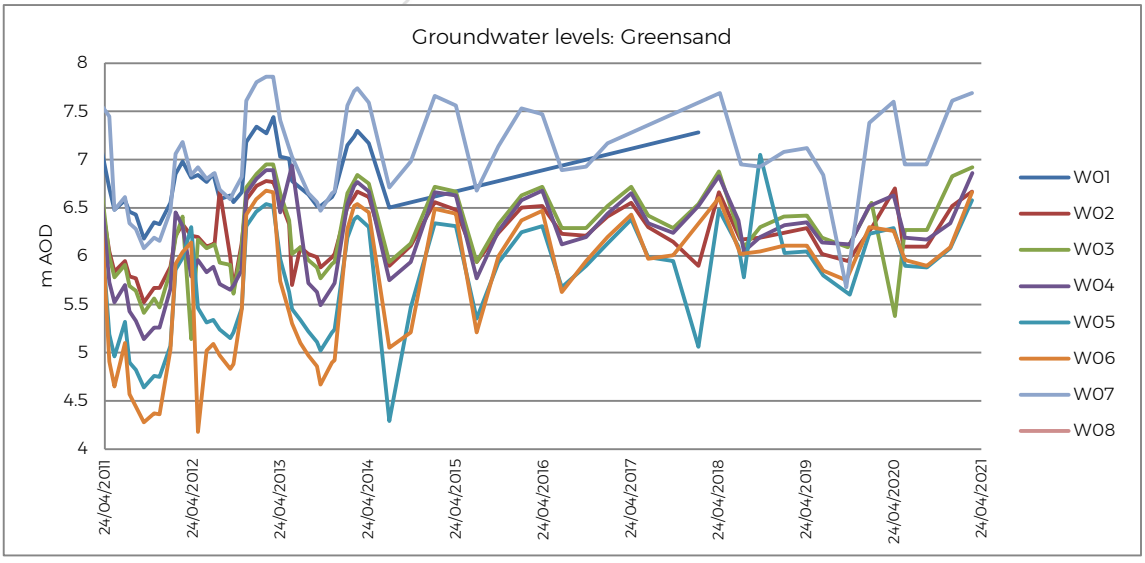
	BH08	BH12	BH16	BH17	BH19	BH20	BH21	BH23	BH30	BH38	BH42
Min	6.02	4.23	5.63	4.4	3.15	6.23	3.06	1.26	4.2	0.91	2.95
Max	10.92	11.87	10.21	9.23	10.22	11.49	11.16	10.67	10.75	11.31	12.26
Average	8.55	7.89	8.22	7.71	8.78	9.89	9.82	9.51	9.68	7.64	9.17
5/3/08	8.66	8.08	8.41	8.65	9.55	10.7	10.25	10.25	10.05	7.72	8.31
26/3/13	8.9	9.83	8.79	9.11	9.74	10.86	10.53	10.59	10.11	5.43	11.87

Using data from March 2008 as an example and a time of year when groundwater levels are at their highest, a hydraulic gradient of 2.17m in 600m, or 0.0036 is seen between boreholes BH21 and BH12. Data from March 2013, gives a hydraulic gradient of 0.0011. Previous HRAs have given a range of 0.001 to 0.005 for the hydraulic gradient of the shallow aquifer and a southeasterly direction of flow, which is consistent with the data above. Boreholes BH38 and BH42 are discounted from the calculation as they appear to be influenced by landfill construction activities: the River Terrace/Drift is dewatered in BH38 and also some of the time in BH42 and therefore, the measured groundwater levels sit within the Gault Clay.

Deeper W Series Boreholes

Groundwater levels in the deeper boreholes, which are understood to be installed within the Greensand are presented in Figure 9.

Figure 9: Groundwater Levels, Greensand (m AOD)



Borehole W01 has been affected by adjacent road works and has recently been replaced. Groundwater levels since the boreholes were first installed are summarised in the table below and indicate an average piezometric surface of 6 to 6.5m AOD.

Table 6: Groundwater data, Greensand Boreholes (from first installation)

	W01	W02	W03	W04	W05	W06	W07	W08
Max	9.34	8.95	7.04	6.99	9.46	8.2	8.36	7.67
Min	5.37	4.83	3.87	4.95	4.29	3.62	3.69	5.69
Average	6.8	6.25	6.31	6.21	5.85	5.83	6.85	7.02
GWL 5/3/2008	5.8	6.24	6.48	6.4	6.1	6.28	6.9	

Example data from March 2008 gives a hydraulic gradient of approximately 0.001 between W7 and W4 and W7 and W5. This suggests an easterly/northeasterly direction of groundwater flow and is consistent with previous HRAs. The last 10 years of data, as graphed, shows a rise in the average levels for boreholes W05 and W06 in the north of the site. This may be linked to the disuse of the spray irrigation borehole north of the site.

1.2.6. Receptors

Principal receptors are

- groundwater held within the River Terrace/Drift;
- groundwater held within the Greensand;
- surface waters of the Thirteenth Public Drain and connecting drainage downgradient.

Local abstraction information obtained from previous HRAs is given in section 1.2.2. There are six groundwater abstractions within 2km of the site, predominantly for agricultural use, with only one listed as still being active. The site is not within a source protection zone for a public water supply borehole.

The environmental permit gives limits for the concentration of key determinands within the water quality of the shallow and deep groundwater and for the surface water discharge point shown on environmental monitoring plan 653M282, downgradient of the Thirteenth Public Drain. These are presented in the table below. It is noted that the source of the surface water discharge is written into the permit as the effluent treatment plant. This is understood to no longer be in operation but perimeter surface water quality continues to be monitored when water is present. A conceptual cross section of the site is presented as Appendix 2.

Table 7: Environmental Assessment Levels

Borehole	Ammoniacal Nitrogen (mg/l)	Chromium (mg/l)	Zinc (mg/l)	Mecoprop (ug/l)	Xylene (ug/l)	Cadmium (ug/l)
BH8	1.99	0.05	0.11	0.1	3	1
BH12	2.57	0.05	0.08	0.1	3	1
BH16	1.57	0.05	0.04	0.1	3	1
BH17	0.38	0.05	0.02	0.1	3	1

Borehole	Ammoniacal Nitrogen (mg/l)	Chromium (mg/l)	Zinc (mg/l)	Mecoprop (ug/l)	Xylene (ug/l)	Cadmium (ug/l)
BH19	0.26	0.05	0.02	0.1	3	1
BH20	2.56	0.05	0.64	0.1	3	1
BH21	4.63	0.05	0.08	0.1	3	1
BH23	1.16	0.05	0.07	0.1	3	1
BH30	0.69	0.05	0.04	0.1	3	1
BH38	1.15	0.05	0.08	0.1	3	1
BH42	1.09	0.05	0.07	0.1	3	1
W02	3.05	0.05	0.17	0.1	3	1
W03	0.82	0.05	0.04	0.1	3	1
W04	3.02	0.05	0.1	0.1	3	1
W05	0.96	0.05	0.04	0.1	3	1
W06	1.25	0.05	0.04	0.1	3	1
Discharge point	5	Suspended solids: 50 mg/l; chloride: 250 mg/l; pH: 6-10; oil and grease: none visible				

1.2.7. Groundwater Quality

The tables below compare all available groundwater quality data against the permitted trigger levels. Chloride is included in the assessment, however, there are no trigger levels for chloride and the construction of the adjacent bypass appears to have had an adverse effect on chloride concentrations locally.

Table 8: Groundwater Quality Data: BH series shallow boreholes

	BH8	BH12	BH16	BH20	BH21	BH23	BH30	BH38	BH42	BH17	BH19
m p xylene NOTE 1											
Trigger level (ug/l)	3	3	3	3	3	3	3	3	3	3	3
n	11	16	17	16	16	16	14	14	14	17	17
n> LOD	0	0	0	0	0	0	0	0	0	0	0
Min (ug/l)	0.1	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Mean (ug/l)	0.68	0.78	0.79	0.78	0.78	0.78	0.75	0.75	0.75	0.79	0.79
Max (ug/l)	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Cadmium											
Trigger level (mg/l)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
n	63	90	93	94	90	93	92	92	93	59	62
n> LOD	7	7	8	9	10	11	16	11	11	4	7
Min (mg/l)	0.00008	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Mean (mg/l)	0.0022	0.0021	0.0021	0.0021	0.0020	0.0020	0.0018	0.0021	0.0020	0.0002	0.0002
Max (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.001	0.001
Ammoniacal nitrogen											
Trigger level (mg/l)	1.99	2.57	1.57	2.56	4.63	1.16	0.69	1.15	1.09	0.38	0.26
n	187	227	230	235	225	228	222	234	234	124	126
n> LOD	89	185	131	126	99	119	88	139	126	93	59
Min (mg/l)	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mean (mg/l)	0.21	0.64	0.25	0.19	0.19	0.15	0.12	0.17	0.19	0.20	0.11
Max (mg/l)	6.86	5.80	7.80	4.40	8.90	1.60	0.93	3.60	2.90	5.90	4.90
Chloride											
Trigger level (mg/l)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
n	187	227	231	235	227	230	224	234	233	125	127
n> LOD	187	227	231	235	227	230	224	234	233	125	127
Min (mg/l)	0.00	3.10	3.10	20.00	41.00	42.00	56.80	21.00	15.00	3.00	53.00
Mean (mg/l)	782.63	90.89	67.66	87.52	86.92	113.75	444.00	154.32	184.39	181.14	319.53

	BH8	BH12	BH16	BH20	BH21	BH23	BH30	BH38	BH42	BH17	BH19
Max (mg/l)	1910	1344.00	131.00	320.00	288.00	282.00	960.00	402.00	575.00	336.00	400.00
Chromium											
Trigger level (mg/l)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
n	90	116	121	122	115	117	118	122	121	100	102
n> LOD	37	41	40	39	33	34	38	33	38	39	42
Min (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0003	0.0001	0.0004	0.001	0.001
Mean (mg/l)	0.0091	0.0061	0.0057	0.0053	0.0052	0.0052	0.0054	0.0049	0.0050	0.003	0.003
Max (mg/l)	0.091	0.030	0.031	0.030	0.030	0.030	0.030	0.030	0.030	0.03	0.02
Mecoprop											
Trigger level (ug/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
n	27	54	58	55	57	56	56	52	53	53	55
n> LOD	1	4	5	1	4	4	1	1	3	1	3
Min (ug/l)	0.0020	0.0100	0.0020	0.0020	0.0030	0.0020	0.0020	0.0020	0.0020	0.002	0.002
Mean (ug/l)	0.0345	0.0363	0.0368	0.0257	0.0557	0.0277	0.0288	0.0256	0.0298	0.03	0.06
Max (ug/l)	0.100	0.430	0.340	0.040	1.400	0.100	0.120	0.040	0.200	0.22	1.50
Zinc											
Trigger level (mg/l)	0.11	0.08	0.04	0.64	0.08	0.07	0.04	0.08	0.07	0.02	0.02
n	98	124	130	132	125	127	128	131	131	97	100
n> LOD	58	100	80	68	70	72	77	82	69	39	65
Min (mg/l)	0.001	0.002	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.002	0.002
Mean (mg/l)	0.013453	0.0133	0.00897	0.01322	0.00899	0.00955	0.00865	0.01092	0.0092	0.00552	0.00849
Max (mg/l)	0.29	0.11	0.05	0.66	0.05	0.074	0.05	0.086	0.069	0.056	0.145

Note 1 - where monitoring results are found to be at the laboratory limit of detection (LOD), the value of LOD is used for the purpose of compiling the table above. In the case of m p xylene all results were found to be <LOD, however the LOD varies between 0.1, 0.2 and 1 ug/l, hence an average is derived. The same is true for o – xylene. Compliance levels relate to total xylene.

Table 9: Groundwater Quality Lower Greensand

	W02	W03	W04	W05	W06		W01	W07	W08
m p xylene Note 1									
Trigger level (ug/l)	3	3	3	3	3		n/a	n/a	n/a
n	17	16	15	16	15		12	14	0
n> LOD	0	0	0	0	0		0.00		0
Min (ug/l)	0.10	0.10	0.10	0.10	0.10		0.10	0.10	0
Mean (ug/l)	0.79	0.78	0.77	0.78	0.77		0.71	0.75	0
Max (ug/l)	1.00	1.00	1.00	1.00	1.00		1.00	1.00	0
Cadmium									
Trigger level (mg/l)	0.001	0.001	0.001	0.001	0.001		n/a	n/a	n/a
n	95	94	90	91	90		70	88	12
n> LOD	6	7	5	11	7		5	9	2
Min (mg/l)	0.00002	0.00002	0.00003	0.00002	0.00002		0.00008	0.00002	0.0005
Mean (mg/l)	0.0019	0.0020	0.0020	0.0021	0.0018		0.0026	0.0021	-
Max (mg/l)	0.0100	0.0100	0.0100	0.0100	0.0100		0.0100	0.0100	0.5200
Ammoniacal nitrogen									
Trigger level (mg/l)	3.05	0.82	3.02	0.96	1.25		n/a	n/a	n/a
n	233	228	223	224	222		204	227	33
n> LOD	155	138	169	153	159		125	144	18
Min (mg/l)	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.01
Mean (mg/l)	0.78	0.32	0.64	0.42	0.42		0.31	0.49	-
Max (mg/l)	14.40	7.39	9.88	12.00	6.33		4.10	26.00	3.70
Chloride									
Trigger level (mg/l)	n/a	n/a	n/a	n/a	n/a		n/a	n/a	n/a
n	234	231	224	225	223		205	228	34
n> LOD	234	231	224	225	223		205	228	34
Min (mg/l)	31.0	26.0	23.0	2.9	3.0		49.0	3.1	44.0
Mean (mg/l)	68.1	58.9	71.0	66.1	67.1		91.8	64.7	-

	W02	W03	W04	W05	W06		W01	W07	W08
Max (mg/l)	137.0	210.0	166.0	160.0	98.0		270.0	303.0	85.0
Chromium									
Trigger level (mg/l)	0.05	0.05	0.05	0.05	0.05		n/a	n/a	n/a
n	121	120	117	118	117		95	117	10
n> LOD	33	31	30	28	27		39	25	0
Min (mg/l)	0.0001	0.0001	0.0001	0.0001	0.0003		0.0006	0.0003	0.0001
Mean (mg/l)	0.004	0.005	0.005	0.006	0.005		0.006	0.005	-
Max (mg/l)	0.020	0.021	0.041	0.061	0.046		0.030	0.030	0.020
Mecoprop									
Trigger level (ug/l)	0.10	0.10	0.10	0.10	0.10		n/a	n/a	n/a
n	57	58	56	55	55		28	50	0
n> LOD	4	5	2	2	0		3	2	0
Min (ug/l)	0.002	0.002	0.002	0.002	0.002		0.004	0.002	0.000
Mean (ug/l)	0.033	0.060	0.037	0.028	0.028		0.039	0.228	-
Max (ug/l)	0.220	1.300	0.490	0.100	0.100		0.210	10.000	0.000
Zinc									
Trigger level (mg/l)	0.17	0.04	0.1	0.04	0.04		n/a	n/a	n/a
n	129	130	127	128	127		104	127	10
n> LOD	61	69	44	48	43		53	57	6
Min (mg/l)	0.002	0.002	0.002	0.002	0.002		0.002	0.002	0.001
Mean (mg/l)	0.0101	0.0095	0.0081	0.0077	0.0080		0.0148	0.0080	0.0218
Max (mg/l)	0.18	0.09	0.09	0.05	0.05		0.32	0.07	0.06

Note 1 - where monitoring results are found to be at the laboratory limit of detection (LOD), the value of LOD is used for the purpose of compiling the table above. In the case of m p xylene all results were found to be <LOD, however the LOD varies between 0.1, 0.2 and 1 ug/l, hence an average is derived. The same is true for o – xylene. Compliance levels relate to total xylene.

BH SERIES SHALLOW GROUNDWATER QUALITY DATA

1.2.7.1 m p xylene

The data shows that m p xylene has not been found above the LOD in the shallow groundwater.

1.2.7.2 Cadmium

The data shows that cadmium is rarely found above the limit of detection: only in approximately 10% of samples. The LOD has varied between 0.001 and 0.01 (mg/l), the latter being greater than the trigger level, thus affecting the data assessment. The maximum values are equal to the higher LOD and the average includes values of 0.01mg/l when this was the LOD. Otherwise the concentrations remains below the trigger level. Cadmium is no longer classified as a hazardous substance and therefore, a more appropriate assessment level could be considered to be equal to the UKDWS of 0.005mg/l. Cadmium is not considered to have impacted the shallow groundwater.

1.2.7.3 Ammoniacal Nitrogen

The average concentrations of ammoniacal nitrogen are significantly below the trigger levels in all boreholes. Exceedances of the trigger levels have been few and are isolated events, rather than a developing trend. Many of the boreholes, on all sides of the site have exceedances on the 7/10/2011, for example and this suggests a data error on that date, rather than a contamination event. All boreholes are currently compliant with their trigger level.

1.2.7.4 Chloride

There are no groundwater trigger levels for chloride. Chloride data shows high concentrations in BH8, which is adjacent to the bypass and appears to have been influenced by the road construction. Early data for BH12 show high concentrations, but these noticeably reduce after the time of construction of the cut-off wall. Mean concentrations in most boreholes are much lower than the UK Drinking Water Standard (UKDWS), with the exception of BH30. This borehole is furthest from the current landfill areas and has had concentrations above the UKDWS from first installation. It is upgradient of the early landfill cells. It is possible the water quality is affected by its position close to Butt Lane.

1.2.7.5 Chromium

Chromium is generally found to be below the trigger level in all boreholes. The exception is BH8, however, there have only been three exceedances: one in the early 1990s and two in 2011.

1.2.7.6 Mecoprop

There have been occasional exceedances of the trigger level in some boreholes, but these are limited to one or two isolated events since installation and exceedances have not been repeated. All boreholes are currently compliant with the trigger level.

1.2.7.7 Zinc

The maximum values from the dataset for zinc show marginal exceedances of the trigger levels in some locations. However, a review the data shows these exceedances all occurred during the 1990s when the LOD was also higher and therefore, the analytical accuracy less. All

boreholes have otherwise been generally compliant with the trigger level for some years.

1.2.7.8 Summary

The data shows there have been occasional exceedances of trigger levels since boreholes were first installed, but that these are isolated events, not repeated on subsequent monitoring rounds. The shallow groundwater is currently compliant with the groundwater trigger levels in all boreholes.

During pre-application discussions it was noted that groundwater quality should be assessed against baseline conditions rather than drinking water quality standards. The above assessment is made against permitted compliance levels. Such levels are derived based on background groundwater quality. The only exception is chloride. This determinand does not have a compliance level within the permit and data is presented for context, to explain what has happened in relation to engineering of the retrospective side seal and the adjacent road works on the southeast of the site. Current boreholes were installed between 1990 and 1992. Landilling in Phase I began around 1980 and as such there is no baseline data for chloride on the southeast of the site.

LOWER GREENSAND GROUNDWATER QUALITY DATA

1.2.7.9 m p xylene

A review of the dataset for m p xylene indicates this determinand has not been found above the LOD in the Greensand. The mean value is based on varying limits of detection.

1.2.7.10 Cadmium

The data shows that cadmium is rarely found above the limit of detection: only in approximately 10% of samples. The LOD has varied between 0.001 and 0.01 (mg/l), the latter being greater than the trigger level, thus affecting the data assessment. The maximum values are equal to the higher LOD and the average includes values of 0.01mg/l when this was the LOD. Otherwise the data remains below trigger level. Cadmium is not considered to have impacted the groundwater quality of the Greensand.

1.2.7.11 Ammoniacal Nitrogen

W02, located on the northeastern corner of Phase I exceeded the trigger level from September 2003 to February 2005. Landfilling activity at this time was taking place in Cells 16 A and 16B and above a substantial thickness of Gault Clay. The reason for this occurrence does not appear to be directly linked to landfilling activities. The borehole has remained compliant since this date. Similar patterns have been seen in other Greensand boreholes

- W03 had three trigger level exceedances in 2004/2005 and three during 2011. It has remained compliant since.
- W04 had several trigger level exceedances in 2005 but has since remained compliant.
- W05 had a number of trigger level exceedances in 2004, one exceedance during 2011, but has remained compliant since.
- W06 had trigger level exceedances during 2003/2004, one exceedance during 2011, but has remained compliant since.

1.2.7.12 Chloride

There are no trigger levels for chloride in Greensand boreholes. Average and maximum values are very similar between boreholes. Average values are less than 100 mg/l, which is less than half of the UKDWS.

1.2.7.13 Chromium

In most Greensand boreholes the chromium concentrations remain below the trigger level. There have been three minor exceedances in W05, but these have been isolated events and the borehole is currently compliant.

1.2.7.14 Mecoprop

Current monitoring data shows the Greensand water quality to be compliant with trigger levels. There were occasional exceedances in 2009 and 2010 in most locations, including the upgradient borehole W7. This may be related to a monitoring, or laboratory error.

1.2.7.15 Zinc

The maximum values from the dataset for zinc show marginal exceedances of the trigger levels in some locations. However, a review the data shows these exceedances all occurred during the 1990s when the LOD was also higher and therefore, the analytical accuracy less. All boreholes have otherwise been generally compliant with the trigger level for some years.

1.2.7.16 Summary

Current groundwater quality monitoring of the Greensand shows all boreholes to be compliant with the permitted trigger levels. The trigger levels are set based on background groundwater quality. Reference has been made to UKDWS for chloride for context, as discussed above.

1.2.8. Surface Water Quality

The upstream and downstream discharge points have been dry since April 2010 and therefore, no sampling data is available. Data from early 2010 indicates the discharge points were generally compliant with the discharge limits, with the exception of chloride, which exceeded the limit both up and downgradient of the site.

2. Hydrogeological Risk Assessment

2.1. The Nature of the Hydrogeological Risk Assessment

The nature of the hydrogeological risk assessment is to determine whether the leachate and groundwater parameters remain within previously characterised ranges and therefore, whether the existing modelling of the site is still representative.

A second part of the assessment is to determine whether a change to the permitted leachate level above the cell base could be sustained without adverse impact to the hydrogeological regime.

A review of the leachate quality data above indicates there have been changes to the source term, most notably a reduction in certain determinands in Phase 1. The most recent Landsim model (2015) is revisited on this basis and on the basis of the assumptions made in relation to acting leachate heads.

2.2. The Proposed Assessment Scenarios

The conceptual model of the site is revisited based on a detailed review of borehole logs. Groundwater quality data from the shallow and deep aquifers since first construction is reviewed. Ten years of leachate level quality data from all phases of landfilling is reviewed to determine whether the previous modelling assumptions remain appropriate for the site.

Based on the current conceptual understanding of the site the scenario to be assessed is the proposal for a 9m AOD compliance limit for leachate in Phase III and an 8mAOD compliance limit in Phases I and II. In the eastern cells of Phase III (Cells 12A, 12C, 13A, 14A, 15B and 20B), where the base of the River Terrace Deposits is slightly lower the proposed compliance level is 8.5m AOD. However, for the purpose of quantitative assessment it is conservatively assumed that all of Phase III will have a leachate head of 9m AOD. There are some cells where levels higher than this have been previously agreed with the EA and form part of the permit. No change is proposed to those cell-specific levels.

2.3. The Priority Contaminants

The priority contaminants are those which have been previously modelled in former HRAs.

- Hazardous substances: m,p xylene
- Non-hazardous pollutants: mecoprop, ammoniacal nitrogen, chloride and zinc cadmium

Cadmium concentrations were reviewed in the 2015 HRA and found to have a detection rate of less than 50%. Based on this criterion cadmium was deemed to no longer be a priority contaminant. Data for cadmium is still reviewed within this assessment to determine whether this is still the case.

Chromium is also assessed against compliance limits.

An assessment of the concentrations of each of these determinands in groundwater boreholes surrounding the site enables a determination of whether the site is compliant with the Environmental Permitting Regulations 2016, refer to section 1.2.7, which demonstrates that the groundwater is currently compliant with trigger levels in all boreholes.

2.4. Review of Technical Precautions

2.4.1. Capping

Phase I, II and parts of Phase III have been permanently capped with 1m of site derived clay, engineered to a permeability of < 1 x 10^{-9} m/s. CQA reports reveal the clay to be laid a permeabilities of between 6 x 10^{-11} and 2 x 10^{-10} m/s. Capping of Phase III continued in line with the progress of cell completion. Cell 24A was constructed in 2018 and Cell24B, the final cell, was constructed in 2019. These cells are partially complete. The site closed in April 2020 due to the coronavirus pandemic. Cells 22, 23 and 24 are temporarily capped. It is planned to re-open the site in 2022 to bring the site to final levels.

2.4.2. Lining

The base of the site rests on low permeability Gault Clay. Details presented in the 2015 HRA indicate that a 1m thick engineered clay liner of maximum permeability 1 x 10^{-9} m/s has been placed at the base of Cell 5 and all subsequent cells. The details of basal lining in Phase I and earlier cells of Phase II are unknown.

The sidewall lining system comprises a 1m thick engineered clay liner of maximum permeability 1 x 10^{-9} m/s in Phase II and much of Phase III. The sidewall liner changed from 1m to 3m thick from Cell 17 onwards. In the final cells, closest to Butt Lane, the sidewall liner thickness reduces to 1m above the original ground level, where fill will be up against the inert stockpile.

Phase I was initially unlined, however, an engineered cut-off wall/side wall liner was retrospectively put in place during 1996 along the northern, eastern and southern perimeter.

2.4.3. Leachate drainage

Phase I and the earlier cells of Phase II to Cell5a, are understood not to have a basal leachate drainage system, as reported in the 2015 HRA. However, all Phases have a large number of leachate wells retrospectively fitted and kept under constant review for effectiveness. During 2018 an additional number of wells were installed within Phase I. From Cell 5b onwards a radial drainage system was installed at the base of all cells. This comprises 160mm diameter pipes placed on a separation geotextile with a gravel surround.

2.4.4. Leachate Levels Review

As described in Section 1.2.3, most cells within the landfill have a leachate limit of 6.5m AOD. Due, it is understood, to the variable level of cell bases relative to Ordnance Datum, higher leachate levels are permitted in some cells:

- Phase II Cell 3 (LO3/2014R) = 8.1m AOD; Phase II Cell 2 (LO7RB) = 8m AOD; Phase II Cell 6 (L11) = 8.4m AOD.
- Phase III Cell 12C (L12DR2) = 9.5m AOD and Phase III Cell 12A (L15R) = 8m AOD.

Figures 10.1 to 10.5 below present graphs of leachate levels in different areas of the site. While there is a large amount of data to interpret, some general observations can be made:

1. Phase I has leachate levels in adjacent wells which have ranged from dry (-3m AOD) to 12m AOD. This suggests the waste mass is very heterogeneous and variable in permeability both horizontally and vertically and also that some wells may not be appropriate to monitor levels. No individual well is giving a true picture of leachate levels in the cell. A recent set of retro drilled wells, slotted only in the bottom 3m, have been installed in order to try and better understand the leachate levels. Data is presented in Figure 10.3 and shows levels in three of the wells are below 5mAOD. In the fourth the levels are generally 7mAOD, or lower and compliant with the proposed limit of 8m AOD.
2. Phase II leachate levels have improved since 2015 and are largely compliant with the proposed compliance limit of 8m AOD. There is a ditch feature around an area the cap in this phase. The Site Plan shows the feature around the area of Cells 3, 4, 12B and 12C. The construction details are not clear. It is thought it may have some connection with the reed bed arrangement over Cell 12C and the west of Phase I. The feature will be removed during final restoration.
3. Wells within Cells 12 to 14 are mostly compliant. Wells L12DR and L15R have higher compliance limits than elsewhere in Phase 3. There has been a rise in levels for a few wells in the latest monitoring round, but it is not expected to be an increasing trend.
4. Cells 15 to 18 are largely compliant. Levels in later cells from Cell 19 onwards reflect the absence of permanent capping with them being more susceptible to increases during significant rainfall. Levels have been seen to fall since the installation of the temporary cap.

Figures 10.1 to 10.6 indicate that there are sufficient wells in each Phase that are compliant and fit for purpose. The most recent Leachate Management Plan lists all effective wells. Original wells, which have been installed from the basal drainage upwards, are indicated separately from those that have been retro-drilled. Retro-drilled wells are denoted with an R. Retro-drilled wells are installed in line with approved CQA plans. Targetted, incremental drilling ensures that the wells meet the basal drainage system. Although a drainage system is absent in Phase I, the data gathered from the four retro-drilled wells in this phase indicated good control of leachate to below the proposed level. Milton Landfill has an extensive leachate monitoring network. The recent drilling within Phase I indicates that all areas of the site are now fit for purpose.

A pump suspension trial was carried out during 2016. A recovery assessment was undertaken, with levelling off of results after about 24 hours. On the basis of the results a 48 hour suspension of pumps prior to monitoring was agreed with the EA.

Figure 10.1 Phase I Leachate Level

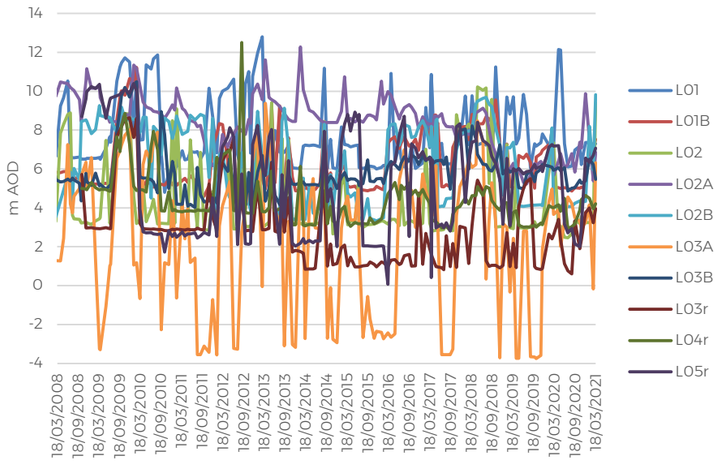


Figure 10.2 Phase II Leachate

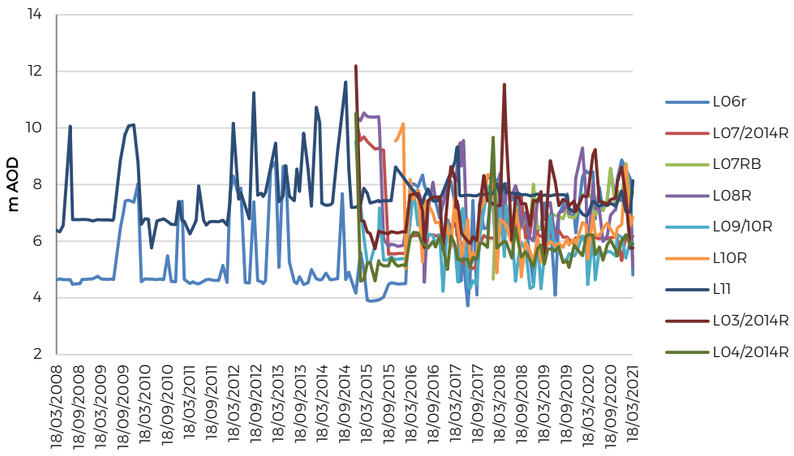


Figure 10.3 Phase I New Wells

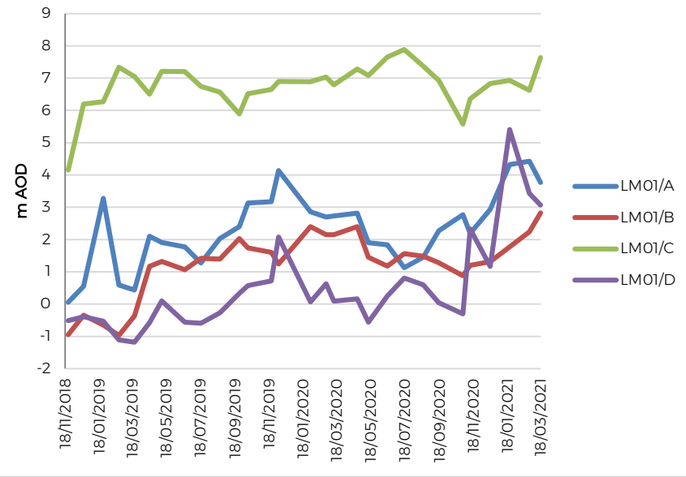


Figure 10.4 Cell 12 - 14

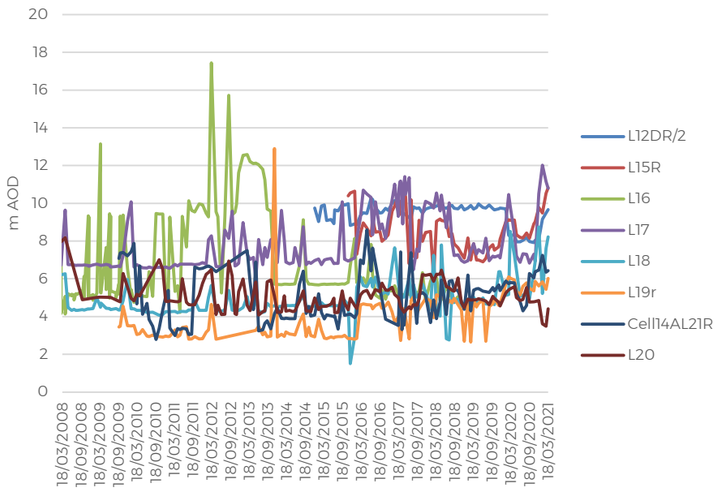


Figure 10.5 Cells 15 - 18 Leachate (mAOD)

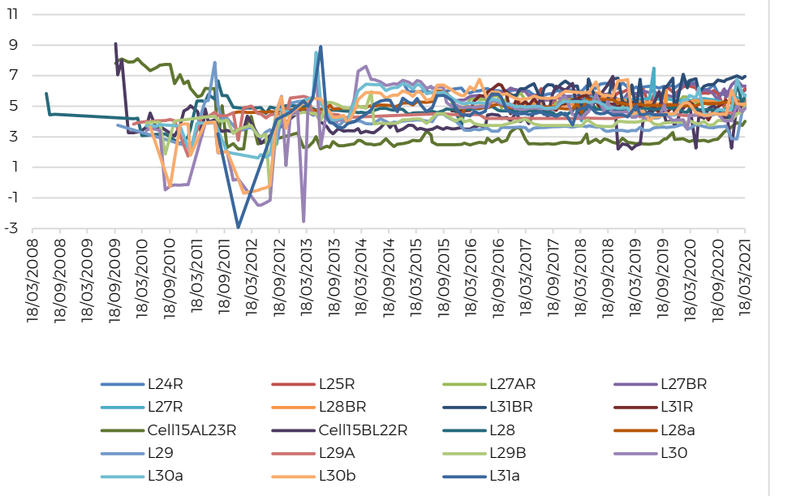
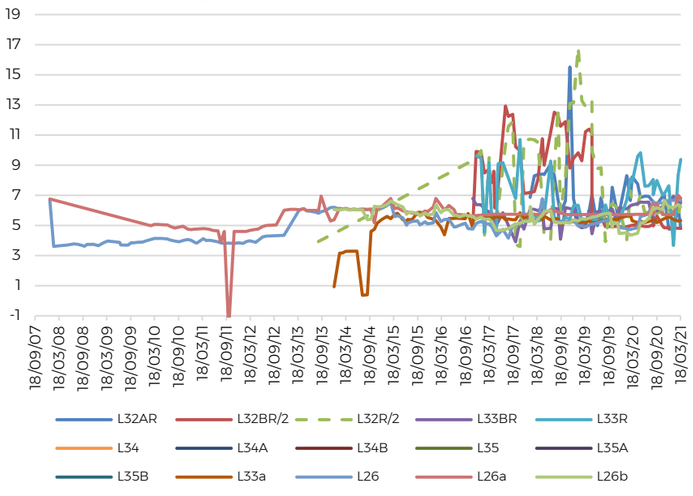


Figure 10.6 Cell 19 - 23 Leachate (mAOD)



2.4.5. Leachate Levels Proposal

As the site is approaching completion FCC are reviewing the governing leachate level. The option to raise the level is being considered, such that it is closer to the natural equilibrium which will establish once the site is complete and management control ceases. It is considered appropriate to propose an increase to the leachate compliance levels across the site to reduce the burden on managing the leachate at a lower level. This would allow the greatest operational flexibility to temporarily target leachate abstraction to priority zones as needed, whilst maintaining an overall continuous removal of leachate from the site. It also allows greater opportunity to take action when levels exceed the control level and well in advance of the level rising above the compliance level.

FCC seeks to raise the leachate compliance level across the site. The geological cross sections in Figures 2 to 5 indicate that in the majority of Phase III the base of the River Terrace/Drift deposits is around 9m AOD, or higher to the west. It is proposed to raise leachate levels in the majority of Phase III to 9mAOD. In the eastern cells of Phase III (Cells 12A, 12C, 13A, 14A, 15B and 20B), where the base of the River Terrace Deposits is slightly lower the proposed compliance level is 8.5m AOD. With this proposal the leachate within Phase III would be hydraulically contained by between 0.2 and 1.4m. In the east of the site average groundwater levels in the River Terrace Deposits are around 8m AOD, refer to section 1.2.5. This could mean an average head of 1m acting outwards across the sidewall liner, which is 3m thick around Phase I and 1m thick around Phase II, if leachate was raised to a similar level, as proposed for Phase III. Therefore, it is proposed to raise leachate levels to 8m AOD in Phase I and II. For cells with higher bases where higher cell-specific leachate compliance limits have previously been agreed, no change is proposed.

2.4.6. Leachate Levels Relative to River Terrace Deposits

The risk of leachate seepage to the River Terrace Deposits only exists where the leachate level rises above the base of the River Terrace Deposits. Historically the lowest level of the deposits, which is 6.7m AOD in BH14 on the eastern boundary of the site, has been assumed as the worst case for the whole of the site. A review of borehole logs, as summarised in Figures 2 to 5 indicates this is over conservative and in most parts of the site the base of the River Terrace Deposits is 9mAOD, or higher. Where the base of the River Terrace Deposits is lower than 9m AOD, is restricted to the following borehole logs, with the base of the River Terrace Deposits (in mAOD) is given in brackets.

W05 (8.5) and BH25 (8.2) in the northeast
BH21 (8.9) – central eastern boundary
BH12 (6.9), BH14(6.7) – east
BH4 (8.9), BH5 (8.7), BH6 (8.9), BH8 (6.9) – southern boundary

If the level of leachate rises above the base of the River Terrace Deposits, but the level of the groundwater is higher than the leachate, then there is hydraulic containment, refer to Table 10.

The cells highlighted in orange indicate hydraulic containment remains with leachate at 8m AOD.

Table 10: Groundwater Level Review: eastern River Terrace Deposits

Borehole Log	Location	Base of River Terrace mAOD	Nearest RT monitoring BH	Low groundwater level (5th percentile)	High groundwater level (95th percentile)	Average groundwater level
W05	NE	8.5	BH30	9.15	10.28	9.68
BH25	NE	8.2	BH30	9.15	10.28	9.68
BH21	Central E	8.9	BH21	8.44 bRTD	10.83	9.82
BH12 / BH14	E	6.9 / 6.7	BH12	7.42	9.1	7.89
BH7,8	S	9.1 / 6.9	BH8	8.18	9.11	8.55

bRTD – measured groundwater level is below base of River Terrace Deposits

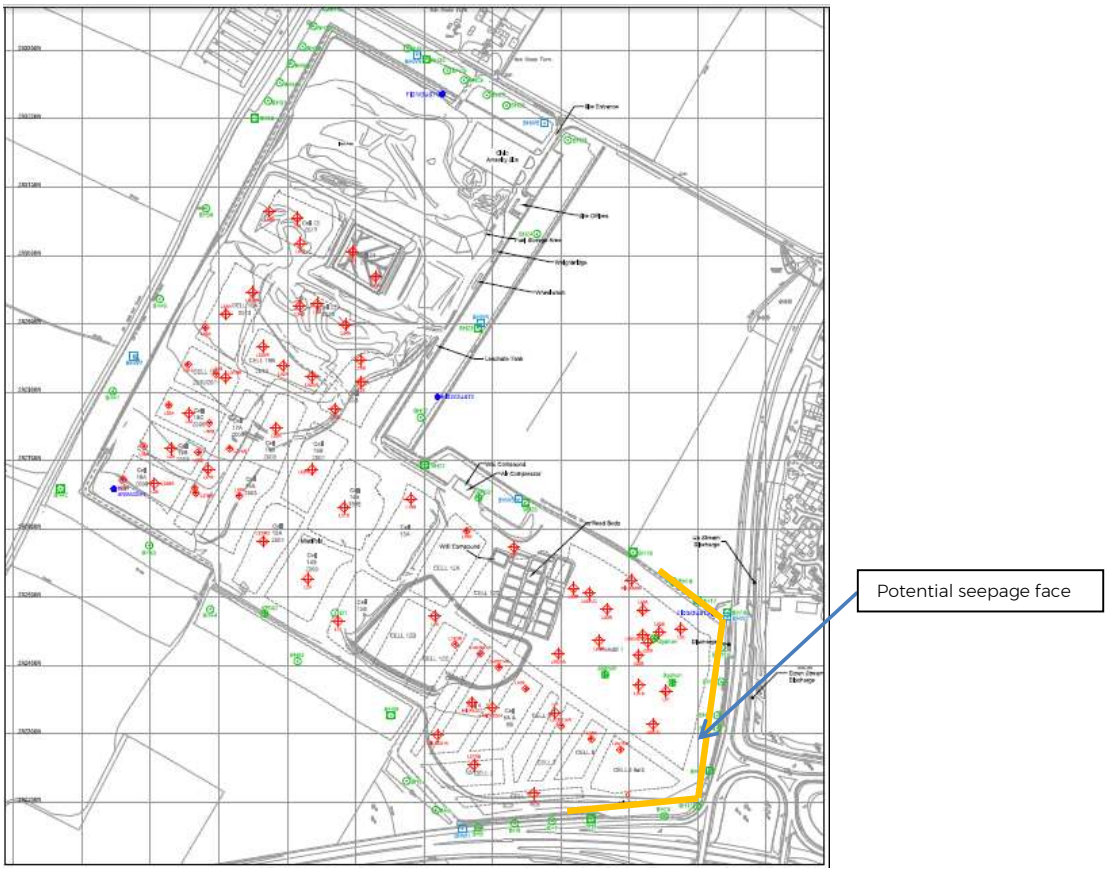
Table 10 indicates low (5th percentile), high (95th percentile) and average groundwater levels for each of the above boreholes, to determine whether a leachate elevation of 8m AOD would be hydraulically contained. Where the borehole has no installation, groundwater levels are taken from the nearest borehole installed within the River Terrace Deposits.

The table shows that

- a leachate level of 8mAOD in the northeast of the site would be hydraulically contained.
- The area where lateral seepage could occur is taken from information in borehole logs BH12 and BH14.

Figure 11 highlights where sidewall seepage to the River Terrace deposits could occur. The extent of the area is defined by a mid-point between borehole logs where the eastern log has River Terrace deposits below 8mAOD and the closest log to the west indicates the base of the River Terrace Deposits is above 8m AOD.

Figure 11: Potential seepage to RTD if leachate level at 8mAOD



The length of perimeter containment where seepage could occur to the River Terrace Deposits is approximately 600 m. The maximum head difference between a proposed leachate elevation of 8mAOD and the low (5th percentile) groundwater level would be 0.58 m. On average the head would be 0.11 m. This is on the worst case assumption that the whole of the seepage face is represented by the worst case groundwater and River Terrace levels found in borehole BH12. In reality a proportion of the seepage face will have higher groundwater levels at the 5th percentile, as shown by borehole BH8 and therefore, a smaller seepage face. A proportion of the length of seepage face would occur in Phase I, where the engineered barrier is 3m thickness and a proportion in Phase II where the barrier is 1m thickness. The height of seepage face is conservatively assumed to be 0.58m. The leachate seepage rate across the 3m engineered barrier of Phase 1 would be given as below:

$Q_{Phase\ 1} = k\ i\ a$

Where

K = permeability of the engineered barrier = 1×10^{-9} m/s

i = hydraulic gradient across the barrier = 0.58/ 3 = 0.19

A = cross sectional area of flow = 350 x 0.58 = 203m^2

$Q = 3.92 \times 10^{-8}$ m^3/s

$Q_{Phase\ 2} = k\ i\ a$
Where
K = permeability of the engineered barrier = 1×10^{-9} m/s
i = hydraulic gradient across the barrier = 0.58 / 1 = 0.58
A = cross sectional area of flow = 250 x 0.58 = $145m^2$
$Q = 8.41 \times 10^{-8}$ m^3/s

Total seepage above a conservatively low groundwater level = 1.23×10^{-7} m^3/s.
For the receiving flow in the aquifer

$Q_{RTD} = kia$
Where
K = 3×10^{-4} m/s, Bricker and Bloomfield, 2014 mean value for river terrace deposits
i = 0.0025, mid value for River Terrace Deposits
a = $800m^2$: pathway width of 400m, aquifer thickness 2m
$Q_{RTD} = 6 \times 10^{-4}$ m^3/s

Table 11 presents the resulting concentrations in the River Terrace deposits directly downgradient of the seepage face in the sidewall liner. The conservative calculations include the following:

- Maximum seepage face height of 0.58m , based on proposed leachate head versus 5th percentile groundwater level in BH12 along entire length of seepage face;
- 95th percentile concentration of contaminant in leachate;
- Full length of seepage face considered in seepage calculations, when a proportion is parallel to the direction of groundwater flow;
- Width of aquifer used is that perpendicular to groundwater flow and is, therefore, less than the length of the seepage face.

Due to the age of the phases, the leachate source for Phase I is taken to be that from 2012 to present. For Phase II the full dataset is used. The calculations in the 2019 draft of the HRA used maximum concentrations in the leachate. This has been reviewed and the 95th percentile concentrations in the leachate have been used. This is particularly relevant to mecoprop, where concentrations are very variable within the landfill leachate, as seen in Figures 7.10 and 7.11.

The data for mecoprop has been entered into the ESI Soil and Groundwater statistics calculator, version 2. This tool uses the same statistical approach to the EA's R+D technical report P1-471, A.3 Statistical Analysis assuming normality. The normality test used depends on the sample size and includes the D'Agnostino method, as described in Appendix B3 of P1-471. When data is proven to be non-normal by the ESI calculator this is flagged. The method then applied is the Chebychev Theorem. Methods are based on the assumption that 's'- the estimate of the true population standard deviation 'σ' is close enough to the true value.

Outliers within the data are identified. The data for Phase 2b was found to be normally distributed with no outliers. The data for Phase 1 was found to be non-normal, with one outlier. This outlier was removed in determining the 95th percentile concentration. More details are presented in Appendix 3.

Table 11: Contaminant Concentrations in River Terrace Deposits

Determinand	Phase 1 Source 95th %ile (2012 – present)	Phase 2b Source 95th %ile (whole dataset)	Phase 1 Diluted	Phase 2 Diluted	EAL = permit limit	Background concentration non-haz substances, mean/max for RTD boreholes
Xylene (ug/l)	120.45	78.6	0.0126	0.0294	3	< LOD
Ammoniacal nitrogen (mg/l)	1109	1520	0.1161	0.5679	1.57-2.47	0.22 / 8.9
Cadmium (mg/l)	0.0022	0.001	2.30E-07	3.74E-07	0.001	0.0017 / 0.01
Chloride (mg/l)	6340	3042	0.6635	1.1366	250*	228 / 1344
Mecoprop (ug/l)	735	213	0.0769	0.0796	0.1	0.04 / 1.5
Zinc	0.3	0.84	3.14E-05	0.0003	0.04-0.11	0.01 / 0.66

* - chloride has no limit on environmental permit. Value quoted is UKDWS and EQS.

Table 11 presents the resulting concentrations in the River Terrace Deposits after dilution and in the absence of any attenuation. Based on a conservative assessment using 95th percentile leachate concentrations, all determinands are found to be less than the EAL on dilution within the River Terrace Deposits.

Of the determinands assessed, xylene is a hazardous substance. Resulting concentrations are below the limit within the environmental permit, which is also the minimum reporting value. Therefore, the assessment shows no discernible discharge of hazardous substances.

Of the non-hazardous substances, concentrations are below the permit limit and do not exceed existing background concentrations within the River Terrace Deposits. Using average leachate concentrations, which would be closer to the case in a probabilistic assessment, the resulting diluted concentrations would be even lower. For example, using the average concentration of mecoprop from Phase I would give a diluted concentration of 0.0245 ug/l. If average groundwater levels were used, rather than 5th percentile groundwater levels, the acting head of leachate would reduce from 0.58 to 0.11. This would further reduce resulting concentrations by a fifth, for example a resulting concentration of 0.0049 ug/l for mecoprop.

The Environmental Permitting Regulations require that there is no pollution from non-hazardous pollutants. The above calculations are point source concentrations on the boundary of the site. They do not allow for further dilution, dispersion, or attenuation downgradient. They are compliant with the EAL in the worst case conditions of very high

leachate concentration and very low groundwater level. This combination of conditions is unlikely and therefore, if it occurred it is likely to be of short duration. In the short term worst case scenario and in the longer term more likely scenario the assessment indicates that there would be a very low likelihood of pollution from non-hazardous substances.

Summary of Assessment: Leachate Levels relative to River Terrace Deposits

The assessment above indicates that if leachate heads were permitted to rise to 9m AOD in Phase III, 8.5m AOD in the eastern cells of Phase III (Cells 12A, 12C, 13A, 14A, 15B and 20B), and 8m AOD in Phases I and II, the only potential for seepage to the River Terrace Deposits is along a small proportion of the site perimeter in the southeast. The resulting diluted maximum concentrations show no impact above the permitted limits and would be compliant with the Environmental Permitting Regulations.

2.4.7. Leachate Levels Relative to Lower Greensand

If the leachate level is raised there will also be a greater potential for downward migration to the Greensand through the Gault Clay. A review of the failure scenarios modelled in the 2008 HRA indicates that an acting head of 0.4 - 0.8m above the piezometric surface of the Greensand is acceptable.

The Landsim model from 2015 has been reviewed and the revised assessment is presented in Section 2.5. It is considered that as the Gault Clay below the base of the site is all below the piezometric surface of the Greensand it is the head difference between the leachate level and the piezometric surface of the Greensand which will govern the rate of vertical seepage. A 3m head difference is assessed in Phase III and a 2m head in Phases I and II, to determine the potential effects from a proposed raise in leachate head across the site.

2.5. Quantitative Assessment

A quantitative assessment is required of the potential impacts to the greensand aquifer from an increase in leachate heads to 8 or 9mAOD across the site. This would create a 2- 3m head difference between the leachate and the piezometric surface of the Lower Greensand.

2.5.1. Leachate Head

Section 1.2.5 presents data in Figure 9 and Table 6 that indicates the average piezometric surface of the Lower Greensand is between 6 and 6.5m AOD. Therefore, a rise in leachate levels to 9m AOD will give an active leachate head above the piezometric surface of 2.5 to 3m. The seasonal fluctuation in groundwater levels is of the order of 2m. Therefore, during the wetter periods of the year the leachate head difference will lower to between 2 and 0m. Therefore, an assessment of a leachate head of 3m in Phases III represents a conservative assessment. Using the full dataset of groundwater levels in the Greensand from 1991 to

present, which would include the period when the abstraction to the north of the site was still active, so groundwater levels were artificially lower, the 5th percentile, average and 95th percentile groundwater levels are as follows: 5.53, 6.39 and 6.99 mAOD. This would give a range of leachate heads for Phases I and II of (1.01, 1.61, 2.47) and for Phase III of (2.01, 2.61, 3.47). Using this range in Landsim would mean a most likely head of 2.61 m, rather than the 3m modelled. Therefore, the modelled heads are considered justified.

2.5.2. Leachate Quality

Leachate quality is detailed in section 1.2.3. This indicates there have been

- Decreases in leachate concentration in Phase I, particularly from 2012;
- Little change in Phase II;
- Increases in Phase III.

The revised source term is presented below in tables 12 to 15 for the four landfill phases modelled. Data since the 2019 draft of this HRA reviewed at the pre-application stage has been reviewed and makes insufficient change to the ranges within the source term below to require a rerun of the Landsim model. This is partly because some cells are sampled only quarterly, so there is no new data.

Table 12: Phase I: 2012 to present

	NH4-N (mg/l)	Cadmium (mg/l	Chloride (mg/l)	Mp xylene (ug/l)	Mecoprop (ug/l)	Zinc (mg/l)
Min	16.8	0.001	116	1	2	0.002
Max	1350	0.0036	6640	154	1720	1.49
Average	675	0.0012	3520	40	308	0.14

Table 13: Phase 2a: Whole dataset

	NH4-N (mg/l)	Cadmium (mg/l	Chloride (mg/l)	Mp xylene (ug/l)	Mecoprop (ug/l)	Zinc (mg/l)
Min	25	0.0003	110	0.1	0.04	0.008
Max	1480	0.01	6278	97	410	12.32
Average	525	0.0012	1233	15	66	0.44

Table 14: Phase 2b: Whole dataset

	NH4-N (mg/l)	Cadmium (mg/l	Chloride (mg/l)	Mp xylene (ug/l)	Mecoprop (ug/l)	Zinc (mg/l)
Min	120	0.0003	321	0.37	0.04	0.023
Max	1560	0.0012	3650	81	255	2.104
Average	841	0.0009	1939	23	98	0.23

Table 15: Phase 3: Whole dataset

	NH4-N (mg/l)	Cadmium (mg/l	Chloride (mg/l)	Mp xylene (ug/l)	Mecoprop (ug/l)	Zinc (mg/l)
Min	0.3	0.0008	5	0.1	0.4	0.002
Max	5080	0.016	6720	133	1810	31.1
Average	878	0.0016	1663	30	104	0.51

Data derived from some of the retro-drilled wells can differ widely within the old waste masses of Phase I, indicating rapid changes in the permeability of the waste, enabling perching and concentrated pockets to develop. While retro-drilled wells seem to have encountered more concentrated leachate chemistry, the concentrations do seem to be declining after a number of sampling visits.

There is a vast amount of leachate data available for Milton Landfill. This report has aimed to try and determine the general trends and overall characteristics of the leachate and how it differs between phases. It is recommended that the number of leachate quality sampling points is reduced. This is discussed further in section 3.1.1. However, in Phase I in particular, it will be important to retain some of the long term monitoring records for comparison with new wells, where newly encountered leachate "pockets" may give a misleading picture of leachate quality in the whole phase.

2.5.3. Revised Model Input Parameters

Details of the revised source term are given above. The minimum, maximum and average as input as a triangular, or log triangular distribution as appropriate. Due to uncertainty in the basal containment design, the model has no engineered basal liner in Phase I and 2a. The remaining input parameters are presented below. Retardation values remain the same as used in previous HRAs.

Input parameters can be input as single values, or a distribution as indicated in the table below. The type of distribution will be denoted Uni, for uniform, Tri, for triangular, or LogTri, for log triangular.

Initial model runs recorded several errors in the form of seepage exceeding 10% of the aquifer flow and leachate head decrease with time, meaning the specified head could not be sustained by the containment system. The values of hydraulic conductivity for the liner and the Gault Clay were altered iteratively to the lower end of the range to reduce the magnitude of the errors and present a more realistic scenario.

Table 16: General Input Parameters

Parameter	Units	Value	Notes
Infiltration to open waste	mm/yr	Single (51)	From original HRA , based on effective rainfall
Cap design infiltration	mm/yr	Single (10)	Rate after capping to be a fraction of effective rainfall
Waste thickness	m	10.6 – 16.9	Based on site survey data
Waste porosity	fraction	Uni (0.1, 0.3)	Typical for non-haz waste
Waste dry density	Kg/l	Uni (1, 1.5)	Typical for non-haz waste
Waste field capacity	fraction	Uni (0.2, 0.4)	Typical for non-haz waste
Head of leachate when surface water breakout occurs	m	5	Height above piezometric surface of Greensand to ground level
Head on engineered barrier system	m	3m - Phase III 2m – Phase I + II	Required increase above piezometric surface
Engineered barrier system			
Thickness	m	1	1 m in Phase 2b and 3 Absent in Phase 1 and 2a
Moisture content	fraction	(0.25, 0.35)	Typical for clay liner
Hydraulic conductivity	m/s	3e-10	Lower value from range
Longitudinal dispersivity	m	0.1	10% of pathway
Unsaturated Zone			
Pathway length	m	0.5	Nominal thickness to allow calculation for vertical pathway. Base of some cells above low GWL in Greensand by up to 0.85m
Moisture content	fraction	Uni (0.25, 0.35)	Equivalent to pathway porosity in saturated vertical pathway
Hydraulic conductivity	m/s	3e-10	Lower value from range for Gault Clay
Dispersion	m	0	
Vertical Pathway			
Pathway length	m	16	Minimum thickness of Gault Clay (after allowance for nominal thickness of unsaturated zone) Range is up to 27m in parts of the site.
Pathway porosity	fraction	Uni (0.25, 0.35)	
Longitudinal dispersivity	m	1.6	10% of pathway
Aquifer Pathway			
Pathway width	m	Phase 1 – 215 Phase 2a – 200 Phase 3 – 750 Phase 2b - 200	Site survey
Calculate mixing zone thickness		Yes	
Aquifer thickness	m	Tri (4.9, 6.25, 7.25)	From site borehole logs and BGS

Parameter	Units	Value	Notes
			borehole logs downgradient, where aquifer reaches 9m thickness
Relative vertical dispersivity		0.1	
Hydraulic conductivity	m/s	Single (2e-4)	BGS, 1997
Regional gradient		Uni (0.001, 0.003)	Site data
Pathway porosity	fraction	Uni (0.19, 0.34)	Assumed for Greensand
Dispersion	m	10% and 1% of pathway length	Longitudinal and transverse dispersion

Table 16A summarises the changes from the 2015 Landsim model.

Table 16 A: Summary of Model Updates

Parameter	Units	2015 Value	Value – this HRA	Justification for this HRA
Cap design infiltration	mm/yr	Normal (40,10)	Single (10)	Based on actual CQA data for cap, permeability of 6 x 10^{-11} to 2 x 10^{-10} m/s
Head of leachate when surface water breakout occurs	m	10.6 – 16.9	5	Height above piezometric surface of Greensand to ground level. When leachate is below piezometric surface the site is hydraulically contained: no acting leachate head on base. In 2015 the full thickness of waste was used.
Head on engineered barrier system	m	1.8 – 12.4	3m – Phase III 2m – Phase I & II	Acting leachate head above piezometric surface. When leachate is below piezometric surface site is hydraulically contained: no acting leachate head on base. 2015 HRA used full depth of leachate.
Unsaturated Zone				
Pathway length	m	0	0.5	Landsim requires a nominal thickness to allow calculation for vertical pathway. Value used is 3% of min. vertical pathway. Base of some cells above low GWL in Greensand by up to 0.85m. Unsaturated pathway is given high moisture content of 25-35%, which is equal to the pathway porosity of the vertical pathway.
Vertical Pathway				
Pathway length	m	12.7	16	Minimum thickness of Gault Clay after review of borehole logs. Range is up to 27m in parts of the site.
Pathway porosity	fraction	Uni (0.1, 0.4)	Uni (0.25, 0.35)	Kept equivalent to moisture content in liner and unsaturated zone
Longitudinal dispersivity	m	1.27	1.6	10% of pathway
Aquifer Pathway				
Pathway width	m	Phase 3 -	Phase 3 - 750	Allows for full width. 2015 width was

Parameter	Units	2015 Value	Value – this HRA	Justification for this HRA
		350		equivalent to that of Phase I and II only, with filling at an earlier stage.
Aquifer thickness	m	Uniform (4.9 – 6.25)	Tri (4.9, 6.25, 7.25)	From site borehole logs and BGS borehole logs downgradient, where aquifer reaches 9m thickness
Dispersion	m	141, 42	10% and 1% of pathway length	100 and 10 used, limited to length of landfill in direction of groundwater flow

2.6. Emissions to Groundwater

2.6.1. Results of Landsim Model

Results of the Landsim model are presented in Table 17. All results are expressed at the 95th percentile concentration. For the hazardous substance mp xylene the concentrations are assessed at the base of the vertical pathway. Other substances are assessed at the monitor well on the downgradient boundary of the site.

Table 17: Revised Landsim model results for seepage to Greensand (mg/l)

Determinand	EAL	2019 Model			
	mg/l	Phase I	Phase II a	Phase II b	Phase III
Ammoniacal nitrogen	0.82 – 3.05	No exceedance of EAL for 4000 yrs	No exceedance of EAL for 4000yrs	No exceedance of EAL for 5000yrs	No exceedance of EAL for 4000yrs
Cadmium	0.001 / 0.005	<1e-8	<1e-8	<1e-8	<1e-8
Chloride	250	127	46	52	156
Mecoprop	1e-4 / 0.01	No exceedance of EAL for 7000yrs	No exceedance of EAL for 7,000yrs	No exceedance of EAL for 7000yrs	No exceedance of EAL for 6,000yrs
M p xylene	0.003	<1e-8	<1e-8	<1e-8	<1e-8
Zinc	0.04 – 0.17	<1e-8	<1e-8	<1e-8	<1e-8

EAL based on environmental permit limits, which vary between boreholes, or UKDWS where none exists. For mecoprop and cadmium higher recommended limits are also shown

2.6.2. Conclusions

The model demonstrates that for cadmium, m p xylene and zinc, the likelihood of impact on the Lower Greensand is very low as predicted concentrations are much less than 1e-8mg/l. The predicted concentrations for chloride at the monitor well are below the EAL for each phase of the landfill. For ammoniacal nitrogen and mecoprop the travel times for exceedance of the EAL range from 4000 to 7,000 years. Travel times of this magnitude suggest there will not be a significant impact from these two determinands.

The results indicate that a 3m leachate head above the piezometric surface of the Greensand in Phase III and a 2m head in Phases I and II, is unlikely to cause deterioration below the EAL within the Lower Greensand aquifer.
The assessment has been carried out using a source term which has notably declined in Phase I. Based on the evidence from Phase I it is anticipated that a similar decrease in the leachate chemistry will be seen in newer phases of the site and future assessments may show resulting aquifer concentrations which are further reduced.

Landfilling has been taking place at Milton for 40 years. The review of groundwater quality in 1.2.7 indicates that the groundwater quality in the Lower Greensand remains compliant with trigger levels. This is evidence of the containment afforded by the significant thickness of Gault Clay below the base.

2.7. Hydraulic Containment Assessment

2.7.1. Existing Situation

The existing leachate compliance levels are presented in Table 4. It is understood that the general compliance level of 6.5m AOD was introduced to maintain leachate below the lowest level of the River Terrace Deposits, the base of which is at 6.7m AOD at the lowest point on the east of the site. This would give 0.2m of hydraulic containment.

In some cells leachate levels are permitted to be above this level up to 9.5m AOD.

- The level of 9.5m AOD applies to Phase III Cell 12C, which may not give hydraulic containment.
- Phase II Cell 6 has a compliance level of 8.4m AOD, but has a central location, such that leachate would not act directly outwards into the River Terrace Deposits.
- Phase II Cell 3 has a compliance level of 8.1m AOD, which is lower than the base of the River Terrace Deposits in this location
- Phase II Cell 2 and Phase III Cell 12A have a compliance level of 8m AOD. In both cells the compliance level is lower than the base of the adjacent River Terrace Deposits.

The basal construction drawing is presented as Drawing 653B350 As Built Base. This shows intercell bunds are 2m above the base of the site. Cell bases vary from -3.68 to 6.38 mAOD, which means there is no containment for leachate between adjacent cells where base levels are higher than 4.5 m AOD and intercell bunds are a maximum of 6.5m AOD.

For descriptive purposes when assessing the hydraulic containment, the east of the site is taken to be the boundary from the site entrance, near borehole W05, southwards to borehole BH21, eastwards to borehole BH16, southwards to borehole BH12 and along the southern boundary to borehole W01. The west of the site is from borehole W01 westwards to borehole BH42 and north to borehole BH32.

The waste is separated from the Greensand by between 16 and 27m of Gault Clay. Groundwater levels in the Greensand are as follows: 5th percentile 5.53, average 6.39 and 95th percentile 6.99 mAOD. The existing minimum permitted leachate level of 6.5m AOD exceeds the average piezometric surface for the Greensand by 0.11m.

2.7.2. Containment with respect to River Terrace Deposits

Using the principle already established on site, the proposed rise in leachate levels will ensure a minimum of 0.2m of hydraulic containment with respect to the base of the adjacent River Terrace Deposits.

The degree of hydraulic containment cannot be assessed against 5th percentile groundwater levels, as the River Terrace Deposits are seen to dewater at certain times of the year. The monitoring installations are slotted into the Gault Clay below and therefore, seasonal low groundwater levels are measurements of residual water in the low permeability clay base of the boreholes.

PHASE III

From the borehole log information, summarised in cross sections Figures 2 to 5, it is possible to determine where the proposed leachate levels are hydraulically contained below the base of the River Terrace deposits by at least 0.2m. Figure 12 plots the base of the River Terrace Deposits in the positions of the available borehole logs. This shows that in the majority of Phase III, where the proposed leachate level is 9m AOD, the base of the River Terrace is at, or above 9m AOD. The exceptions are in the northeast corner, adjacent to the household waste site. There will be no landfilling in this area. The other exception is a base level of 8.9m in BH21. Borehole logs to either side show that base rises to 9m AOD, or above within a short distance.

To ensure there is complete hydraulic containment in Phase III, it is proposed to have a slightly lower compliance level in the cells closest to BH21, where the base of the River Terrace Deposits is slightly lower. Cells 12A, 12C, 13A, 14A, 15B and 20B will have compliance level of 8.5m AOD, giving hydraulic containment of 0.4 – 0.5m.

Table 18 shows all the boreholes around the perimeter of Phase III. Where the borehole log is available the base of the River Terrace is given. Five of these boreholes are constructed as River Terrace monitoring boreholes. In four monitoring boreholes the 5th percentile groundwater level is lower than the base of the River Terrace Deposits and indicates they are dewatered at certain times. The acting head of leachate against the River Terrace Deposits must be limited by the base of these deposits and not the groundwater level in the Gault below, therefore the use of the average groundwater level is more applicable. The average groundwater levels in BH21 and BH23 shows at least 0.5m above the proposed leachate level. For the two monitoring boreholes that are dewatered all year round at present the base of the River Terrace is between 0.2 and 0.8m above the proposed leachate level, so even on groundwater rebound the leachate would remain hydraulically contained. The 5th percentile groundwater level in Borehole BH30 is above the proposed leachate level.

Table 18: Phase III Boreholes, Groundwater level relative to River Terrace Base

Phase III - perimeter BHs									
	W03	BH21	BH22	BH23	W04	BH25	W05	BH28	BH30
Base of RTD	9.05	8.9	9	-	9.4	8.2	8.5	9.2	-
5th %ile GWL		8.441	-	7.64		-		-	9.15
Ave GWL		9.82	-	9.51		-		-	9.68

Phase III - perimeter BHs									
	W06	BH31	BH32	BH37	BH38	W07	BH42	W08	BH46
Base of RTD	9.15	9.8	9.1	9.4	9.2	10.4	10	9.2	9.55
5th %ile GWL		-	-	-	4.164		4.6755		-
Ave GWL		-	-	-	7.64		9.17		-

	GWL is below the base of the RTD
	BH monitors Greensand only
-	Borehole log available to determine base of RTD, but no installation for monitoring

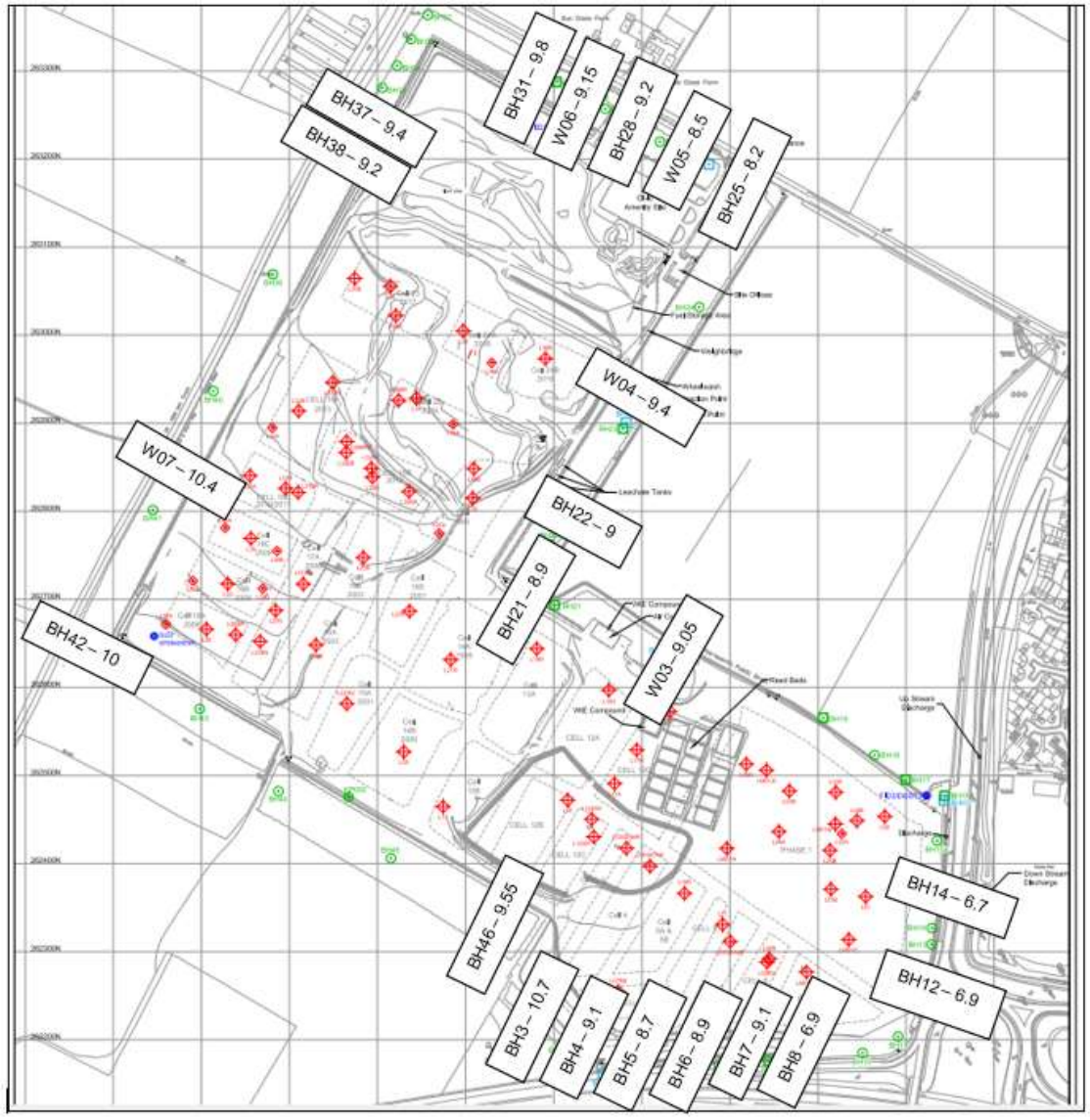
PHASE II

In Phase II there are several closely spaced logs along the phase boundary that show there is only a short distance where the base of the River Terrace is lower than the proposed leachate level of 8m AOD. Hydraulic containment of between 0.7 and 2.7m exists along the majority of the boundary. Potential seepage along the remainder of the boundary has been assessed in section 2.4.6.

PHASE I

In Phase I at the northwest corner, the borehole log for W03 shows the base of the River Terrace to be at 9.05m AOD. Therefore, in the west of Phase I there will be more than 1m of hydraulic containment above the proposed level. The base of the River Terrace deposits falls between borehole W03 and BH12. It is assumed that from a midway point between the two boreholes the base of the River Terrace deposits will become lower than the proposed leachate compliance level. Therefore, for a section of the Phase I boundary there will be no hydraulic containment. Potential seepage over a height of 0.58m (the difference between the 5th percentile groundwater level in the most downgradient borehole, BH12, and the proposed leachate level) is assessed in section 2.4.6, over a length of the northern and the all of the eastern boundary of Phase I.

Figure 12: Base of River Terrace Deposits (mAoD)



2.7.3. Containment with respect to Greensand

The site is separated from the Greensand by the confining layer of Gault Clay. Leachate levels are not currently required to be hydraulically contained by the piezometric surface of the Greensand. The increase in the head difference between the proposed leachate level and the piezometric surface of the Greensand has been assessed by quantitative risk assessment.

3. Requisite Surveillance

3.1. The Risk Based Monitoring Regime

3.1.1. Leachate

Leachate levels have been discussed in section 2.4.4. Further assessment of the proposed revision to the compliance limit is presented in sections 2.4.5 to 2.6, where groundwater modelling has assessed likely impact on emissions to groundwater. Based on the assessment of seepage to the River Terrace Deposits and the updated Landsim model for basal seepage to the Lower Greensand, a leachate compliance level of 9m AOD is proposed for Phase III, 8.5m AOD in the eastern cells of Phase III (Cells 12A, 12C, 13A, 14A, 15B and 20B) and 8m AOD for Phases I and II. Where cell-specific limits exist, which are higher than these proposals, no change to the permitted level is proposed.

Table 19 below summarises these changes and can be used to update Table S3.1 of the environmental permit.

Table 19: Revised Leachate Compliance Levels

Phase / Cell	Leachate Well	Existing Limit (mAOD)	Proposed Limit (mAOD)
Phase III - operational	L32R2, L32AR, L32BR2, L33R, L33A, L33BR, L34, L34A, L34BR, L35, L35A, L35B, L36, L36A, L36B	6.5	9
Phase III - operational east	L26, L26A, L28B	6.5	8.5
Phase III general	L16, L18, L20, L22/R2, L24R,L25R, L27R, L27AR, L27BR, L28, L28A, L28B, L29, L29A, L29B, L30, L30A, L30B, L31R, L31A, L31B	6.5 unless noted below	9
Phase III east : Cells 12A, 12C, 13A, 14A, 15B and 20B	L15R, L17, L17R, L17A, L19R, L21R, L23R, L26, L26A, L26B	6.5 unless noted below	8.5
Phase II, Cells 1, 4, 5, 7, 8, 9-10	L6R, LO6R2, LO7RB, LO4/2014R,L10R, LO7/2014R, LO8R2, LO8R2, LO9/10R	6.5 unless noted below	8
Phase I	All wells	6.5	8
Phase II Cell 3	L03/2014R	8.1	8.1
Phase II Cell 6	L11	8.4	8.4
Phase III Cell 12C	L12DR2	9.5	9.5

FCC have a well-documented Leachate Management Plan which sets out the type and frequency of leachate monitoring required at Milton Landfill. Leachate monitoring is carried out in compliance with the environmental permit. A vast number of leachate wells are now in place within the landfill as FCC have constantly tried to improve the leachate extraction regime, particularly in the older phase of the site. While it remains important to continue to monitor leachate levels in all areas of the site, it is recommended that the number of wells from which samples are taken for analysis is reduced.

Regulatory position statement (RPS) 156, requires monitoring of leachate in all Phases/Cells. The site has Phase I and Phase II of similar areal extent and the much larger area of Phase III, which has 13 cells, many of which are subdivided. The number of leachate quality samples should be 15 to remain compliant. It is recommended the following wells are selected for continued sampling and analysis and Table S3.10 of the permit amended accordingly. While the selected leachate wells below may not be the most representative of leachate level in each cell, it will be useful to continue to monitor leachate quality at the same points, so that a picture of degradation over time is established.

Table 20: Leachate Quality Monitoring Points

Leachate well *	Parameter	Monitoring frequency	Monitoring standard
Cells with temporary cap			Environment Agency TGN02.
Cell 19B – L32R2 Cell 20B – L26 Cell 22 – L34 Cell 23 – L35 Cell 24 – L36	pH, EC, total alkalinity, ammoniacal nitrogen, chloride, COD, BOD, cadmium, chromium, copper, lead, nickel, iron, arsenic, magnesium, potassium, sulphate, calcium, sodium, zinc, manganese	Quarterly	
	Hazardous substances	Annually	
	Depth to base	Annually	
Non-operational cells			
Phase I – L02, L04R Phase II – L10R, L11 <u>Phase III</u> Cell 12 – L16 Cell 13 – L19R Cell 14 – L20 Cell 15 – L23R Cell 16 – L24R Cell 17 – L27R Cell 18 – L29	pH, EC, total alkalinity, ammoniacal nitrogen, chloride, COD, BOD, cadmium, chromium, copper, lead, nickel, iron, arsenic, magnesium, potassium, sulphate, calcium, sodium, zinc, manganese	Annually	
	Hazardous substances	Once every 4 years	
	Depth to base	Annually	

* Should the nominated well become disfunctional, a replacement well may be agreed in writing with the EA, without the need for a permit variation.

All wells should continue to be monitored for levels.

3.1.2. Groundwater Monitoring Regime

Groundwater level and groundwater quality data is presented in sections 1.2.5 and 1.2.7. Based upon monitoring data to present, groundwater is currently compliant with trigger levels.

New boreholes have been installed to replace BH12 and W01. These are BH12R and W01R respectively, which have been drilled close to the boreholes they replace, as indicated on the updated Environmental Monitoring Plan. Weekly monitoring data was obtained for eight months after installation. From September 2021 the monitoring reduced to monthly. The data is assessed to determine compliance levels for groundwater quality. The monitoring data is presented in Appendix 4. Electronic versions of all data used in this report are supplied in support.

Existing boreholes all have the same compliance levels for some determinands:

Chromium – 0.05 mg/l
Mecoprop – 0.1 ug/l
Xylene – 3 ug/l
Cadmium – 1 ug/l

The monitoring data suggests these compliance levels remain appropriate for the new boreholes for chromium, xylene and cadmium and for mecoprop in W01R. Mecoprop, however, was found to exceed 0.1 ug/l in BH12R in early January, but has since declined. It is proposed that the maximum recorded value of 0.15ug/l is used as the compliance level for this borehole.

Ammoniacal nitrogen and zinc require borehole specific compliance levels. These are proposed on the basis of using the average plus three standard deviations. The proposed compliance levels for the new boreholes are presented in Table 21.

Table 21: Proposed Compliance Levels for New Boreholes

Borehole	Determinand	Average (mg/l)	Standard deviation	Compliance level (mg/l unless noted)
W01R	Ammoniacal nitrogen	0.49	0.14	0.91
W01R	Zinc	0.0038	0.0038	0.015
W01R	Mecoprop			0.1 (ug/l)
BH12R	Ammoniacal nitrogen	2.43	0.69	4.5
BH12R	Zinc	0.0063	0.0039	0.018
BH12R	Mecoprop			0.15 (ug/l
W01R + BH12R	Cadmium			1 (ug/l)
W01R + BH12R	Chromium			0.05
W01R + BH12R	Xylene			3 (ug/l)

The new compliance limits given above should be inserted into Table S3.4 of the environmental permit and the previous limits for BH12 and W01 should be removed.

3.1.3. Surface Water

The environmental permit requires monitoring of surface water up and downgradient of the point where the Thirteenth Public Drain leaves the site boundary. The source of the discharge is listed within the permit to be the effluent treatment plant. The treatment plant is no longer in operation. It is, therefore, requested that the permit is amended to indicate the source to be surface water drainage. Monitoring data shows the sampling points to have been dry since 2010.

A new surface water management system has been designed for the site, as detailed in Sirius report reference WR7544/01, 2020. This incorporates an attenuation lagoon in the northeast of the site, to which all surface water will fall. The outfall from the attenuation lagoon will discharge to the Thirteenth Public Drain. Monitoring of the discharge will continue in line with Table S3.3 of the Environmental Permit.

4. Conclusions

4.1. General Conclusions

This HRA has given a detailed review of the geology and hydrogeology of the site. Previous assessments appear to have worked on maxima and minima for strata and water levels. This assessment has aimed to conceptualise the geology below each phase of the site. The findings are summarised below.

- The River Terrace / Drift deposits are classed as a Secondary A aquifer, but are relatively thin and of variable nature in the vicinity of the site. Monitoring data indicates the horizon may become dry at certain times of the year and in relation to landfill engineering activities.
- Shallow groundwater monitoring boreholes are completed with installations that intersect both the River Terrace/Drift and the Gault within the same borehole. The bases of these installations are several metres below the base of the River Terrace/Drift and the groundwater level can be found to rest several metres below the base of this horizon when it becomes dewatered.
- On the west of the site the base of the River Terrace / Drift is around 9m AOD, or higher. The base of the River Terrace/Drift is only found to be lower than 8.5m AOD in boreholes BH8, BH12 and BH14, on the most easterly boundary of the site. Here the base of the geological horizon is around 6.7 to 6.9m AOD.
- An increase to 9m AOD for the leachate level in Phase III will be lower than the base of the River Terrace/Drift on the west of the site. Therefore, there is minimal risk of a pathway for leachate seepage to the River Terrace/Drift in Phase III.
- An increase to 8m AOD for the leachate level in Phase I and II will be approximately equal to the average groundwater level on the east of the site.
- Assessment of risks to the shallow groundwater indicates that leachate could be raised to 9m AOD in the majority of Phase III, 8.5m AoD in the east of Phase III (Cells 12A, 12C, 13A, 14A, 15B and 20B) and 8m AOD in Phase I and II.
- Based on recent well installations in Phase I the base of the phase is found to be approximately 16-16.5m above the Lower Greensand, as recorded in boreholes at the perimeter of this phase. This is the minimum thickness of low permeability Gault Clay below the site. Elsewhere it is up to 25m thick beneath the waste.
- It is noted that the EA's recently updated Manual for the Production of Groundwater Source Protection Zones defines a "protective cover of low permeability" above an aquifer as being 10m thick. Aquifers below this depth of cover are defined to take account of subsurface activities, such as deep drilling for oil. The protective cover of low permeability at Milton is much greater in thickness than 10m, meaning risks to the Greensand are low. However, risks to the confined Greensand aquifer are still assessed.
- An increase up to 9m AOD for leachate level in Phase III and 8m AOD in Phases I and II will be approximately 3m and 2m respectively above the average level of the piezometric surface for the Greensand. This has been assessed using a Landsim model

with 3m and 2m vertical heads acting on the base of the respective phases to determine the risk to the Greensand. Modelling has determined that a 3m acting head of leachate above the piezometric surface ie 9m AOD in Phase III, could be acceptable for the Lower Greensand. An 2m acting head, ie 8m AOD could be acceptable for Phases I and II. It should be noted that at certain times of the year the piezometric surface of the greensand is closer to 7 or 8m AOD and during these periods the acting head of the leachate would be lower than modelled.

- FCC have made this proposal as the site reaches completion and the longer term equilibrium of the site must be considered. It is intended that the agreed higher compliance level will allow greater operational flexibility to target leachate extraction to priority areas of the site and to take rapid action in the event of exceedances, while still maintaining a steady rate of removal from the site.
- FCC has invested in a large number of retro-drilled leachate wells to better manage leachate on site. While it is acknowledged that an increased number of locations is necessary to measure levels, it is not recommended that all wells are sampled for leachate quality. It is suggested that leachate quality could be sufficiently characterised by two wells in completed phases I and II of the landfill and one well in each subsequent cell. It is recognised that more wells will be needed in the operational areas. A maximum of 17 wells will be sampled and analysed for leachate quality and these will be as presented in Table 18.
- No surface water monitoring data has been available for the permitted sampling point since 2010. The effluent treatment plant is no longer in operation and the perimeter drain has been found to be dry since early 2010. The drain will be used to discharge from the new surface water management system and attenuation lagoon. Discharge will be limited to clean surface runoff.

4.2. Compliance with the Landfill Directive/EPR 2016

The available monitoring data to March 2021 has been reviewed and shows some change to the range in leachate chemistry since the original HRA. The maximum concentrations of certain source determinands have decreased and show the leachate concentrations in Phase I have declined more notably since 2012.

The site has an active leachate management system and a Leachate Management Plan which is updated annually. There have been some issues in relation to leachate levels, particularly in some of the older parts of the site where there is a lower level of design with respect to leachate drainage. However, a number of retro-drilled leachate monitor wells have recently been installed in Phase I, in line with FCC's ongoing commitment to better characterise and manage the leachate. These show lower levels of leachate which are compliant with the new proposals.

In order to create greater flexibility for leachate management, maintenance and improvement

it is proposed to raise the leachate compliance level to 9m AOD in Phase III, 8.5m AOD on the east of Phase III and 8m AOD in Phases I and II. Where the current permit specifies higher levels in specific cells, where the base has been constructed higher than the surrounds, no change is proposed to these agreed levels. Modelling of the likely impact of this proposal suggests this should be acceptable.

Groundwater quality monitoring data shows the site to be compliant with groundwater trigger levels despite some historical exceedances of the current permitted leachate compliance levels.

Based on current groundwater monitoring data and model predictions regarding the future leachate management of the site, the site remains compliant with the Environmental Permitting Regulations 2016.

4.3. Recommendations

The following recommendations are made as a result of this hydrogeological risk assessment review:

1. Leachate compliance levels are raised to 9m AOD in most of Phase III; 8.5m AOD in the east of Phase III (Cells 12A, 12C, 13A, 14A, 15B and 20B); 8m AOD in Phases I and II and where current cell-specific compliance limits are slightly higher than these proposed increases, no change will be required.
2. The site comprises Phase I, Phase II and 13 additional cells in Phase III. It is, therefore, recommended that number of leachate wells which require leachate quality sampling and analysis is reduced to 17. Those wells which will continue to be sampled are as presented in Table 18.
3. The permit should be amended in Table S3.3, as the effluent treatment plant is no longer in operation. If the perimeter drain contains flow it will be sampled, however, the source should be listed as surface water drainage.
4. Compliance limits derived for the replacement boreholes BH12R and W01R should be used to replace former compliance limits for boreholes BH12 and W01.

REFERENCES

1. BGS : 1995 : Techncial Report WN/94/31. Engineering Geology of British Rocks and Soils. Gault Clay. British Geological Survey.
2. BGS : 1997 : Technical Report WD/97/34. The Physical Properties of Major Aquifers in England and Wales. British Geological Survey.
3. EA : 2019 : Manual for the Production of Groundwater Source Protection Zones
4. Golder Associates : 2003 : Environmental Setting and Installation Design. Milton Landfill Site.
5. Golder Associates: 2003 : Hydrogeological Risk Assessment. Milton Landfill Site.
6. Golder Associates : 2008 : Milton Landfill Site, Four Year Review of Hydrogeological Risk Assessment.
7. Wardell Armstrong : 2015 : Milton Landfill. Hydrogeological Risk Assessment Review.
8. Water Supply (Water Quality) Regulations 2016.

McDonnell Cole

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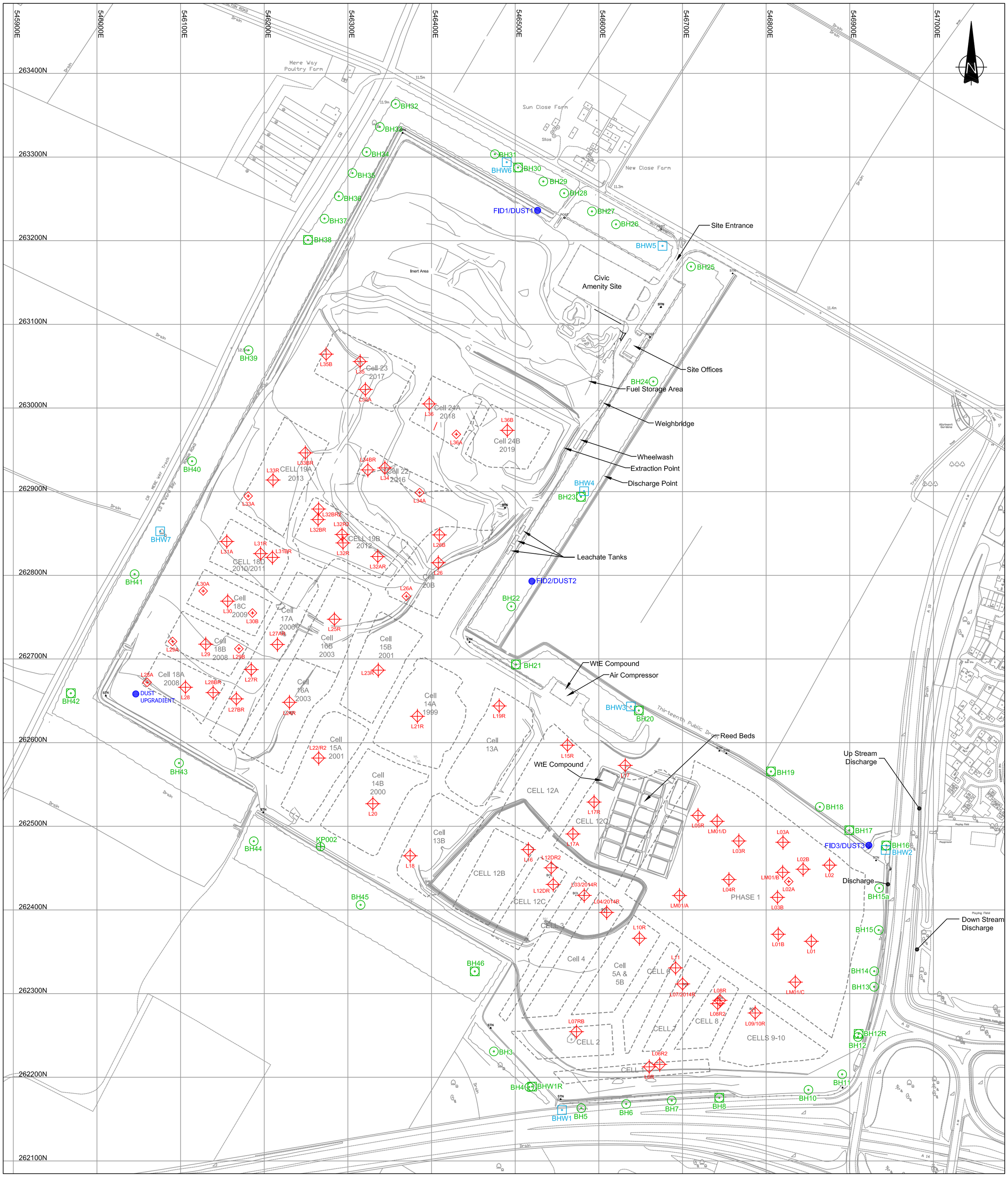
DRAWINGS



NOTES:

1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.

2. DO NOT SCALE FROM THIS DRAWING.

3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF FCC ENVIRONMENT (UK) LIMITED PRIOR TO CONSTRUCTION WORKS COMMENCING.

LEGEND:

- Landfill Gas Monitoring Borehole
- Landfill Gas Surface Monitoring Point
- Combined Gas/ Groundwater Monitoring Point
- Gas Flare Stack
- Landfill Gas Extraction Point
- Landfill Gas Extraction/ Leachate Monitoring Point
- Condensate Unit (Knock-out Pot)
- Gas Manifold
- Groundwater Monitoring Borehole
- Groundwater Pumping Point
- Surface Water Monitoring Point
- Leachate Collection Point
- Leachate Monitoring Point
- Leachate Recirculation Point
- Leachate Collection Sump
- Leachate Discharge Sampling Point
- Leachate Detection Point
- Underdrainage Monitoring Point
- Settlement Monitoring Point
- Drain/ Dewatering Tank
- Valve
- As-built Cell Footprint
- Dust Points
- Proposed Well

Revision:	Date:	Description:	By:	Chk:
S	23.02.21	Location amended L36B, L36A, L34BR, L30A, L30, L30B, L17R, L17A, L08R2, L06R2, BH6, BH5, BHW1, BH4, BH12, BH15A, BH15, BH14, BH13, BH11 & BH10. BHW1R & BH12R added. L34B removed.	BS	RH
R	09.11.20	L34BR, L17R, L17A, L17B, L08R2 & L06R2 location amended, Relocated Leachate Tank added	BS	RH
Q	14.08.20	L34BR, L17R, L17A, L17B, L08R2 & L06R2 proposed wells added	BS	RH
P	13.11.19	Site survey updated	BS	RB
O	08.10.19	Site survey updated. Extraction & discharge labels added. Cell 24B detail added.	BS	RB
N	20.05.19	L12DR2, L32R2 & L32BR2 installed	BS	RB
M	02.04.19	Site survey updated. Proposed wells L12DR2, L32R2 & L32BR2 added	BS	RH
L	11.03.19	L32BR REDRILL, L32R REDRILL & L12DR REDRILL added	BS	RH

Reference files:
Information taken from plans;

Site Survey:	653W2247
Monitoring Plan:	6373 - Milton - Leachate System - April 2013
Cell Footprint:	653B2190

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster, DN4 5NU

Site:

MILTON
LANDFILL SITE

Drawing Title:

Environmental Monitoring Plan

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
BS	RH	23.02.21	1:3000	A2

Status:	Revision:	Drawing No:	Plan Number:
FINAL	S	**653M282**	**Plan 04A**

Last Saved By: BenStocks Date: 26-Jan-21 Plot By: ben stocks Date: 23-Feb-21

NOTES:

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LEGEND:

- Property Interest Boundary (Yellow)
- Limit of Landfill at Surface (Orange)
- PPC Boundary or WML Boundary (Red)
- Open Waste
- 52,404m² — Temporary Cap
- 339,991m² — Capped Clay
- Capped Lap Lay Membrane
- Capped Welded Membrane
- Capped Non Engineered
- 6,152m² — Future Cells
- As-built Cell Footprint

Revision:	Date:	Description:	By:	Chk:
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Reference files:
Information taken from plans;

Site Survey: 653W2247- 2020 Q1 FULL TOPO 090320

Leachate: 653L2253

Cell Footprints: 653B2205

FCC Environment (UK) Limited
6 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Site: **MILTON** LANDFILL SITE

Drawing Title: **Leachate Infiltration Plan Q3 2020**

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
BS	RH	19.11.20	1:4000	A3

Status:	Revision:	Drawing No:	Plan Number:
FINAL	-	653L362	PLAN 21C

Last Saved By: BenStocks Date: 19-Nov-20Plot By: ben stocks Date: 19-Nov-20

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.

2. DO NOT SCALE FROM THIS DRAWING.

3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF FCC ENVIRONMENT (UK) LIMITED PRIOR TO CONSTRUCTION WORKS COMMENCING.

LEGEND:

- PPC Boundary or WML Boundary
- Cell X — As-built Cells
- LCP — As-built Leachate Collection Point
- LMP — As-built Leachate Monitoring Point
- Cell X — Proposed Cells
- LCP — Proposed Leachate Collection Point
- LMP — Proposed Leachate Monitoring Point

Pit Base Confidence

- 100 — Data from In-House Surveys
- Data from Third Party Surveys
- No Information Available or Extrapolated Data

Revision:	Date:	Description:	Rv:	Chk:
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Reference files:
Information taken from plans:
Site Survey: 653B2239
Cell Footprints: 653B2238

FCC Environment (UK) Limited
6 Skillings Court, White Rose Way, Doncaster, DN4 5NU

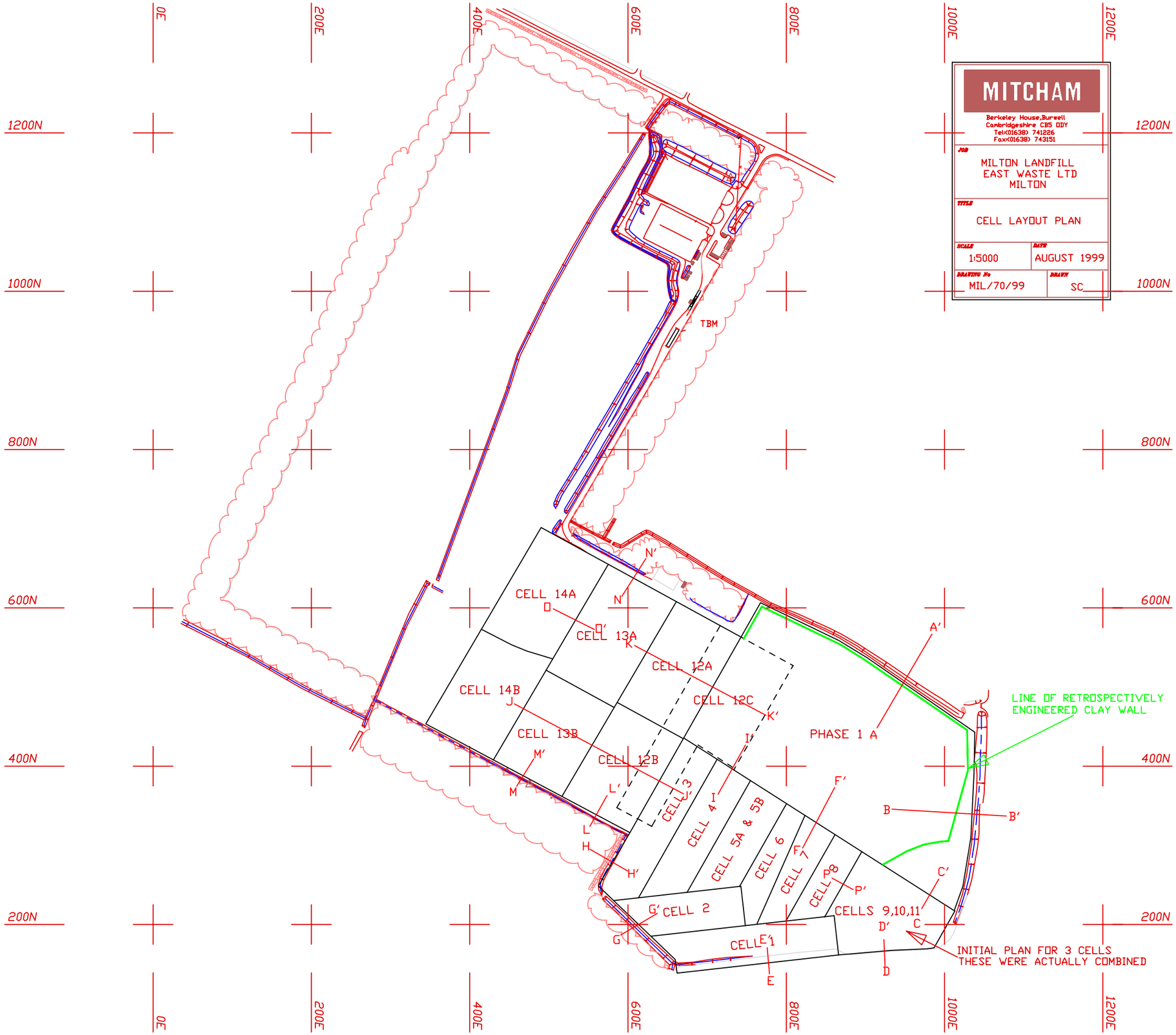
Site:
MILTON
LANDFILL SITE

Drawing Title:
As-built Cell Base & Outline Phasing Plan

Drawn By:	Checked By:	Date:	Scale:	Paper Size:
BS	RH	21.08.19	1:2000	A1

Status:	Revision:	Drawing No:	Plan Number:
FINAL	-	**653B350**	**PLAN 12**

Last Saved By: Ben Stocker Date: 22-Aug-19 Date: 08-Aug-19 File: Ben stocker



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JOB

MILTON LANDFILL
EAST WASTE LTD
MILTON

TITLE

CELL LAYOUT PLAN

SCALE	DATE
1:5000	AUGUST 1999
DRAWING No	DRAWN
MIL/70/99	SC

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Vt 1:500

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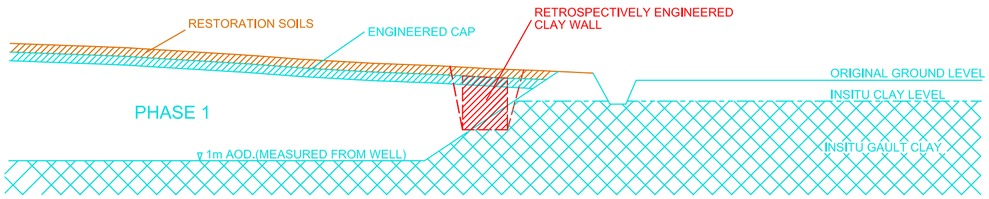

SECTION B-B'

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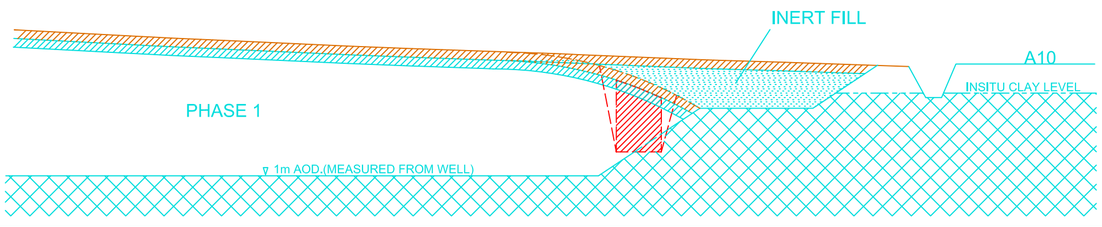

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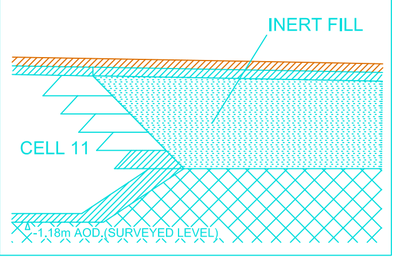

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Vt 1:500

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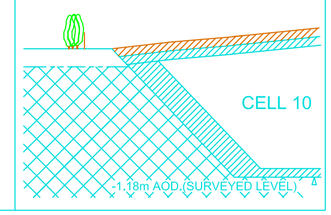

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Vt 1:500

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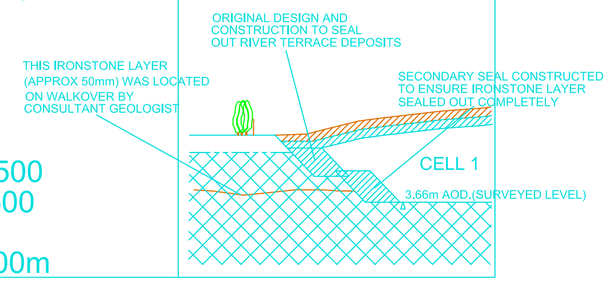

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Vt 1:500

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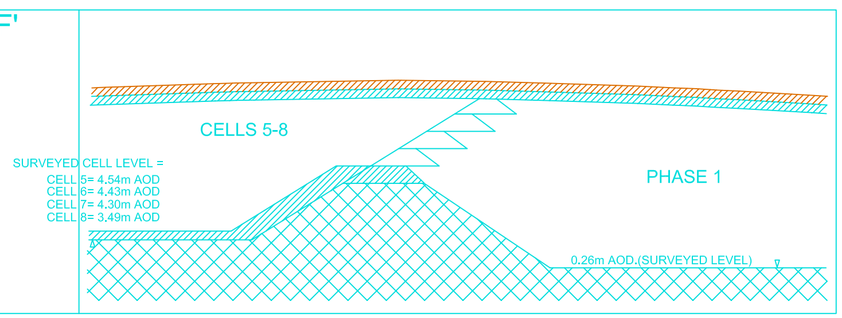

SECTION G-G'

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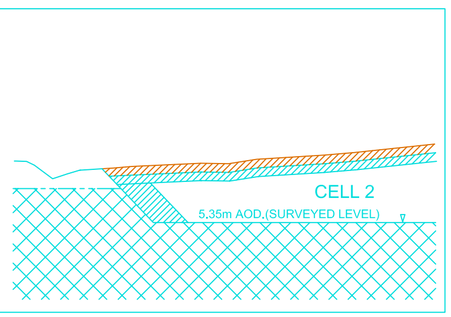
Vt 1:500

▽-5.000m



LEGEND

- RESTORATION SOILS
- INSITU GAULT CLAY
- ENGINEERED CLAY — ALL ENGINEERED AREAS OUTLINED ARE CONSTRUCTED TO SPECIFICATION OF <1 x 10 m/s
- INERT FILL MATERIAL
- MEASURED FROM WELL — DEPTH OF SITE MEASURED TO BASE OF LEACHATE MONITORING WELL
- SURVEYED LEVEL — LOWEST RECORDED BASE LEVEL TAKEN FROM RECORDS HELD BY EARTHWORKS CONTRACTOR

THIS PLAN IS TO BE READ IN CONJUNCTION WITH CELL LAYOUT PLAN MIL/70/99. AUGUST 1999

EAST WASTE LTD
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JOB
MILTON LANDFILL
EAST WASTE LTD

TITLE
SECTIONS THROUGH SITE
(SHEET 1 OF 3)

SCALE	DATE
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DRAWING No	DRAWN
MIL/72/99	SC

SECTION H-H'

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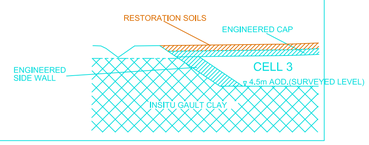
Vt 1:500

▽-5.000m



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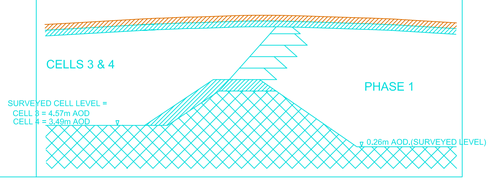

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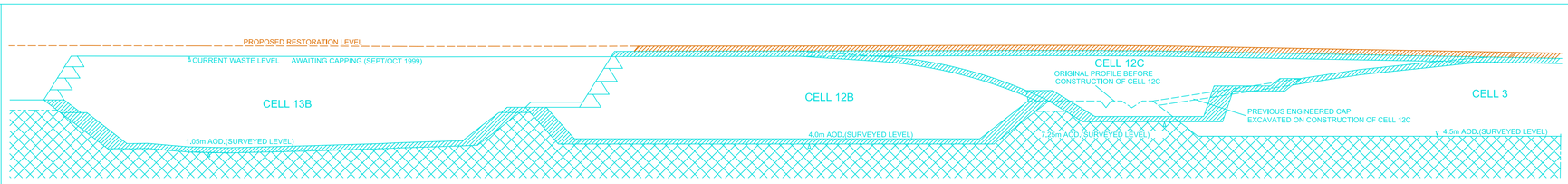

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Vt 1:500

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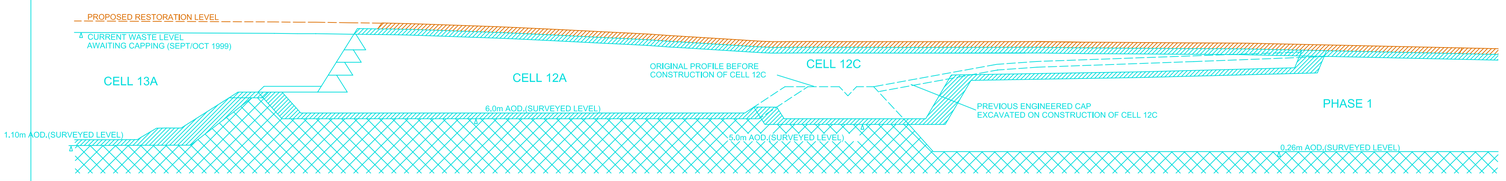

LEGEND

- RESTORATION SOILS
- INSITU GAULT CLAY
- ENGINEERED CLAY. ALL ENGINEERED AREAS OUTLINED ARE CONSTRUCTED TO SPECIFICATION OF <1 x 10 m/s
- INERT FILL MATERIAL
- MEASURED FROM WELL — DEPTH OF SITE MEASURED TO BASE OF LEACHATE MONITORING WELL
- SURVEYED LEVEL — LOWEST RECORDED BASE LEVEL TAKEN FROM RECORDS HELD BY EARTHWORKS CONTRACTOR

THIS PLAN IS TO BE READ IN CONJUNCTION WITH CELL LAYOUT PLAN MIL/70/99, AUGUST 1999

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TITLE
SECTIONS THROUGH SITE
(SHEET 2 OF 3)

SCALE	DATE
1:500	SEPT 1999

DRAWING No	DRAWN
MIL/73/99	SC

APPENDIX 1

Borehole Logs

RECORD OF BOREHOLE No. 1

Client Cambridge CC

Contractor A Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 11.2 metres AoD Co-ordinates TL 46544 E 62406 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
3/10/90	0.8		Medium dense light brown slightly clayey SAND with fine and medium gravel incl. brick above 0.5m (MADE GROUND)	+10.4
	2.2		Medium dense yellowish/orange brown clayey SAND and GRAVEL incl. Chalk (RIVER TERRACE DEPOSITS)	+ 9.0
			Stiff grey brown mottled finely laminated moderately weathered silty MARL (GAULT)	
	5.0		becoming fissured with extremely/	+6.2
	6.0		very closely spaced discontinuities becoming slightly weathered with	+5.2
	7.2		a little brown iron staining on disconts	+4.0
			Very stiff etc unweathered silty MARL	
	9.0		with occasional medium gravel grade phosphatic nodules	+2.2
	10.0		with some black carbonaceous smears and occasional shell fragments	+1.2
	13.0		with occasional phosphatic nodules	−1.8
3/10/90	20.5		Base of borehole	−9.3

Remarks

1. 'MARL' = calcareous clay
2. Water not encountered
3. 50mm diameter gas standpipe installed at base.

PETER SCOTT Consultant Engineering Geologist
8 Woodhill Road, Portishead, Bristol BS20 9ET Telephone: (0272) 848616

RECORD OF BOREHOLE No. 2

Client Cambridge CC

Contractor A. Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 11.5 metres AoD Co-ordinates TL 46492 E 62320 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
4/10/90			Medium dense yellowish brown clayey SAND with fine to coarse gravel becoming more abundant with depth (RIVER TERRACE DEPOSITS)	
	2.8			+8.7
			Firm grey with slight traces of brown very slightly weathered silty MARL (GAULT)	
	4.0			+7.5
			Stiff light blueish grey thinly laminated unweathered MARL	
	5.0			+6.5
			becoming fissured with extremely/very closely spaced discontinuities	
	6.0			+5.5
			becoming very stiff and with occasional medium gravel grade phosphatic nodules to 7.0m	
	12.5		with many shell fragments	-1.0
	15.0		with phosphatic nodules	-3.5
	17.5		with thin laminae of shelly sand	-6.0
4/10/90	20.5		Base of borehole	-9.0

Remarks

1. 'MARL' = Calcareous clay
2. N.B. virtual absence of weathered gault
3. Water not encountered
4. 50mm gas standpipe installed at base

PETER SCOTT Consultant Engineering Geologist
8 Woodhill Road, Portishead, Bristol BS20 9ET Telephone: (0272) 848616

RECORD OF BOREHOLE No. 3 A

Client Cambridge CC

Contractor A. Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 12.7 metres AoD Co-ordinates TL 46467 E 62243 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
3/10/90			MADE GROUND See BH3 log	
	1.7		Dense orange brown very clayey SAND with occasional fine gravel and iron staining	+11.0
	2.0			+10.7
	2.7		Very stiff light (RIVER TERRACE DEPOSITS)	
	3.1		grey silty CLAY with fine and medium chalk gravel (disturbed GAULT)	+10.0
				+ 9.6
	5.0		Medium dense orange brown very clayey SAND with fine and medium gravel (RIVER TERRACE DEPOSITS)	+ 7.7
	7.0		Stiff grey brown mottled thinly laminated moderately weathered silty MARL (GAULT)	+ 5.7
			Very stiff etc Slightly weathered silty MARL	
	10.0		Very stiff light blueish grey thinly laminated fissured unweathered silty MARL with extremely/very closely spaced discontinuities	+ 2.7
			with occasional medium gravel grade phosphatic nodules	
	12.0		with a large bivalve	+ 0.7
	17.0		with belemnites, shell fragments and occasional phosphatic nodules	- 4.3
			Very fossiliferous horizon at 19.5 with belemnites and sand grade shell debris	
3/10/90	22.0		Base of borehole	- 9.3

Remarks

1. Borehole located 0.5m from BH3
2. 'MARL' = calcareous clay
3. Water not encountered
4. 100 mm gas standpipe installed at base

PETER SCOTT Consultant Engineering Geologist
8 Woodhill Road, Portishead, Bristol BS20 9ET Telephone: (0272) 848616

RECORD OF BOREHOLE No. 3

Client Cambridge CC

Contractor A. Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 12.7 metres AoD Co-ordinates TL 46467 E 62243 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
3/10/90			Very stiff yellowish brown sandy silty CLAY with much fine and medium gravel incl. chalk and occasional concrete boulders (MADE GROUND),	
	1.25			+11.45
	1.90		Medium dense light grey brown	+10.80
3/10/90	2.10		slightly clayey fine SAND with occasional fine and medium gravel, rootlets and overlain by straw	+10.60
			CONCRETE Base of borehole	

Remarks

Borehole abandoned after ½ hours chiselling

PETER SCOTT Consultant Engineering Geologist
8 Woodhill Road, Portishead, Bristol BS20 9ET Telephone: (0272) 848616

RECORD OF BOREHOLE No. 4

Client Cambridge CC

Contractor A Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 12.3 metres AoD Co-ordinates TL 46498 E 62194 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
3/10/90			Stiff yellowish and greyish brown sandy silty CLAY with fine to coarse gravel incl. brick and tarmacadam (MADE GROUND)	
	1.2		Medium dense light brown clayey SAND and fine to medium gravel incl. chalk and brick	+11.1
	2.4		Medium dense yellowish brown very sandy slightly clayey fine to coarse GRAVEL	+9.9
	3.4		Stiff grey brown (RIVER TERRACE DEPOSITS)	+8.9
	4.0	— x —	Mottled thinly laminated moderately weathered silty MARL (GAULT)	+8.3
	5.0	—	slightly weathered ditto	+7.3
		— x —	Stiff becoming very stiff by 7.0m light blueish grey thinly laminated fissured unweathered silty MARL with extremely / very closely spaced discontinuities and occasional medium gravel grade phosphatic nodules	
		—		
		— x —		
		—		
		— x —		
		—		
		— x —	Thin laminae of sand grade shell debris at 20.0m	
		—		
3/10/90	21.5		Base of borehole	−9.2

Remarks

1. 'MARL' = calcareous clay
2. Water not encountered
3. 100mm gas standpipe installed at base

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RECORD OF BOREHOLE No. 5

Client Cambridge CC

Contractor A. Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 11.4 metres AoD Co-ordinates TL 46566 E 62168 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
2/10/90			Very stiff yellowish brown and grey sandy silty CLAY with fine and medium gravel. Layer of moss at 0.8m and rootlets below.	
	2.0		medium dense orange (MADE GROUND)	+9.4
	2.7		brown very clayey SAND with much fine and medium flint and chalk gravel	+8.7
			Stiff grey brown (RIVER TERRACE DEPOSITS)	
			mottled thinly laminated moderately	
	5.0		weathered silty MARL (GAULT)	+6.4
	6.0		Very stiff light blueish grey thinly laminated slightly weathered silty MARL	+5.4
			very stiff etc fissured slightly weathered	
			silty MARL with limited iron staining	
			becoming much staining by 7.0m	
	8.0		on very closely spaced discontinuities	+3.4
			Very stiff etc. unweathered silty	
			MARL with extremely / very closely	
			spaced discontinuities and	
			occasional medium gravel grade	
			phosphatic nodules and	
			shell fragments	
2/10/90	20.5		Base of borehole	-9.1

Remarks

1. 'MARL' = calcareous clay
2. Water not encountered
3. 100 mm gas standpipe installed at base

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RECORD OF BOREHOLE No. 6

Client Cambridge CC

Contractor A Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 11.1 metres AoD Co-ordinates TL 46622 E 62176 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
2/10/90			Very stiff grey/off white/yellow/brown sandy silty CLAY with fine and medium gravel incl. chalk and brick, and rootlets	
	1.9		Dense light brown (MADE GROUND) clayey SAND with fine to coarse gravel incl. concrete and tile as G.L. to 1.0m.	+9.2
	2.2		Medium dense orange brown very clayey SAND with much fine & medium flint and chalk gravel (RIVER TERRACE DEPOSITS)	+8.9
	6.0		Stiff becoming very stiff by 5.0m grey brown mottled thinly laminated moderately weathered silty MARL (GAULT)	+5.1
	8.0		Very stiff light blueish grey thinly laminated fissured slightly weathered silty MARL with iron stained very closely spaced discontinuities	+3.1
	13.0		becoming unweathered and incl. occasional medium gravel grade phosphatic nodules with intact ammonite and bivalve	−1.9
	15.0		with thin black streaks and fine pyrite	−3.9
2/10/90	20.5		Base of borehole	−9.4

Remarks

1. 'MARL' = calcareous clay
2. Water not encountered
3. 100mm gas standpipe installed at base

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RECORD OF BOREHOLE No. 7

Client Cambridge CC

Contractor A. Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 11.0 metres AoD Co-ordinates T L 46677 E 62181 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
			Very stiff greyish brown sandy silty CLAY and medium dense orange brown clayey SAND with fine and medium gravel incl. brick fragments and rootlets below 1.5m (MADE GROUND)	
	1.9			+9.1
		X	Very stiff becoming stiff by 2.5m grey brown mottled thinly laminated moderately weathered silty MARL with occasional medium gravel grade phosphatic nodules (GAULT)	
	5.0	X		+6.0
	6.0		Stiff light blueish grey thinly laminated fissured slightly weathered silty MARL with extremely closely spaced discontinuities	+5.0
	7.0	X	Very stiff etc silty MARL with brown iron stained extremely/very closely spaced discs.	+4.0
		X	Very stiff light blueish grey thinly laminated fissured unweathered silty MARL with extremely/v. closely spaced disconts.	
	11.5	X	with black iron stained discontinuity	−0.5
	12.5	X	with occasional shell fragments	−1.5
	14.5	X	slickensided shear surface	−3.5
	17.5	X	with ammonites belemnites & pyrite	−6.5
	19.5		parting of sand grade shell debris	−8.5
	20.0		Base of borehole	−9.0

Remarks

1. MARL = calcareous clay
2. Water not encountered
3. 100 mm diameter gas standpipe installed at base
4. N.B Absence of River Terrace Deposits

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RECORD OF BOREHOLE No. 8

Client Cambridge CC

Contractor A Bedford Site Milton Landfill Sheet 1 of 1

Ground Level 11.9 metres AoD Co-ordinates TL 46736 E 62186 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
1/10/90			Stiff becoming very stiff by 1.0m brown and grey silty CLAY with occasional fine and medium gravel and, below 1.4 m, rootlets (MADE GROUND)	
	2.2			+9.7
			Medium dense yellowish brown very clayey SAND with occasional fine gravel including chalk, small pockets of black iron stained sand, and c. 4.0m thin laminae of shelly sand (RIVER TERACE DEPOSITS)	
	5.0			+6.9
	6.5	— X —	Stiff grey brown mottled thinly laminated moderately weathered silty MARL (GAULT)	+5.4
		—	Stiff light blueish grey thinly laminated fissured slightly	
		— X —	weathered silty MARL with some,	
	9.0	—	becoming much at 7.0m, brown iron staining on very closely spaced discontinuities	+2.9
		— X —	unweathered and with extremely/	
	11.0	—	very closely spaced disconts. below 9.0m	+0.9
			Very stiff below 11.0m	
	12.0	— X —	with pyritised fossils	−0.1
		—		
	14.0	— X —	with occasional shell fragments	−2.1
	15.0	—	" " " "	−3.1
		— X —		
		—		
	18.0	— X —	with sand grade off white shell debris	−6.1
		—		
1/10/90	21.0		Base of borehole	−9.1

Remarks

1. MARL = calcareous clay
2. Water struck at 4.0m, no rise after 10 minutes. Ground water level 4.0m on 31/10/90.
3. 100 mm diameter gas standpipe installed at base

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Summary

RECORD OF BOREHOLE No. 9

Client CAMBRIDGE C.C.

Contractor DRILLSURE Site MILTON LANDFILL Sheet 1 of 1

Ground Level Approx. 11.2 metres AoD Co-ordinates TL 46528 E 62476 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
9/10/90	1.50		MADE GROUND	+9.7
	2.30		SAND AND GRAVEL	+8.9
			GAULT	
9/10/90 10/10/90	26.95			
	31.10			−19.9
			LOWER GREENSAND	
10/10/90	39.00		Borehole not complete	−27.8

Remarks

1. Rotary rig with compressed air flush and 7⅞" rock roller bit.
2. Copious water strike at top of Lower Greensand.
3. See also 'Penetration Rate and Interpretation'

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RECORD OF BOREHOLE No. 12

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 9.7 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
11/2/92			Brown gravel FILL	
			Firm grey clay FILL (Driller's descriptions) (MADE GROUND)	
	1.3			8.4
	1.5		Stiff grey brown mottled sandy silty CLAY with rootlets & trace of fine gravel	8.2
	2.2		Medium dense pale yellowish grey slightly clayey SAND & trace of fine gravel	8.5
	2.8		Medium dense orange brown clayey SAND with fine & medium gravel & stiff grey CLAY with much fine gravel incl. chalk (? POCKETY DRIFT)	6.9
			Firm to stiff grey silty MARL with brown streaks along laminae - Moderately weathered (GAULT)	
	4.0		Stiff blueish grey silty MARL etc. slightly weathered	5.7
	6.0		Very stiff blueish grey fissured silty unweathered MARL to . . .	3.7
11/2/92			. . . . base of borehole at 19.0m	-9.3

Remarks

1. MARL = calcareous clay.
2. Borehole dry throughout.

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RECORD OF BOREHOLE No. 14

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 2

Ground Level 13.4 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
11/2/92			Grey and brown clay FILL	
	1.4			12.0
			Firm grey clay FILL with traces of sand and gravel and brick rubble (Drillers descriptions) (MADE GROUND)	
	5.3			8.1
			Medium dense yellowish brown slightly clayey SAND with fine and medium gravel (?POCKETY DRIFT)	
	6.7			6.7
	7.0		Stiff greybrown mottled moderately weathered silty MARL (GAULT)	6.4
	8.0		Very stiff blueish grey with some brown silty MARL with rootlet traces	
	9.0		Body unweathered but iron staining on discontinuities	
11/2/92	10.0		Borehole not complete	3.4

Remarks

1. MARL = calcareous clay
2. Slight water seepage at 6.5m

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RECORD OF BOREHOLE No. 14

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 2 of 2

Ground Level 13.4 metres AoD Co-ordinates E N

Daily Progress	Depth 10.0 m	Legend	Description of Strata	Reduced Level m AoD
11/2/92			Very stiff blueish grey with some brown slightly weathered silty MARL	
	11.0		with rootlet traces.	2.4
	12.0		Very stiff blueish grey unweathered silty MARL to	1.4
11/2/92			. . . base of borehole at 22.0m	−8.6

Remarks

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RECORD OF BOREHOLE No. 2 1

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 11.7 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
7/2/92	0.3		Topsoil	11.4
	1.0		Firm light orange brown slightly sandy silty CLAY	
	1.8		Stiff yellowish brown sandy silty CLAY with much fine + medium gravel incl. chalk + below 1.5m cobble sized pockets of chalky boulder clay	9.9
	2.8		Medium dense light orange brown SAND with much gravel incl. chalk and occasional clayey pockets (? POCKETY DRIFT)	8.9
	4.0		Stiff becoming very stiff by 3.5m grey brown mottled silty MARL - moderately weathered (GAULT)	7.7
	5.0		Very stiff light blueish grey silty MARL with some brown along laminae - slightly weathered with many traces of rootlets	6.7
	5.5		still traces of roots	6.2
	6.0		Some soft clay smearing on discont.	5.7
	7.0		Some localised iron staining	4.7
	8.0		Very stiff light blueish grey silty MARL with much iron staining on extremely / very closely spaced discontinuities	3.7
	8.5		Very stiff lt. blueish grey unweathered silty MARL to base of borehole at 13.0m	3.2 / -1.3
7/2/92				

Remarks

1. MARL = calcareous clay.
2. Borehole dry throughout.

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RECORD OF BOREHOLE No. 22

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 11.1 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
5/2/92	0.3		Topsoil	10.8
	0.7		Medium dense orange brown clayey SAND with gravel increasing with depth	10.4
	2.1		Medium dense brown slightly clayey SAND & GRAVEL with off white fine SAND inclusions in upper part (? POCKETY DRIFT)	9.0
			Stiff becoming very stiff by 2.5m grey brown mottled mod weathered silty MARL with traces of rootlets (GAULT)	
	4.0		as 2.5m	7.1
	7.0		Very stiff blueish grey silty MARL with iron stained discontinuities - slightly weathered.	4.1
	8.0		Unweathered MARL to . . .	3.1
5/2/92			. . . . base of borehole at 13.0m	-1.9

Remarks

1. MARL = calcareous clay.
2. Borehole dry throughout.

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RECORD OF BOREHOLE No. 25

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 10.1 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
6/2/92	0.4		Topsoil	9.7
	0.9		Stiff greyish brown mottled CLAY with varying sand + a little gravel medium dense lt. orange brown SAND + GRAVEL incl. cobble sized pockets of stiff grey CLAY with much fine + medium gravel incl. chalk (? POCKETY DRIFT)	9.2
	1.9		Very stiff light blueish grey silty MARL weathered light brown on discontinuities and along laminae. (GAULT) with traces of rootlets down to 5.5 m bgl	8.2
			MARL is either thinly laminated or fissured with extremely/very closely spaced discontinuities	
	7.0		Much iron staining on discontinuities	3.1
	8.25		Very stiff light blueish grey silty MARL showing no sign of weathering to base of BH at 13.0 m (-2.9 m AOD)	1.85
6/2/92				

Remarks

1. MARL = calcareous clay.
2. Ground damp between 1.5 and 1.9 mbgl.

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RECORD OF BOREHOLE No. 28

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 11.0 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
4/2/92	0.2		Topsoil	10.7
	1.1		Medium dense brown clayey SAND with a trace of fine gravel incl. chalk	9.9
	1.5		Stiff grey brown mottled silty CLAY with much fine mainly chalk gravel	9.5
	1.8		Medium dense orange brown slightly clayey SAND with much fine & medium gravel (? POCKET DRIFT)	9.2
			Stiff grey brown mottled moderately weathered silty MARL (GAULT)	
	3.0		as 1.8m	8.0
	4.0		Very stiff greybrown mottled etc MARL	7.0
	5.0		as 4.0m	
	6.0		as 4.0m	
	7.0		Very stiff blueish grey unweathered silty MARL to	4.0
4/2/92			. . . base of borehole at 13.0m	-2.0

Remarks

1. MARL = calcareous clay
2. Slight seepage at 1.0m

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RECORD OF BOREHOLE No. 31

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 11.3 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
5/2/92	0.3		Topsoil	11.0
	1.5		Medium dense orange brown slightly clayey SAND with much fine and medium gravel below 1.0m (? POCKETY DRIFT)	9.8
	1.8		Stiff grey brown mottled moderately weathered silty MARL (GAULT)	9.5
	2.8		Stiff blueish grey with a little brown slightly weathered silty MARL	8.5
	3.8		as 2.8m	7.5
	4.8		Very stiff blueish grey unweathered silty MARL to . . .	6.5
5/2/92			. . . base of borehole at 13.0m	-1.7

Remarks

1. MARL = calcareous clay.
2. Borehole dry throughout.

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RECORD OF BOREHOLE No. 32

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 10.9 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
3/2/92	0.6		Topsoil	10.3
	1.8		Medium dense orange brown / yellow mottled clayey SAND + GRAVEL with much chalk (TPOCKETY DRIFT)	9.1
	2.0		Stiff grey brown mottled moderately weathered silty MARL (GAULT)	
	3.0		as 2.0 m	7.9
	4.0		Very stiff blueish grey with some brown slightly weathered silty MARL	6.9
	5.0		Very stiff blueish grey unweathered silty MARL	5.9
	5.8		Body unweathered but iron staining on discontinuities	5.1
	7.0		Unweathered MARL to...	3.9
3/2/92			...base of borehole at 17.0 m	−6.1

Remarks

1. MARL = calcareous clay
2. Slight seepage at 1.3m.

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RECORD OF BOREHOLE No. 37

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 11.3 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
4/2/92	0.35		Topsoil	10.95
	0.65		Stiff light brown sandy CLAY	10.65
	1.00		Stiff grey CLAY with much fine chalk gravel	10.3
	1.9		Medium dense pale yellow slightly clayey SAND with much fine gravel (? POCKETY DRIFT)	9.4
	2.3		Stiff grey brown mottled moderately weathered silty MARL (GAULT)	
	3.5		as 2.3 m	7.8
	4.5		Very stiff blueish grey with some brown slightly weathered silty MARL	6.8
	5.5		Very stiff blueish grey unweathered silty MARL to ...	5.8
4/2/92			... base of borehole at 13.0m	-1.7

Remarks

1. MARL = calcareous clay
2. Borehole dry throughout

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RECORD OF BOREHOLE No. 38

Client Cambridge CC

Contractor Tony Bedford Site

Sheet 1 of 1

Ground Level 11.2 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
6/2/92	0.4		Top soil	10.8
	0.8		Firm light yellowish brown slightly sandy silty CLAY with occ. fine + medium gravel incl. chalk	10.4
	2.0		Stiff grey with some brown silty CLAY with varying amounts of fine mainly chalk gravel (?POCKETY DRIFT)	9.2
	2.5		Very stiff grey brown mottled silty MARL moderately weathered (GAULT)	8.7
			Very stiff light blueish grey silty MARL with some brown on extremely / very closely spaced discontinuities - slightly weathered	
	4.5		with some powdery calcite	6.7
	5.0		traces of plant rootlets	6.2
			Fresh i.e. unweathered MARL	
6/2/92			to base of borehole at 13.0m	-1.8

Remarks

1. MARL = calcareous clay.
2. Borehole dry throughout.

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RECORD OF BOREHOLE No. 4 2

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of 1

Ground Level 12.0 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
6/2/92	0.4		Topsoil	11.6
	0.8		Firm lt. yellowish brown silty sandy CLAY with a little fine + medium gravel incl. chalk	11.2
	1.2		Firm to stiff lt. grey brown mottled silty CLAY with much mainly chalk fine gravel	10.8
	2.0		Medium dense light orange brown slightly clayey SAND with some gravel (? POCKETY DRIFT)	10.0
	3.0		Stiff becoming very stiff by 2.3m grey brown mottled silty MARL - moderately weathered (GAULT)	9.0
	3.5		Very stiff light blueish grey silty MARL with brown on discontinuities and along laminae - slightly weathered traces of plant rootlets	
	4.5		fissured with extremely/very closely spaced discontinuities	
	4.75		Very stiff light blueish grey unweathered silty MARL to base of borehole at 13.0m	-1.0

Remarks

1. MARL = calcareous clay
2. Minor water strike at 1.5m

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RECORD OF BOREHOLE No. 46.

Client Cambridge CC

Contractor Tony Bedford Site Milton Sheet 1 of

Ground Level 11.45 metres AoD Co-ordinates E N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
10/2/92	0.3 0.6		Topsoil Dark brown clay FILL (Drillers description)	11.15 10.85
	0.95		Firm orange brown CLAY(" ")	10.50
	1.9		Medium dense orange brown SAND with much fine gravel & firm light grey sandy CLAY (? POCKETY DRIFT)	9.55
	2.1		Stiff grey brown mottled moderately weathered silty MARL (GAULT)	9.35
	4.0		Very stiff blueish grey with some brown slightly weathered silty MARL	7.45
	5.0		Very stiff blueish grey unweathered silty MARL	6.45
	5.8		Body unweathered but iron staining on discontinuities	5.65
			Unweathered MARL to	
10/2/92			....base of borehole at 13.0m	-1.55

Remarks

1. MARL = calcareous clay.
2. Borehole dry throughout.

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RECORD OF BOREHOLE No. W 3

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 1 of 2

Ground Level 11.2 metres AoD Co-ordinates 728.24 E 624.62 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
21/3/92	2.15		Clayey SAND + GRAVEL (? POCKETY DRIFT)	9.05
			Blueish grey silty CLAY (GAULT)	
21/3/92	20.0		Borehole not complete	

Remarks

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RECORD OF BOREHOLE No. W 3

Client Cambridge C C

Contractor Centaur Drilling Site Milton Sheet 2 of 2

Ground Level 11.2 metres AoD Co-ordinates E N

Daily Progress	Depth 20 om	Legend	Description of Strata	Reduced Level m AoD
2/3/92			Blueish grey silty CLAY (GAULT)	
2/3/92	27.90			
3/3/92				
	30.90			−19.7
			Greenish grey glauconitic SAND (LOWER GREENSAND)	
	32.20	- - -	- - - - - - - - - -	−21.0
			Light grey silty CLAY	
	33.60	- - -	Fine & medium GRAVEL	−22.4
	34.05	- - -		−22.85
			Greenish grey glauconitic SAND	
	36.0	- - -	Light grey silty CLAY	−24.8
	36.45	- - -		−25.25
	37.15		Greenish grey glauconitic SAND	−25.95
			Light grey silty CLAY (KIMMERIDGE CLAY)	
3/3/92	39.50		Base of Borehole	−28.3

Remarks
1. Minor water strike at 25.60m bgl
2. Major " " " 30.05 "
3. Ground water level 11.30am 3/3/92 19.43 "

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RECORD OF BOREHOLE No. W4

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 1 of 2

Ground Level 11.1 metres AoD Co-ordinates 664.06 E 879.27 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
5/3/92	1.7		Clayey SAND and GRAVEL (? POCKETY DRIFT)	9.4
			Blueish grey silty CLAY (GAULT)	
5/3/92	20.0		Borehole not complete	

Remarks

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RECORD OF BOREHOLE No. W 4

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 2 of 2

Ground Level 11.1 metres AoD Co-ordinates E N

Daily Progress	Depth 2.00 m	Legend	Description of Strata	Reduced Level m AoD
6/3/92			Blueish grey silty CLAY (GAULT)	
	28.0			−16.9
			Greenish grey glauconitic SAND (LOWER GREENSAND)	
	31.0			−19.9
	31.75		Greenish grey glauconitic SANDSTONE	−20.65
			Greenish grey glauconitic SAND	
	33.7			−22.6
			Light grey silty CLAY with thin coal (KIMMERIDGE CLAY)	
6/3/92	36.25		Base of Borehole	−25.15

Remarks Major water strike at 28.0 m

PETER SCOTT Consultant Engineering Geologist
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RECORD OF BOREHOLE No. W 5

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 2 of 2

Ground Level 10.30 metres AoD Co-ordinates E N

Daily Progress	Depth 20.0 m	Legend	Description of Strata	Reduced Level m AoD
			Clays (GAULT)	
	27.30			-17.00
			Sands (LOWER GREENSAND)	
	29.30		Sandstone	
	30.00			-19.70
			Sands	
	31.80			-21.50
			Clay (KIMMERIDGE CLAY)	
			Base of Borehole	
	33.80			-23.50

Remarks

Water strike not recorded in drillers log, but presumed to have occurred on reaching the Greensand.

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RECORD OF BOREHOLE No. W S

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 1 of 2

Ground Level 10.30 metres AoD Co-ordinates 744.06 E 1171.74 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
9/3/92	1.80		Sands & Gravel (?POCKETY DRIFT)	8.50
			Clays (GAULT)	
9/3/92	20.0		Borehole not complete	

Remarks

Driller's descriptions, my interpretations.

PETER SCOTT Consultant Engineering Geologist
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RECORD OF BOREHOLE No. W 7

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 1 of 2

Ground Level 12.1? metres AoD Co-ordinates ? E ? N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
11/3/92	1.70		Sands/ gravels (?POCKETY DRIFT)	
			Clays (GAULT)	
11/3/92	20.0			

Remarks

Driller's description, my interpretation.

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RECORD OF BOREHOLE No. W 7

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 2 of 2

Ground Level 12.1? metres AoD Co-ordinates ? E ? N

Daily Progress	Depth 20.0 m	Legend	Description of Strata	Reduced Level m AoD
11/3/92			Clays (GAULT)	
11/3/92	26.5			
12/3/92			Sands (LOWER GREENSAND)	
	29.0			
	30.0		Clay	
			Sands	
	31.4			
			Clay (KIMMERIDGE CLAY)	
12/3/92	33.4		Base of Borehole	

Remarks

Driller's log does not record a water strike but it is presumed that water was encountered on reaching the Greensand.

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RECORD OF BOREHOLE No. W 8

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 1 of 2

Ground Level 12.0 metres AoD Co-ordinates 271.251 E 433.27 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
25/2/92			Topsoil Clays Gravel (?POCKETY DRIFT)	
	2.8			9.2
			Clays (GAULT)	
25/2/92	16.0			
26/2/92				
26/2/92	20.0		Borehole not complete	

Remarks

Driller's descriptions, my interpretations.

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RECORD OF BOREHOLE No. W 8

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 2 of 2

Ground Level 12.0 metres AoD Co-ordinates E N

Daily Progress	Depth 28.0 m	Legend	Description of Strata	Reduced Level m AoD
26/2/92			Clays (GAULT)	
	27.20			-15.20
26/2/92 27/2/92	28.0		Greensands (LOWER GREENSAND)	
	32.10		Cemented band. Fine gravels	-20.10
	32.75			-20.75
			Clays (KIMMERIDGE CLAY)	
	34.20			-22.20

Remarks

Water strike not recorded in driller's log, but presumed to have occurred on reaching the Greensand.

PETER SCOTT Consultant Engineering Geologist
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RECORD OF BOREHOLE No. W 6

Client Cambridge C C

Contractor Centaur Drilling Site Milton Sheet 1 of 2

Ground Level 11.25 metres AoD Co-ordinates 552.71 E 1273.28 N

Daily Progress	Depth m	Legend	Description of Strata	Reduced Level m AoD
4/3/92	2.10		Clayey SAND & GRAVEL (?POCKETY DRIFT)	9.05
			Blueish grey silty CLAY (GAULT)	
4/3/92	20.0		Borehole not complete	

Remarks

PETER SCOTT Consultant Engineering Geologist
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RECORD OF BOREHOLE No. W6

Client Cambridge CC

Contractor Centaur Drilling Site Milton Sheet 2 of 2

Ground Level 11.25 metres AoD Co-ordinates E N

Daily Progress	Depth 20.0 m	Legend	Description of Strata	Reduced Level m AoD
4/3/92			Blueish grey silty CLAY (GAULT)	
	26.30		? Nodule bed	-15.05
	27.00		Greenish grey glauconitic SAND (LOWER GREENSAND)	-15.75
	29.00			-17.75
	29.70		Greenish grey glauconitic SANDSTONE	-18.45
	31.50		Greenish grey glauconitic SAND	-20.25
4/3/92	33.50		Light grey silty CLAY (KIMMERIDGE CLAY) Base of Borehole	-22.25

Remarks Major water strike at 27.0m bgl

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CAUSEWAY GEOTECH

Project No.	Project Name: A14 Section 5 Milton Landfill Groundwater Well Replacement	Borehole ID
20-0525	Client: A14	BH12R
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)
Rotary Drilling	Comacchio 601	0.00	2.50
Rotary Coring	Comacchio 601	2.50	5.50
Rotary Drilling	Comacchio 601	5.50	10.00
Rotary Coring	Comacchio 601	10.00	20.00

Coordinates: 546910.60 E, 262251.85 N

Final Depth: 20.00 m | Start Date: 08/10/2020 | Driller: JG | Sheet 1 of 3 | Scale: 1:50

Elevation: 16.28 mOD | End Date: 09/10/2020 | Logger: TMcl | FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description
					16.03	0.25		TOPOSIL
								MADE GROUND: Soft to firm greyish brown slightly andy slightly gravelly CLAY. Sand is fine. Gravel is angular to subangular fine to medium of mixed lithologies.
					15.08	1.20		Possible MADE GROUND: Firm grey slightly sandy slightly gravelly silty CLAY. Sand is fine. Gravel is angular to subangular fine to medium of flint and chalk.
		0 0 0			13.78	2.50		Orangish brown clayey sandy subangular to subrounded fine to coarse GRAVEL of various lithologies. Sand is fine to medium.
4.00		0 0 0				(3.00)		
5.50					10.78	5.50		Firm grey slightly sandy silty CLAY with rare angular to subangular fine to medium gravel.

Water | Backfill

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
10.00	200
20.00	150

Water Added

From (m)	To (m)

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L/SK6L	Water/Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name: A14 Section 5 Milton Landfill Groundwater Well Replacement	Borehole ID
20-0525	Client: A14	BH12R
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Rotary Drilling	Comacchio 601	0.00	2.50	
Rotary Coring	Comacchio 601	2.50	5.50	546910.60 E
Rotary Drilling	Comacchio 601	5.50	10.00	262251.85 N
Rotary Coring	Comacchio 601	10.00	20.00	

Final Depth:	20.00 m	Start Date:	08/10/2020	Driller:	JG	Sheet 2 of 3
Elevation:	16.28 mOD	End Date:	09/10/2020	Logger:	TMcl	Scale: 1:50
						FINAL

Depth (m)	Sample / Tests	Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
									6.78	9.50		Firm grey slightly sandy silty CLAY with rare angular to subangular fine to medium gravel. Stiff to very stiff light grey silty CLAY.		
			0	0	0					(2.00)				
11.50									4.78	11.50		Very stiff light grey silty CLAY.		
			0	0	0					(1.00)				
12.50									3.78	12.50		Stiff locally firm thickly laminated grey silty CLAY.		
			100	97						(1.20)				
									2.58	13.70		Very stiff locally stiff thickly laminated grey silty CLAY.		
14.00														
			91	78						(2.00)				
15.50														
									0.58	15.70		Very stiff thinly laminated grey silty CLAY.		
			100	99										
17.00										(4.30)				
			100	99										
18.50														

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
10.00	200		
20.00	150		

Remarks

Hand dug inspection pit to 1.20m

Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L/SK6L	Water/Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0525	A14 Section 5 Milton Landfill Groundwater Well Replacement	BH12R
	Client: A14	
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)
Rotary Drilling	Comacchio 601	0.00	2.50
Rotary Coring	Comacchio 601	2.50	5.50
Rotary Drilling	Comacchio 601	5.50	10.00
Rotary Coring	Comacchio 601	10.00	20.00

Coordinates: 546910.60 E, 262251.85 N

Final Depth: 20.00 m | Start Date: 08/10/2020 | Driller: JG | Sheet 3 of 3 | Scale: 1:50

Elevation: 16.28 mOD | End Date: 09/10/2020 | Logger: TMcl | FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
		100	100								Very stiff thinly laminated grey silty CLAY.		
20.00								-3.72	20.00		End of Borehole at 20.00m		
		TCR	SCR	RQD	FI								

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
10.00	200
20.00	150

Water Added

From (m)	To (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L/SK6L	Water/Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name: A14 Section 5 Milton Landfill Groundwater Well Replacement	Borehole ID
20-0525	Client: A14	BH-W01R
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth: 43.50 m	Start Date: 10/10/2020	Driller: JG	Sheet 1 of 5
Rotary Drilling	Comacchio 601	0.00	29.50	546520.24 E				Scale: 1:50
Rotary Coring	Comacchio 601	29.50	43.50	262188.85 N	Elevation: 12.44 mOD	End Date: 13/10/2020	Logger: TMcl	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
					12.19	0.25		TOPSOIL		
								MADE GROUND: Soft to firm brownish grey slightly sandy gravelly CLAY. Sand is fine. Gravel is angular to subangular fine to medium of flint, chalk and mudstone.		
					11.34	1.10		MADE GROUND: Firm brownish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is angular to subangular fine to medium of flint and mudstone.		
					10.44	2.00		Orangish brown slightly clayey gravelly fine to medium SAND. Gravel is subangular to subrounded fine to coarse of various lithologies.		
					9.44	3.00		Firm grey slightly sandy silty CLAY. Sand is fine.		

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
29.50	200
43.50	150

Water Added

From (m)	To (m)

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0525	A14 Section 5 Milton Landfill Groundwater Well Replacement	BH-W01R
	Client: A14	
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 2 of 5
Rotary Drilling	Comacchio 601	0.00	29.50	546520.24 E	43.50 m	10/10/2020	JG	Scale: 1:50
Rotary Coring	Comacchio 601	29.50	43.50	262188.85 N	Elevation: 12.44 mOD	End Date: 13/10/2020	Logger: TMcl	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								Firm grey slightly sandy silty CLAY. Sand is fine.		
					0.44	12.00		Stiff thinly laminated grey silty CLAY		

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
29.50	200
43.50	150

Water Added

From (m)	To (m)

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0525	A14 Section 5 Milton Landfill Groundwater Well Replacement	BH-W01R
	Client: A14	
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)	Coordinates	Final Depth:	Start Date:	Driller:	Sheet 3 of 5
Rotary Drilling	Comacchio 601	0.00	29.50	546520.24 E	43.50 m	10/10/2020	JG	Scale: 1:50
Rotary Coring	Comacchio 601	29.50	43.50	262188.85 N	Elevation: 12.44 mOD	End Date: 13/10/2020	Logger: TMcl	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								Stiff thinly laminated grey silty CLAY		
					-9.56	22.00		Very stiff thinly laminated locally fissured grey silty CLAY with rare shell fragments.		

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
29.50	200		
43.50	150		

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0525	A14 Section 5 Milton Landfill Groundwater Well Replacement	BH-W01R
	Client: A14	
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Rotary Drilling	Comacchio 601	0.00	29.50	546520.24 E
Rotary Coring	Comacchio 601	29.50	43.50	262188.85 N

Final Depth:	43.50 m	Start Date:	10/10/2020	Driller:	JG	Sheet 4 of 5
Elevation:	12.44 mOD	End Date:	13/10/2020	Logger:	TMcl	Scale: 1:50
						FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
								Very stiff thinly laminated locally fissured grey silty CLAY with rare shell fragments.		
		TCR 100 SCR 100 RQD 0			-18.06	30.50				
31.00								Dark grey locally dark orangish brown slightly gravelly clayey fine to medium SAND. Gravel is subangular to subrounded fine of various lithologies.		
		TCR 100 SCR 99 RQD 0								
32.50						(4.00)				
		TCR 93 SCR 73 RQD 0								
34.00										
		TCR 77 SCR 54 RQD 52 FI 3			-22.06	34.50		Extremely weak to very weak thinly bedded medium grained weakly cemented greenish grey SANDSTONE. Largely unweathered. Discontinuities: 1.0 to 10 degree bedding fractures, medium spaced (20/200/550), undulating, rough.		
35.50								*No Recovery - Zone of assumed core loss*		
		TCR 0 SCR 0 RQD 0				(3.10)				

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
29.50	200		
43.50	150		

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Water	Terminated by Engineer at scheduled depth	02/11/2020

AGS

CAUSEWAY GEOTECH

Project No.	Project Name:	Borehole ID
20-0525	A14 Section 5 Milton Landfill Groundwater Well Replacement	BH-W01R
	Client: A14	
	Client's Rep: Atkins	

Method	Plant Used	Top (m)	Base (m)
Rotary Drilling	Comacchio 601	0.00	29.50
Rotary Coring	Comacchio 601	29.50	43.50

Coordinates: 546520.24 E, 262188.85 N

Final Depth: 43.50 m | Start Date: 10/10/2020 | Driller: JG | Sheet 5 of 5 | Scale: 1:50

Elevation: 12.44 mOD | End Date: 13/10/2020 | Logger: TMcl | FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mOD	Depth (m)	Legend	Description	Water	Backfill
37.50								-25.06	37.50		Extremely weak to very weak thinly bedded medium grained weakly cemented greenish grey SANDSTONE. Largely unweathered. Discontinuities: 1.0 to 10 degree bedding fractures, medium spaced (20/200/550), undulating, rough.		
		40	32	0							Extremely weak decomposed SANDSTONE recovered as greenish grey slightly clayey fine to medium SAND. [LOW RECOVERY]		
39.00									(4.25)		*No Recovery - Zone of assumed core loss*		
		0	0	0									
40.50													
		27	0	0									
								-29.31	41.75		Very stiff thinly laminated grey silty CLAY with occasional rare shell fragments.		
42.00													
		87	85	0					(1.75)				
43.50								-31.06	43.50		End of Borehole at 43.50m		
		TCR	SCR	RQD	FI								

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
29.50	200
43.50	150

Water Added

From (m)	To (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Hand dug inspection pit to 1.20m
Standpipe Installation (100mm diameter)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Water	Terminated by Engineer at scheduled depth	02/11/2020

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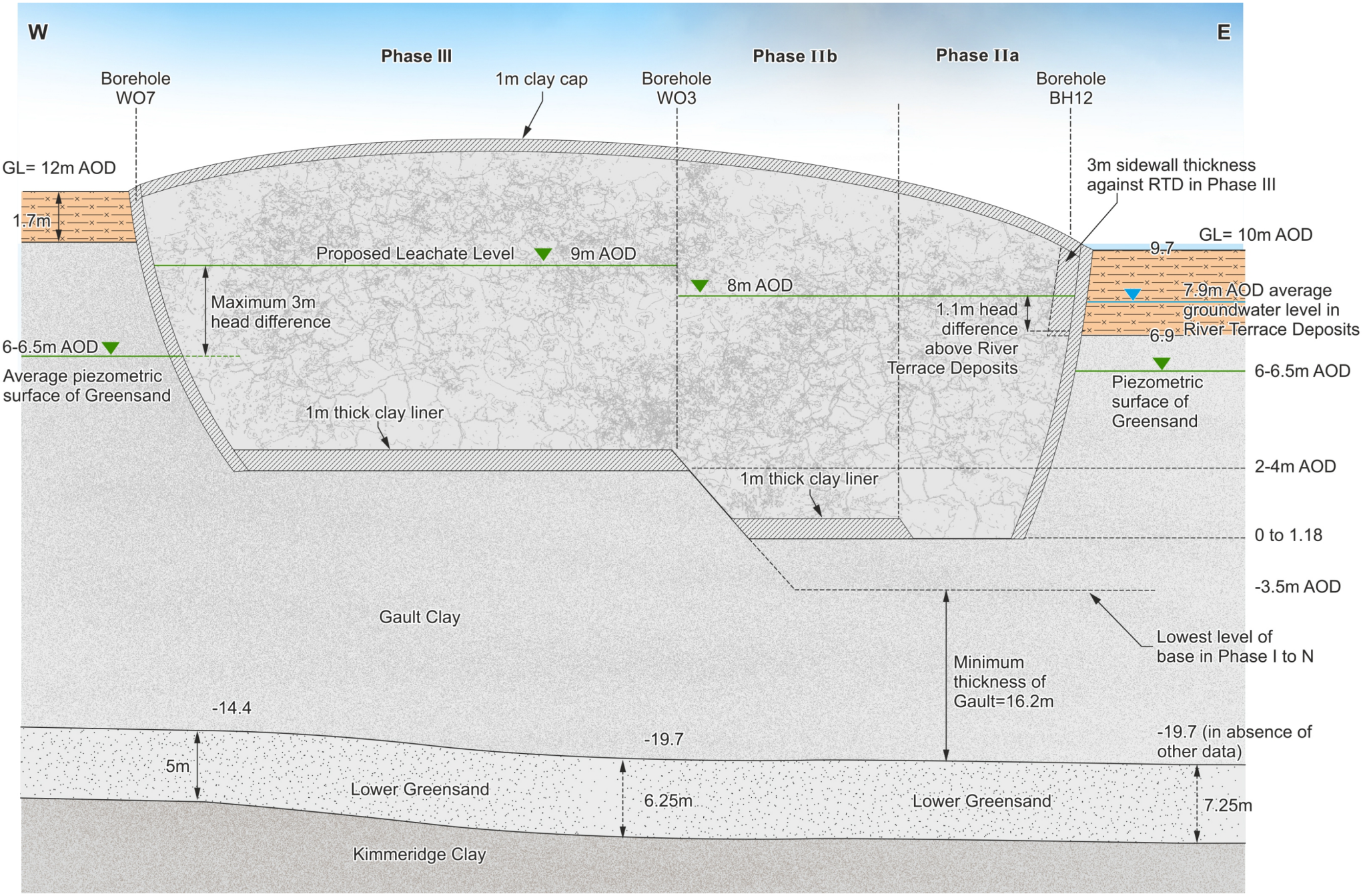
APPENDIX 2

Conceptual Cross Section



McDonnell Cole	Scale: N.T.S. Size: A4 Date: Dec 2019 By: CW	Site Name: **Milton Landfill Site** Drawing Title: **Appendix 1**	Figure No. **Job No 1714**

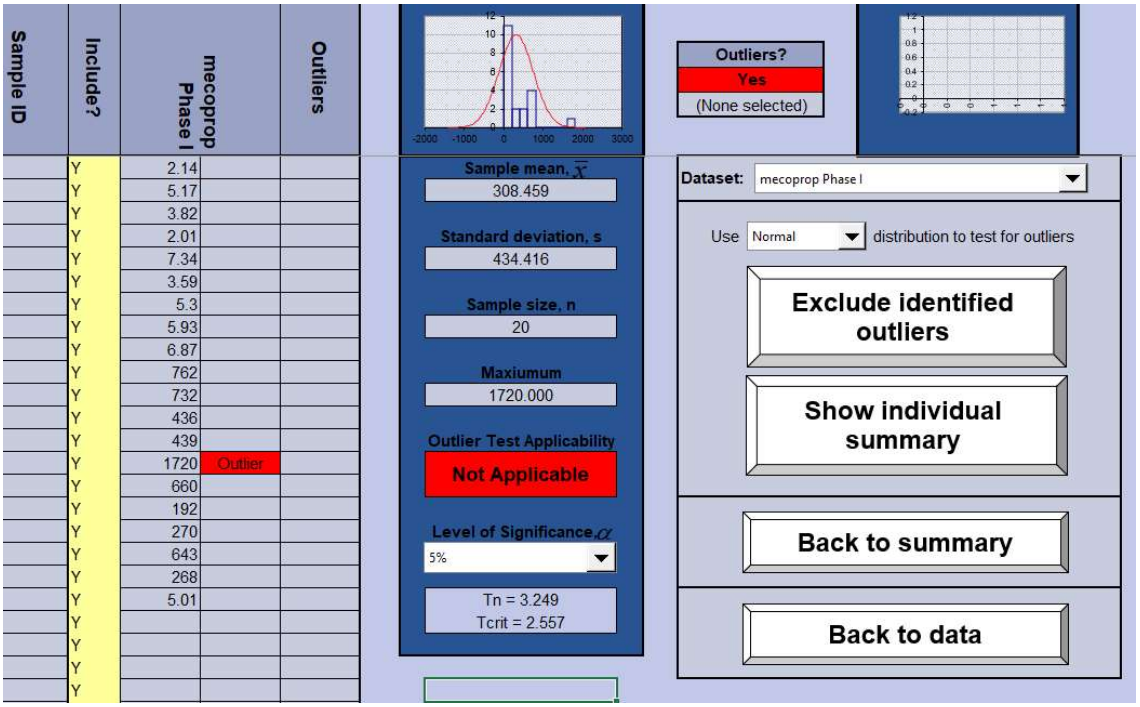
APPENDIX 3

ESI Statistics Calculator

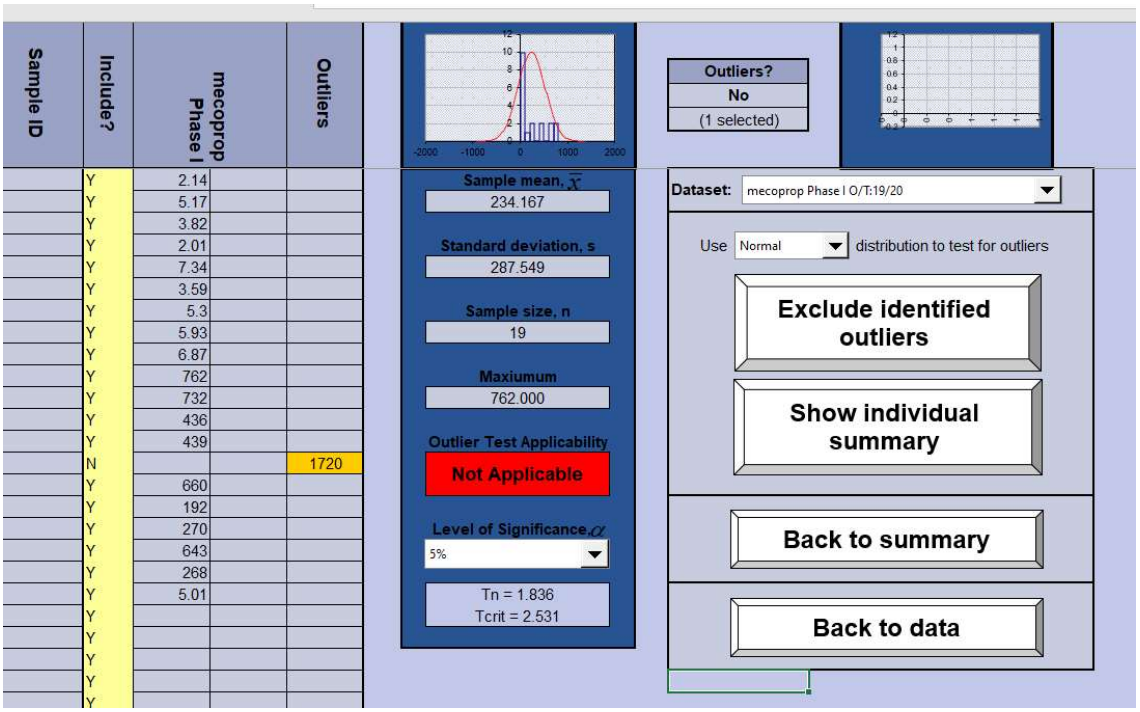
APPENDIX 3

ESI Statisics Calculator extracts

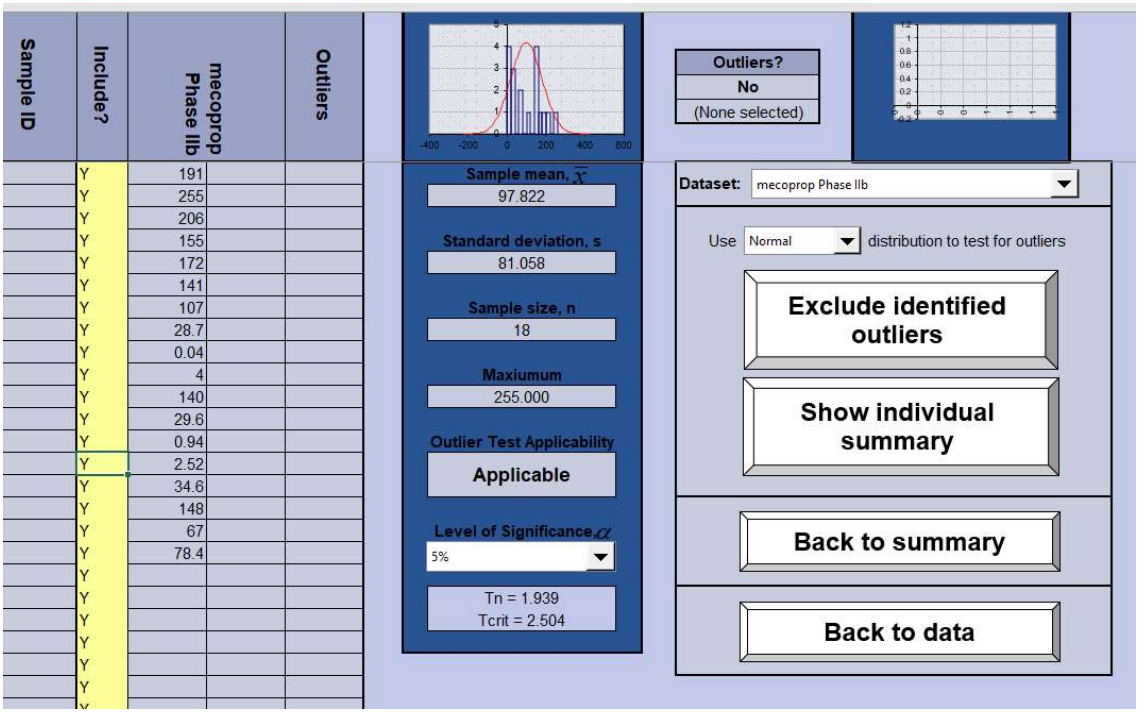
Assessment of Phase 1 data for mecoprop



Data with outlier removed



Assessment of Phase IIb data for mecoprop



APPENDIX 4

New Borehole Monitoring Data

Borehole	Date	Alkalinity	Ammoniac	Benzene ((	Cadmium	Calcium (D	Chloride (r	Chromium	Conductiv	Copper (D	Ethyl Benz	Iron (Diss)	Lead (Diss	m,p-xylen	Magnesiu	Manganes	MCPP (Me	Nickel (Dis	o-xylene ((	pH (Lab)	Potassium	Sodium (D	Toluene (u	Total Sulp	Total Xyle	Zinc (Diss) (mg/l)
BH12R	06/01/2021 00:00		3		<0.00002		101	<0.001	1750								0.11			7						0.005
BH12R	14/01/2021 00:00		2.3		<0.00002		117	<0.001	1700								0.15			7.1						0.006
BH12R	21/01/2021 09:30		2.3		<0.00002		116	<0.001	1690								0.15			7.3						0.002
BH12R	29/01/2021 00:00		3.3		0.00003		108	<0.001	1790								0.06			7						<0.002
BH12R	03/02/2021 00:00		2.9		0.00006		105	<0.001	1720								0.07			7.1						0.007
BH12R	12/02/2021 00:00		2.6		<0.00002		101	<0.001	1640								0.06			7.2						0.006
BH12R	19/02/2021 00:00		2.3		0.00009		95	<0.001	1570								0.05			7.6						0.012
BH12R	23/02/2021 00:00		2.1		<0.00002		95	<0.001	1510								0.05			7.5						0.006
BH12R	01/03/2021 00:00		1.8		<0.00002		95	<0.001	1540								0.05			7.1						0.006
BH12R	09/03/2021 00:00		2.1		0.00002		93	<0.001	1460								0.06			7.6						0.01
BH12R	16/03/2021 00:00		1.6		<0.00002		77	<0.001	1420								0.04			7.1						0.007
BH12R	22/03/2021 00:00		1.5		0.00006		96	<0.001	1480								0.05			7.4						0.008
BH12R	29/03/2021 00:00		1.5		<0.00002		100	<0.001	1460								0.05			7.5						0.004
BH12R	07/04/2021 00:00		1.8		<0.00002		101	<0.001	1440								0.03			7.1						0.016
BH12R	19/04/2021 00:00		1.4		<0.00002		152	<0.001	1590								0.03			7.3						0.004
BH12R	29/04/2021 00:00		1.8		<0.00002		100	<0.001	1460								0.03			7.7						0.009
BH12R	04/05/2021 00:00		1.7		0.00007		102	<0.001	1480								0.03			7.4						0.008
BH12R	14/05/2021 00:00		2.2		<0.00002		102	<0.001	1500								0.03			7.1						0.008
BH12R	19/05/2021 00:00		1.7		0.00005		98	<0.001	1490								0.03			7.1						0.005
BH12R	04/06/2021 00:00		2.5		0.00003		100	<0.001	1540								0.03			7.3						0.003
BH12R	15/06/2021 00:00	697	2.7	<1	0.00008	265	108	<0.001	1550	0.005	<1	0.01	<0.001	<1	31	1.24	0.03	0.012	<1	7.3	16	74	<1	286	<2	0.002
BH12R	16/06/2021 00:00		2.7		0.00004		107	<0.001	1560								0.04			7.4						0.007
BH12R	25/06/2021 00:00		2.7		0.00004		102	<0.001	1520								0.05			7						0.005
BH12R	01/07/2021 00:00		2.7		<0.00002		108	<0.001	1470								0.03			7.3						0.006
BH12R	07/07/2021 00:00		2.6		0.00007		105	<0.001	1540								0.03			7.2						0.005
BH12R	23/07/2021 00:00		2.6		0.00006		101	<0.001	1470								0.04			7.1						0.008
BH12R	27/07/2021 00:00		2.7		0.00004		103	<0.001	1490								0.03			7.2						0.005
BH12R	02/08/2021 00:00		2.6		<0.00002		103	<0.001	1470								0.05			7.1						<0.002
BH12R	23/08/2021 00:00		2.3		0.00002		100	<0.001	1500								0.03			7.5						0.01
BH12R	31/08/2021 00:00		2.4		<0.00002		101	<0.001	1500								0.04			7.1						0.004
BH12R	08/09/2021 00:00		1.4		<0.00002		81	<0.001	1230								0.03			7.2						0.002
BH12R	19/10/2021 00:00		3.5		<0.00002		91	<0.001	1470								0.05			7.2						0.02
BH12R	01/11/2021 00:00		3.6		<0.00002		86	<0.001	1410								0.05			7						0.004
BH12R	23/12/2021 00:00		4.2		<0.00002		90	<0.001	1580								0.05			7.4						0.002
BH12R	28/01/2022 00:00		3.9		0.00005		97	<0.001	1510								0.04			7.3						0.003
W01R	06/01/2021 00:00		0.5		<0.00002		56	<0.001	1030								<0.02			7.9						<0.002
W01R	14/01/2021 00:00		0.5		<0.00002		55	<0.001	1030								<0.02			7.8						<0.002
W01R	21/01/2021 11:00		0.5		<0.00002		54	<0.001	1030								<0.02			8						0.011
W01R	29/01/2021 00:00		0.6		<0.00002		55	<0.001	1030								<0.02			7.8						<0.002
W01R	03/02/2021 00:00		0.5		0.00003		54	<0.001	1020								<0.02			7.8						<0.002
W01R	12/02/2021 00:00		0.6		<0.00002		54	<0.001	1030								<0.02			7.9						<0.002
W01R	19/02/2021 00:00		0.5		<0.00002		53	<0.001	1020								<0.02			8						<0.002
W01R	23/02/2021 00:00		0.6		<0.00002		50	<0.001	1040								<0.02			8.2						<0.002
W01R	01/03/2021 00:00		0.6		<0.00002		51	<0.001	1010								<0.02			7.9						0.002
W01R	09/03/2021 00:00		0.6		0.00008		53	<0.001	1010								<0.02			8						<0.002
W01R	16/03/2021 00:00		0.7		<0.00002		54	<0.001	1020								<0.02			7.9						<0.002
W01R	22/03/2021 00:00		0.5		0.00007		52	<0.001	1020								<0.02			8.1						<0.002
W01R	29/03/2021 00:00		0.6		<0.00002		52	<0.001	1010								<0.02			8						<0.002
W01R	07/04/2021 00:00		0.6		<0.00002		52	<0.001	987								<0.02			7.8						0.004
W01R	19/04/2021 00:00		0.5		<0.00002		53	<0.001	1020								<0.02			8						<0.002
W01R	29/04/2021 00:00		0.6		<0.00002		46	<0.001	1010								<0.02			8.1						0.004
W01R	30/04/2021 00:00		0.5		<0.00002		48	<0.001	1020								<0.02			8						0.002
W01R	04/05/2021 00:00		0.5		<0.00002		58	<0.001	1030								<0.02			8						<0.002
W01R	14/05/2021 00:00		0.6		<0.00002		58	<0.001	1020								<0.02			7.8						0.003
W01R	19/05/2021 00:00		0.5		<0.00002		54	<0.001	1030								<0.02			7.8						<0.002
W01R	04/06/2021 00:00		0.5		0.00002		53	<0.001	1030								<0.02			8						<0.002
W01R	15/06/2021 00:00	190	0.5	<1	<0.00002	62	57	<0.001	1010	<0.001	<1	<0.01	<0.001	<1	25	0.011	<0.02	0.002	<1	8	23	117	<1	259	<2	<0.002
W01R	16/06/2021 00:00		0.5		<0.00002		60	<0.001	1020								<0.02			8						<0.002
W01R	25/06/2021 00:00		0.19		<0.00002		66	<0.001	1020								<0.02			7.6						0.008
W01R	01/07/2021 00:00		0.5		<0.00002		59	<0.001	1010								<0.02			7.9						0.002
W01R	07/07/2021 00:00		0.5		<0.00002		58	<0.001	1020								<0.02			7.7						0.002
W01R	23/07/2021 00:00		0.5		<0.00002		58	<0.001	1010								<0.02			7.8						0.002
W01R	27/07/2021 00:00		0.5		<0.00002		56	<0.001	1020								<0.02			7.5						<0.002
W01R	02/08/2021 00:00		0.6		<0.00002		56	<0.001	1020								<0.02			7.5						0.002
W01R	23/08/2021 00:00		0.5		0.00003		57	<0.001	1010								<0.02			8						0.008
W01R	31/08/2021 00:00		0.14		<0.00002		65	<0.001	1030								0.05			7.7						0.014
W01R	08/09/2021 00:00		0.4		<0.00002		57	<0.001	1010								<0.02			7.7						<0.002
W01R	19/10/2021 00:00		0.08		<0.00002		66	<0.001	976								<0.02			7.7						0.017
W01R	01/11/2021 00:00		0.6		<0.00002		56	<0.001	947								<0.02			7.8						0.012
W01R	23/12/2021 00:00		<0.01		<0.00002		66	<0.001	1000								<0.02			8						<0.002
W01R	28/01/2022 00:00		0.14		0.00005		57	<0.001	979								<0.02			8.1						<0.002