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Stability risk assessment

RATTLECHAIN SLUDGE LAGOON

STABILITY RISK ASSESSMENT (PHASE I)

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EXECUTIVE SUMMARY

This report presents the findings of the desk study or 'Phase I' Stability Risk Assessment (SRA) for the Rattlechain Sludge Lagoon, located near Oldbury, West Midlands.

URS has prepared this report on behalf of Rhodia Consumer Specialties Limited, and is proposed to be incorporated into the Integrated Pollution Prevention and Control (IPPC) authorisation application.

The Rattlechain lagoon is contained within a former clay pit and is currently used for the disposal of calcium phosphate slurry generated by the Rhodia plant located in Oldbury. The lagoon is bounded by earth embankments located to the northeast, east and west of the lagoon and gradually reduce in height towards the south. The embankments are located above the level of the lagoon and do not contribute to the integrity of the lagoon.

This report focuses on stability issues associated with the geometry and material characteristics of each element of the lagoon. These comprise the following elements:

- *Basal Sub-Grade;*
- *Side Slope Sub-Grade;*
- *Basal Lining System;*
- *Side Slope Lining System;*
- *Waste Mass; and,*
- *Capping System.*

A conceptual model was developed for each of these elements, allowing URS to complete a risk screening exercise and provide an initial stability assessment.

URS carried out a stability study of the north eastern embankment between February and May 2004, which included an intrusive investigation and land surface topographic monitoring of the embankment. The investigation was undertaken primarily to assess the potential of a slope failure impacting on the Birmingham Canal, which is located on top of the embankment and approximately 40-50m from the embankment crest.

The report concluded that a deep-seated catastrophic failure of the north eastern embankment that could impact on the canal was considered unlikely.

The potential for shallow slips on the face of the north eastern embankment was considered possible, however it was considered unlikely that these would impact on the overall stability of the embankment. Monitoring of 54 surveying pegs over a 4 month period indicated little evidence of significant slope creep. In addition, since the lagoon is contained within a former clay pit, a potential failure of the embankment would have little impact on the containment of the lagoon.

A review of the Stability Assessment Report of the North Eastern Embankment of the Rattlechain Lagoon, and the Restoration of the Rattlechain Sludge Lagoon Options Study Report, provided sufficient information to assess the potential risks of a slope failure of the aforementioned elements of the lagoon. Based on the available information a failure of base, side slopes, waste and cap are considered unlikely. As such additional investigation and assessment of the lagoon for slope stability purposes should not be required to address the requirements of IPPC. A periodic walkover of the site is recommended to visually monitor the shallow slips observed on the northern embankment.

1. INTRODUCTION

URS Corporation Ltd (URS) was requested by Rhodia Consumer Specialties Limited (Rhodia) to complete a Phase I Stability Risk Assessment (SRA) of the Rattlechain Sludge Lagoon, located near Oldbury West Midlands (the site).

The SRA Report forms part of the application process for the Pollution Prevention and Control (PPC) Authorisation for operating landfills.

Under the Landfill Regulation 2003 facilities have been operating under a Waste Management Licence. The facilities now operate under the Integrated Pollution and Prevention Control (IPPC) regime and are required to apply for a PPC permit to continue operation as a landfill.

This SRA has been completed to address the requirements of Part B of the Application Form for the Landfill Sector, and Section C: Stability Risk Assessment Report Guidelines of the Environmental Agency.

This Phase I SRA presents the conceptual model, and risk screen of the structural elements of the landfill lagoon and the waste sludge. Elements of the lagoon that have been assessed are presented as follows:

- Basal Sub-grade;
- Side Slopes Sub-Grade;
- Basal Lining System;
- Side Slope Lining System;
- Waste Mass Model; and
- Capping System.

1.1. Previous Reports and Additional Sources of Information

In producing this Stability Risk Assessment Report URS has reviewed the following sources of information:

- Cremer & Warner, 'Findings of the Site Investigation (1990-91) ref C333/1, Report no. 91164, dated 12 June 1991;
- URS Corporation Ltd., Options Study for Restoration of the Rattlechain Sludge Lagoon, Ref. 1064/44557-020-787/JC/rc, dated 20 March 2002;

- URS Corporation Ltd., Slope Stability Assessment of the North Eastern Embankment of the Rattlechain Lagoon, Ref 44557-041/RJC, dated 21 September 2004 and,
- URS Corporation Ltd., Additional Investigation and Monitoring of the Rattlechain Lagoon R0487/44557-041-786/LJ/IH/RA/REV1, dated 10 May 2004.
- British Geological Survey (BGS) 1:50,000 Sheet 168 (Birmingham, solid and drift, 1996); and,
- Groundwater Vulnerability 1:100,000 Map of South Staffordshire and East Shropshire, Sheet 22, Environment Agency 1997.

1.2. Site Description and History

The site is located approximately 3.5km to the east of Dudley and 3km south of West Bromwich at approximate National Grid Reference SO 974 913, in the Borough of Sandwell, see Figure 1.

The site comprises an area of approximately 200m by 300m, of which the lagoon covers an area of 150m by 250m; and lies adjacent to Johns Lane within Vaughan Trading Estate; a plan map of the lagoon is given in Figure 2.

The regional topographic map (Ordnance Survey, Landranger, Sheet 139, Birmingham and Wolverhampton Area 1:50,000) indicates that the site lies at an elevation of approximately 130m above Ordnance Datum (m AOD).

The Rattlechain waste lagoon is currently used for the disposal of slurry wastes from the Rhodia production plant situated 3km away, in Oldbury, and transported to the lagoon by tanker, delivering an average of 8 loads per day.

The lagoon is divided into two areas: a large central area (Main Lagoon), into which the waste slurry is discharged by a floating pipe from the southern embankment; and, a smaller lagoon to the west (Secondary Lagoon), separated from the main area by a gravel causeway. Water is pumped from the smaller lagoon and discharged into the Birmingham Canal, located on top of the north eastern embankment. Pumping of this secondary lagoon maintains the water level at approximately 126m AOD.

The lagoon is bounded by sloping embankments to the north-northeast, east and west. These grade southwards to the lower south shore of the lagoon. The embankments are constructed from granular fill material, comprising predominantly granular fill of ash, clinker and brick fragments and are located above the level of the lagoon. The embankments are constructed above the level of the lagoon on the Etruria Marl and do not contribute to the integrity of the lagoon.

Prior to 1948, the site was used as a clay pit and brickworks. In 1948 the site was purchased by Albright and Wilson (A&W) and has since been used for the storage of the

waste calcium phosphate. Until 1970 waste was delivered by barge by the Birmingham Canal and pumped from the north embankment into the lagoon.

From 1970 to present day, waste slurry is and was delivered by road tanker and fed into the lagoon by a floating pipe to avoid the occurrence of "waste islands" in the lagoon.

The waste is considered to comprise predominantly of inert calcium phosphate, however historically some elemental phosphorus was also present. To reduce the potential for a reaction between the phosphorus and the air, the waste is stored under water. This reduces the potential for the release of toxic fumes.

Anecdotal evidence also suggests the potential presence of drums of chemicals, contaminated brickwork and scrap machinery.

1.3. Site Geology

The British Geological Survey (BGS) 1:50,000 map, (Sheet 168 Birmingham, solid and drift, 1996) indicates that the site is located on the Etruria Formation mudstone (Etruria Marl).

1.3.1. Previous Site Investigations

This anticipated ground sequence was confirmed by Cremer & Warner 'Findings of the Site Investigation (1990-1991)'.

The investigation comprised the excavation of six boreholes on the lagoon periphery (cable percussion and rotary), Cone Penetration Testing of the lagoon sediments using pontoons, 'down the hole' geophysics and surface geophysical survey along the western boundary. Standard Penetration Tests were carried out on the embankments, and further supported with geotechnical and chemical testing.

A ground investigation was completed in 2004 under the supervision of URS. The objective of the investigation was primarily to allow sampling of the groundwater both up hydraulic gradient and down hydraulic gradient of the lagoon. The results of the investigation are presented in the URS Corporation Ltd., Additional Investigation and Monitoring of the Rattlechain Lagoon R0487/44557-041-786/LJ/IH/RA/REV1, dated 10 May 2004. The drilling also allowed an opportunity to assess the geotechnical properties of the underlying materials and complete a slope stability analysis of the northern embankment. Details relating to slope assessment are presented in the report 'Slope Stability Assessment of the North Eastern Embankment of the Rattlechain Lagoon'. Ref 44557-041/RJC, dated 21 September 2004.

The intrusive investigation comprised the drilling of three boreholes using a combination of cable percussion and rotary techniques. Two of the boreholes were positioned in the Birmingham Canal towpath, located approximately 25m from the crest of the north

eastern embankment, and the third borehole was located to the south of the lagoon. Monitoring wells were installed in all three wells, two of which were screened in the Etruria Marl and one at the interface between the Made Ground and the Marl.

1.3.2. Site Geology and Geotechnical Characterisation of Ground Materials

The Cremer and Warner (1990-1991) site investigation encountered the following geological sequence at the site:

- ***Made Ground*** - Ranging in thickness between 1.5m in the south lagoon shore and 14m on the north eastern embankment, comprising granular material of loose to medium dense gravely sand with ash, bricks and rubble.

- ***Alluvial Clay*** - This was encountered in the north eastern embankment to a maximum thickness of 2.3m directly underlying the Made Ground. The alluvium comprised stiff light brown red and yellow clay with fine to medium gravel.

- ***Glacial Till*** – A thin lens of boulder clay was encountered in the southern bank of the lagoon, varying in thickness between 0.7m and 1.8m. The boulder clay varied between a soft to firm and firm to stiff, light brown red and yellow gravely clay.

- ***Clay*** (weathered Etruria Marl) – Varied in thickness between 1.8m and 4.68m comprising a stiff to hard dark red, occasionally light brown, mottled orange brown clay containing highly weathered mudstone fragments. The base of the weathered zone lies at an elevation of between 122m AOD, under the northern embankment, and 124m AOD, beneath the southwest corner of the lagoon.

- ***Etruria Marl*** – comprised a red brown to grey moderately to slightly weathered mudstone, often friable and thinly bedded. Espley Horizons, approximately 0.25m to 2.27m thickness were encountered comprising a fine to coarse red brown and grey slightly weathered sandstone and medium coarse slightly weathered and moderately strong to strong conglomerate.

The investigation conducted by URS in February 2004 encountered the following geological sequence underlying the northern embankment:

- ***Made Ground*** – comprising generally SAND and GRAVEL, with ash and clinker with little silt and clay, and a thickness between 11.1m and 14.75m.

- ***Drift material*** – comprised of very clayey SAND, with occasional fine to medium gravel between 1.5m and 2.3m thick.

- ***Bedrock*** – Thinly and thickly bedded fine and coarse-grained mudstone horizons (Etruria Marl Formation), proven to a depth of 30m below ground level.

Assessment of the nature of the lagoon sediments was not conducted as part of the URS investigation.

A conceptual stratigraphic column for the geology of the site is provided in Figure 3.

The characteristics of the lagoon sediment were also investigated and assessed to comprise the following geological sequence:

- ***Lagoon deposits*** - The lagoon waste content was investigated (Cremer & Warner, 1991) with the use of Cone Penetration Test (CPT). The following strata were encountered:

- ***Supernatant water***;

- ***Lagoon sludge*** – unconsolidated waste;

- ***Lagoon sediment*** – consolidated waste; and

- ***Etruria Marl***.

The CPT investigation indicated that the original floor of the clay pit reached a maximum depth of 22m below water level (104m AOD) in the north east corner of the lagoon. The pit shallows to the south and west areas of the site, to depths of approximately 6m below water level (120m AOD) and 15m below water level (111m AOD) respectively, see Figure 4.

Based on the results of the 1990-1991 investigation, the volume of waste was estimated at 230,000m^3 and supernatant water at 135,000m^3. It is considered likely that the thickness of the layers of sediment will now have changed as a result of continued disposal of waste since the investigation since 1990.

From the previous site investigation reports, a summary of geotechnical parameters of the different ground materials has been compiled, as presented in Table 1.0.

Table 1.0 Summary of geotechnical parameters for ground materials. Compiled from Cremer and Warner (1990-1991) and URS Corporation Ltd (2004) site investigations

Geological Unit/*Waste Mass*	Thickness (m)	Description	Moisture Content	Atterberg Limits			Static Cone CPT test	SPT test	Friction Angle	Undrained Triaxial	UCS	Rock Quality Designation (RQD)	Comments
			w	LL	PL	PI	q_c	N value	ϕ'	Cu	σ_c	%	
			%	%	%	%	MN/m^2	(average)	degrees	kN/m^2	MN/m^2		
Made Ground	1.5-14	Loose to medium dense	21	NP	NP	NP		3-19 (10)	27-29				SAND & GRAVEL
Glacial Till	0.7-1.8	Soft to stiff	23							81			Gravely CLAY
Alluvial Clay	1.5-2.3	Stiff	24	45	21	25							CLAY
Weathered Etruria Marl	1.8-4.7	Stiff to hard	19	53	23	25				50-116			CLAY
Etruria Marl	>90m*	Very weak to weak	9								0.3-6.8	0-60	Silty MUDSTONE with coarse grits and conglomerate

Geological Unit/*Waste Mass*	Thickness (m)	Description	Moisture Content	Atterberg Limits			Static Cone CPT test	SPT test	Friction Angle	Undrained Triaxial	UCS	Rock Quality Designation (RQD)	Comments
			w	LL	PL	PI	q_c	N value	ϕ'	Cu	σ_c	%	
			%	%	%	%	MN/m^2	(average)	degrees	kN/m^2	MN/m^2		
Lagoon sludge	0.75-4.8	Very loose, and soft					>0.1						Non cohesive / slightly cohesive
Upper Lagoon sediments	2.0-11.5	Very soft, and loose					0.1						Cohesive and non cohesive
Lower Lagoon sediments	3.0-9.25	Loose, and soft to firm					3.8						Non-cohesive to slightly cohesive

1.3.3. Hydrology and Hydrogeology

The underlying Etruria Marl and Coal Measures are not believed to be a major source of drinking water. The Marl is classified as a Minor Aquifer of variable permeability (Groundwater Vulnerability 1:100,000 Map, sheet 22, Environment Agency, 1997).

Monitoring wells were installed in both site investigations and groundwater levels were reported to vary between 125.98m AOD and 129.9m AOD. An assessment of the groundwater levels suggests that the Rattlechain Lagoon is acting as a 'sump', since the lagoon level is maintained artificially low. Groundwater is drawn in from the southern, eastern and western boundaries of the lagoon, see Figure 5. A review of the regional groundwater regime does however indicate a northerly flow.

The Birmingham Canal is located on top of the northern embankment, at a distance of approximately 40-50m from the crest of the embankment. The canal is raised approximately 13-14m above the level of the lagoon. It is considered likely that the canal is clay lined since the supporting embankment is comprised of granular ash and clinker. Evidence of leakage from the canal was not encountered.

Other surface water features located in close proximity to the site include:

- The Dudley Canal, located approximately 200m from the western boundary of the site;
- The Wolverhampton Level Canal located to the south;
- The Gower Branch Canal located east of the site;
- The river Tame, flowing south-east north-west, approximately 125m to the north of the site, and,
- A number of lakes located beyond the River Tame within the Sheepwash Urban Park, see Figure 1.

1.4. Conceptual Stability Site Model

1.4.1. Basal Sub-Grade Model

The floor of the old clay pit excavated in Etruria Mudstone makes up the basal sub-grade of the Rattlechain Lagoon. This floor slopes from a minimum depth of 6m below the lagoon water level in the south to a maximum depth of approximately of 22.5m below the

water level in the northeast. Based on the findings of previous investigations, the Etruria Marl is anticipated to have a weathered horizon of stiff-to-hard clay, of between 1.7m to 4.7m thick.

1.4.2. Side Slope Sub-Grade Model

The Side Slope Sub-Grade is composed of Etruria Marl on all boundaries resulting from the former land use as a clay pit. Although Made Ground embankments are present to the north, east and west of the site, they are founded on the Marl and above the level of the lagoon.

1.4.3. Basal Lining System Model

Weathered Etruria Marl and unweathered Etruria Marl act as the basal lining to the lagoon. The weathered Etruria Marl is anticipated to have a permeability similar to that of silt/clay, ranging from between 10^{-8}m/s to 10^{-12}m/s.

The weathered Etruria Marl passes gradually into unweathered Etruria Marl, also containing Espley horizons, comprising silty sands/gravels. The Espley horizons were encountered in the 1990-1991 and 2004 site investigations, and varied in thickness between 0.25m to 2.27m.

Field permeability tests carried out in the groundwater monitoring wells sealed in the Etruria Marl returned permeabilities ranging from 9.1×10^{-7}m/s to 3.1×10^{-8} m/s. Coring of the bedrock and cross-referencing between boreholes suggests that the Espley horizons are not laterally continuous and comprise lenses of material. The lenses are not considered to represent a significant pathway for groundwater flow.

1.4.4. Side Slope Lining Model

The former walls of the clay pit (i.e. the Etruria Marl) form the barrier between waste and adjacent groundwater. The hydrogeological conditions describes previously are therefore considered appropriate.

1.4.5. Waste Mass Model

The waste mass in the Rattlechain lagoon is composed predominantly of calcium phosphate slurry. The calcium phosphate resulting from the Rhodia plant is currently disposed of by road tankers feeding the slurry to a distribution pipe located on floating pontoons. The slurry is gravity fed, and the pipe may be re-positioned, preventing the formation of islands of slurry.

Cone Penetrometer Testing (CPT) of the waste indicates a succession of differentiating layers under the supernatant water layer, comprising waste sludge or unconsolidated sediment, and consolidated waste overlying the Etruria Marl.

The CPT investigation of the lagoon sediment indicated a density profile, suggesting that the slurry is consolidating and hence increasing in density with depth. The current operation of the lagoon as a landfill and continued disposal of slurry in the lagoon will result in further consolidation of the waste.

It is our understanding that drums containing chemical waste, including elemental phosphorus, were also disposed of into the lagoon, in conjunction with disused scrap machinery. A brief overview of the waste is provided below as follows.

It is understood that Albright & Wilson originally purchased the site in 1948 for the disposal of chemical waste resulting from the manufacture of phosphate. The principal waste stream was calcium phosphate containing small nodules of elemental phosphorus. However additional chemical wastes may have also comprised a selection of acids, including sulphuric, hydrochloric and fluorosilicic.

Anecdotal evidence also indicates the disposal of chemical drums containing phosphatic muds, possibly containing elemental phosphorus. It has been estimated that 100 drums per annum were disposed of into the lagoon, ceasing around 1995 (URS 'Options Study Restoration of the Rattlechain Lagoon', 2002). In addition to the drums of chemicals it is our understanding that some phosphorus and acid contaminated brickwork, and scrap machinery has also been disposed of in the lagoon.

A conceptual model of the lagoon waste mass is presented as Figure 6.

1.4.6. Capping System Model

A layer of supernatant water forms the capping system of the waste.

The presence of some elemental phosphorus in the waste makes it necessary to avoid the contact of the waste with air, as this may result in a chemical reaction accompanied by the release of toxic fumes.

The water of the lagoon is artificially maintained at approximately 126m AOD by pumping and discharge of filtered water into the Birmingham Canal.

The system of disposal using a movable floating pipe avoids the presence of 'waste islands' above the level of the lagoon.

2. STABILITY RISK ASSESSMENT

2.1. Risk Screening

2.1.1. Basal Sub-Grade Screening

The undrained bearing capacity of the Weathered Etruria Marl (50-116kN/m^2), stiff to hard, and high plasticity (CH), indicates that this sub-grade base is an adequate founding substratum. Uniaxial Compressive Strength testing of the Etruria Marl indicates a strength of 0.3 and 0.68MN/m^2. There is therefore a low risk of failure of the Basal Sub-Grade.

2.1.2. Side Sub-Grade Screening

Since the lagoon is confined within a former clay pit excavated into the bedrock, the side sub-grade comprises Etruria Marl. Details relating to the Marl are presented above and the risk of failure is therefore considered low.

The northern embankment is constructed on top of the Marl and rises 13-14m above the level of the lagoon. Several minor instabilities were observed on the face of the embankment resulting from shallow surface slips. However since the embankment does not form a side slope to the lagoon, and based on the findings of the 'Slope Stability Assessment of the North Eastern Embankment of the Rattlechain Lagoon' (2004), a large slip is considered unlikely. Instabilities on the eastern embankment were reported to be restricted to very shallow slips and were not observed on the western embankment or southern shore of the lagoon.

2.1.2.1. Results of the computer stability analysis

A two-dimensional computer stability program (Rocscience's SLIDE v4.015) was used to model the risk of slope failure of the northern embankment, as presented in the 'Stability

Assessment of the North Eastern Embankment of the Rattlechain Lagoon' Report No 44557-041/RJC.

The slope geometry was derived following a topographic survey of the embankment slopes, and strength parameters were derived from SPT testing.

Five Particle Size Distribution tests were also carried out on samples of Made Ground. The result indicate that the material comprises a variable mixture of sand and gravel sized fragments with variable amount of silt and clay, as presented in Table 2.0

Table 2.0 Results of Particle Size Distribution Tests

URS Exploratory Holes (2004)	No. of Tests	Clay/Silt (%)	Sand (%)	Gravel (%)	Cobbles (%)
RC102	1	33	43	24	0
SA101	4	18-94	4-32	2-53	0

Nine slope-sections were studied and the two most onerous sections (Sections 2 and 5) were modelled using the slope stability software.

The soil parameters used in the analysis are presented in Table 3.0.

Table 3.0 Soil parameters used in computer analysis

Soil Parameters: -	c' kN/m^2	Ø' °	γ kN/m^3
Section 2			
Made Ground (Granular) Lower Bound	0	27	16.0
Made Ground (Granular) Mean Values	0	29	16.0
Section 5			
Made Ground (Granular) Lower Bound	0	28	16.0
Made Ground (Granular) Mean Values	0	31	16.0
Etruria Marl	2	25	19.0

Groundwater levels were estimated from borehole data and groundwater monitoring rounds. The field information was entered into the slope stability model, and the SLIDE software calculating the effect of the associated pore water pressures and its effect in the stability of the slope.

A benchmark for the stability assessment was adopted, a minimum ultimate limit state factor of safety, taken from CIRIA C550 (Infrastructure Embankments condition appraisal and remedial treatment) as seen below in Table 4.0.

Table 4.0 Minimum ultimate limit state factors of safety, after Table 4.14 CIRIA C550

Type of Failure	Factor of Safety	
	Worst Credible	Moderately conservative
Shallow Failure	1.05	1.15
Deep Failure	1.1	1.3

A summary of the results of the SLIDE v4.015 slope stability analysis are presented below in Table 5.0, for lower bound (worst case) and mean parameters.

Table 5.0 Northern embankment factors of safety results

Section	Minimum Factor of Safety	
	Shallow	Deep Seated
Section 2, Lower Bound	<1.0	1.3 - 1.5
Section 2, Mean Parameters	<1.0	1.5+
Section 5, Lower Bound	<1.0	1.1 - 1.3
Section 5, Mean Parameters	<1.0	1.3 - 1.5

The results of the slope analysis suggest an unsatisfactory factor of safety for shallow surface slips, and that some movement within the shallow surface of the embankment

face may be anticipated. However, the potential for a deep-seated slip was considered unlikely.

Progressive failure comprising the propagation of small slips from the toe to crest of the slope, may be possible, however in the long term they are considered unlikely to impact on the canal. A short term catastrophic failure of the embankment, that may impinge on the canal, is considered unlikely.

2.1.2.2. Results of the long term slope creep monitoring

A total of 54 surveying pegs were installed on the embankment across nine pre-selected sections. The surveying pegs were monitored for a period of 4 months, from 23rd February to 27th May 2004, after which the increased presence of vegetation and the effects of vandalism reduced the potential for monitoring of the pegs.

Results of the slope monitoring over the four month period indicated little evidence of slope movement.

2.1.3. Basal Lining System Screening

An engineered basal lining system was not constructed within the lagoon. The base of the lagoon comprises Etruria Marl and the risk of a slope failure is considered low (Section 2.1.1).

2.1.4. Side Slope Lining System Screening

An engineered side slope lining system was not constructed within the lagoon. The sides of lagoon comprise Etruria Marl and the risk of a slope failure is considered low (Section 2.1.2)

2.1.5. Waste Mass Screening

In itself the waste does not pose a risk of other structures of the landfill void. Any mass movement of the waste under the supernatant water is minimised by the movement of the floating feeding pipe that insures a more regular spread of the waste placement. Indeed the continued disposal of slurry into the lagoon results in consolidation of the waste and

an increase in the density of the material. Hence, the waste mass contributes to maintain the integrity of the old clay pit walls.

The pumping station that critically maintains a positive hydraulic gradient between the lagoon surface and the surrounding ground water could not be affected by a potential waste displacement since the gravel causeway that divides the lagoon offers a degree of protection.

It is considered unlikely that the waste mass represents a risk for the stability of the lagoon.

2.1.6. Capping System Screening

The capping system comprises maintaining the level of the lagoon above the level of the waste.

Beyond any emergency contingency that may be in place for the case of a mechanical failure of the pump, the capping system is protected in the worst scenario by the positive hydraulic gradient that exists between the lagoon and the natural ground water. If the pump does fail, the local groundwater regime will ensure a higher water level than the one regulated by pumping.

Therefore, there is no foreseeable risk that can be derived by the capping system.

3. RECOMMENDATIONS AND CONCLUSIONS

URS has reviewed a number of publications and reports relating to the geology, hydrogeology, landfill operations of the lagoon, and waste composition. A conceptual model was developed for the site that scrutinizes the different structural elements of the lagoon and allowing a risk screening exercise of their stability.

The lagoon is contained within the confines of an old clay pit excavated into a mudstone bedrock. The pit forms the base and side slopes of the lagoon and the risk of a slope stability failure are considered low.

There is some evidence of slope instability observed on the north eastern embankment, however this is restricted to shallow surface slips. A deep-seated catastrophic failure on the north eastern embankment is considered unlikely.

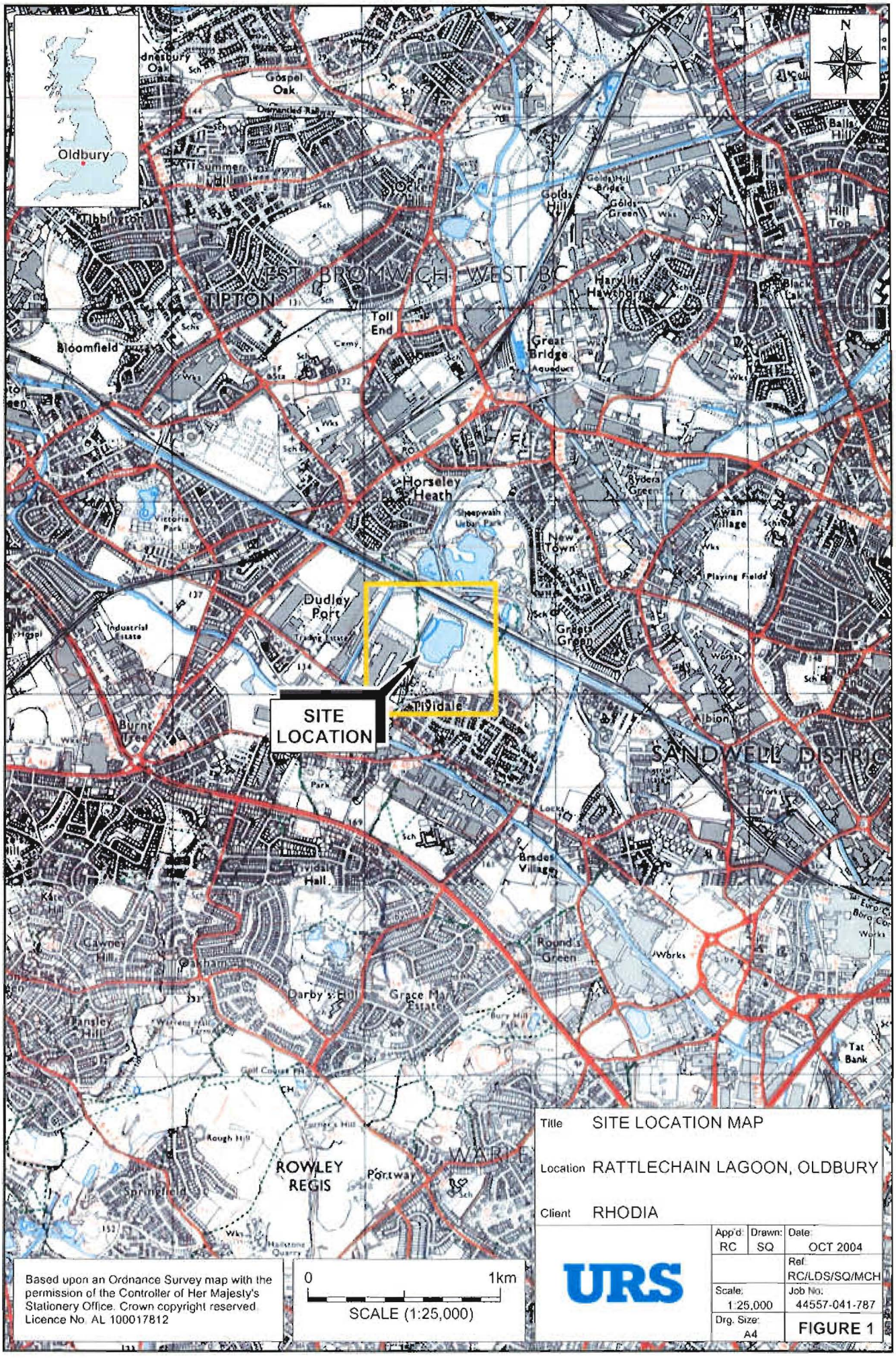
In addition, the embankment is constructed above the level of the lagoon and hence does not contribute to the containment of the lagoon.

The risks of a failure of the waste mass impacting on the stability of the lagoon are considered unlikely. It is considered more likely that the continued disposal of the slurry into the lagoon, resulting in further consolidation of the waste mass already present, will maintain the integrity of the lagoon.

The capping system of the lagoon comprises the lagoon supernatant. Since the water level of the lagoon is maintained below the level of the local groundwater table, any mechanical failure of the pump will not result in the exposure of the waste to the air. Stability issues associated with the cap are not therefore considered relevant.

Based on the findings of this Phase I Stability Assessment presented herein, additional investigation and assessment of the lagoon relating to slope stability issues that may impact on the integrity of the lagoon are not considered necessary to address the requirements of IPPC. However, a periodic walkover of the site is recommended to ensure that the shallow slips observed on the northern and eastern embankments are not propagating into larger slips. A visual assessment of the lagoon as a whole may also be conducted during this visit.

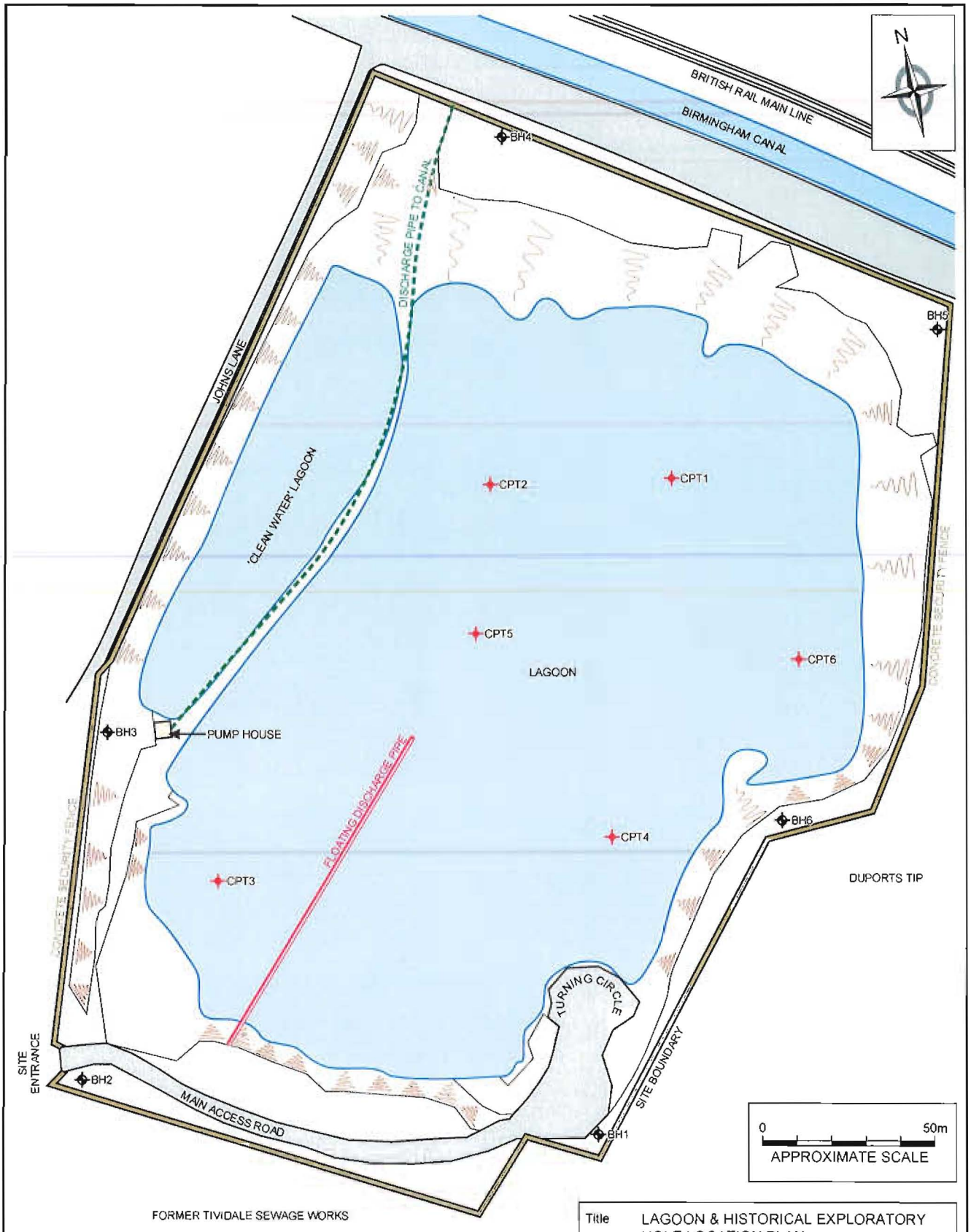
Figures



Title	SITE LOCATION MAP
Location	RATTLECHAIN LAGOON, OLDBURY
Client	RHODIA

URS

App'd:	Drawn:	Date:
RC	SQ	OCT 2004
		Ref: RC/LDS/SQ/MCH
Scale: 1:25,000		Job No: 44557-041-787
Drg. Size: A4		FIGURE 1



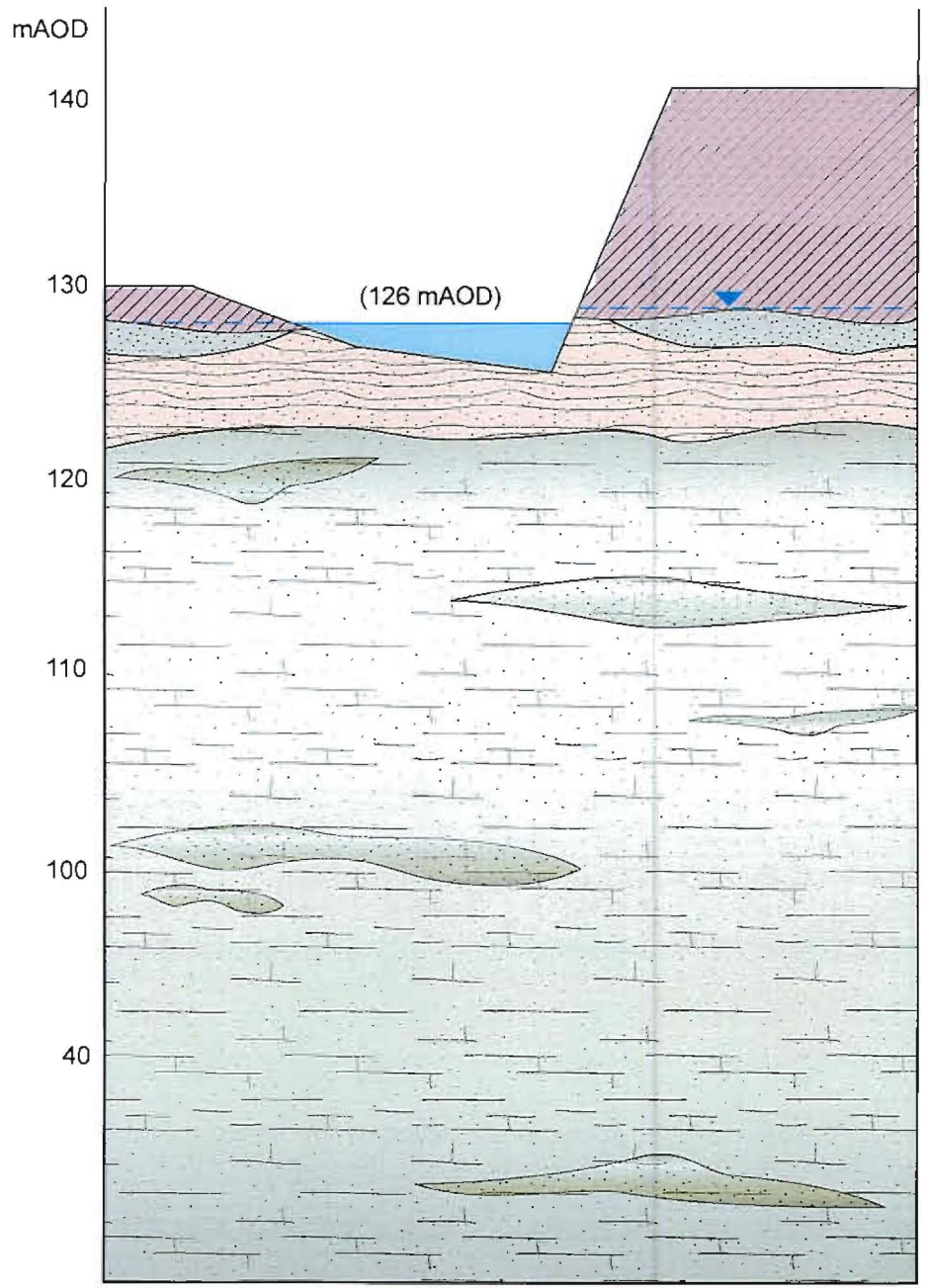
KEY

- HISTORICAL BOREHOLE LOCATION
- HISTORICAL CONE PENETRATION TEST LOCATION

Title	LAGOON & HISTORICAL EXPLORATORY HOLE LOCATION PLAN
Location	RATTLECHAIN LAGOON, OLDBURY
Client	RHODIA

URS

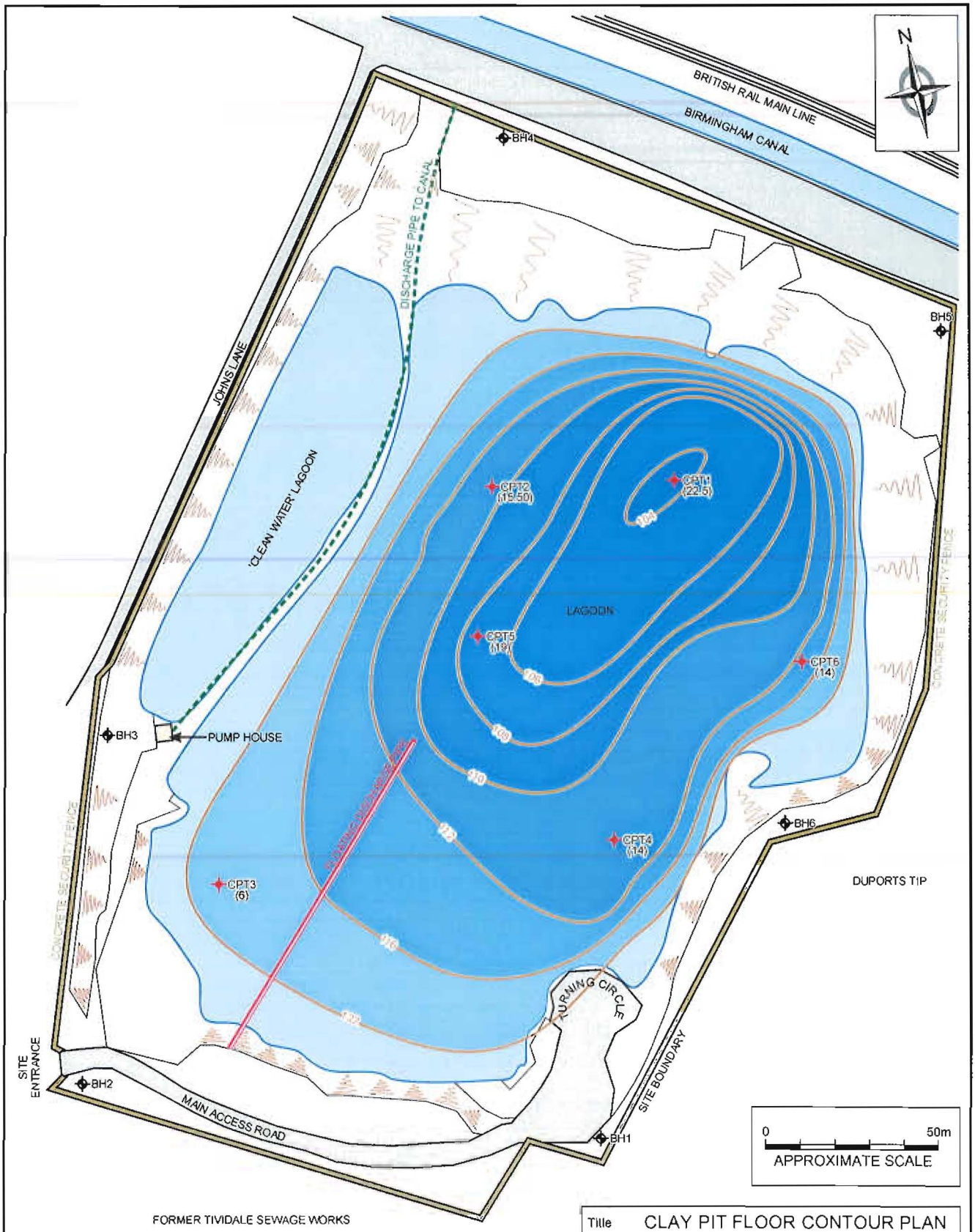
App'd	Drawn	Date
RC	AR	OCT 2004
		Ref. RC/LDS/SQ/MCH
Scale AS SHOWN		Job No 44557-041-787
Drg. Size. A4		FIGURE 2



Title	CONCEPTUAL STRATIGRAPHIC COLUMN
Location	RATTLECHAIN LAGOON, OLDBURY
Client	RHODIA

URS

App'd:	Drawn:	Date:
RC	AR	OCT 2004
		Ref: RC/LDS/SQ/MCH
Scale: AS SHOWN		Job No: 44557-041-787
Drg. Size: A3		**FIGURE 3**



KEY:

- CLAY PIT FLOOR CONTOURS (mAOD)
- (14) CLAY PIT DEPTH BELOW LAGOON WATER LEVEL
- HISTORICAL BOREHOLE LOCATION
- HISTORICAL CONE PENETRATION TEST LOCATION

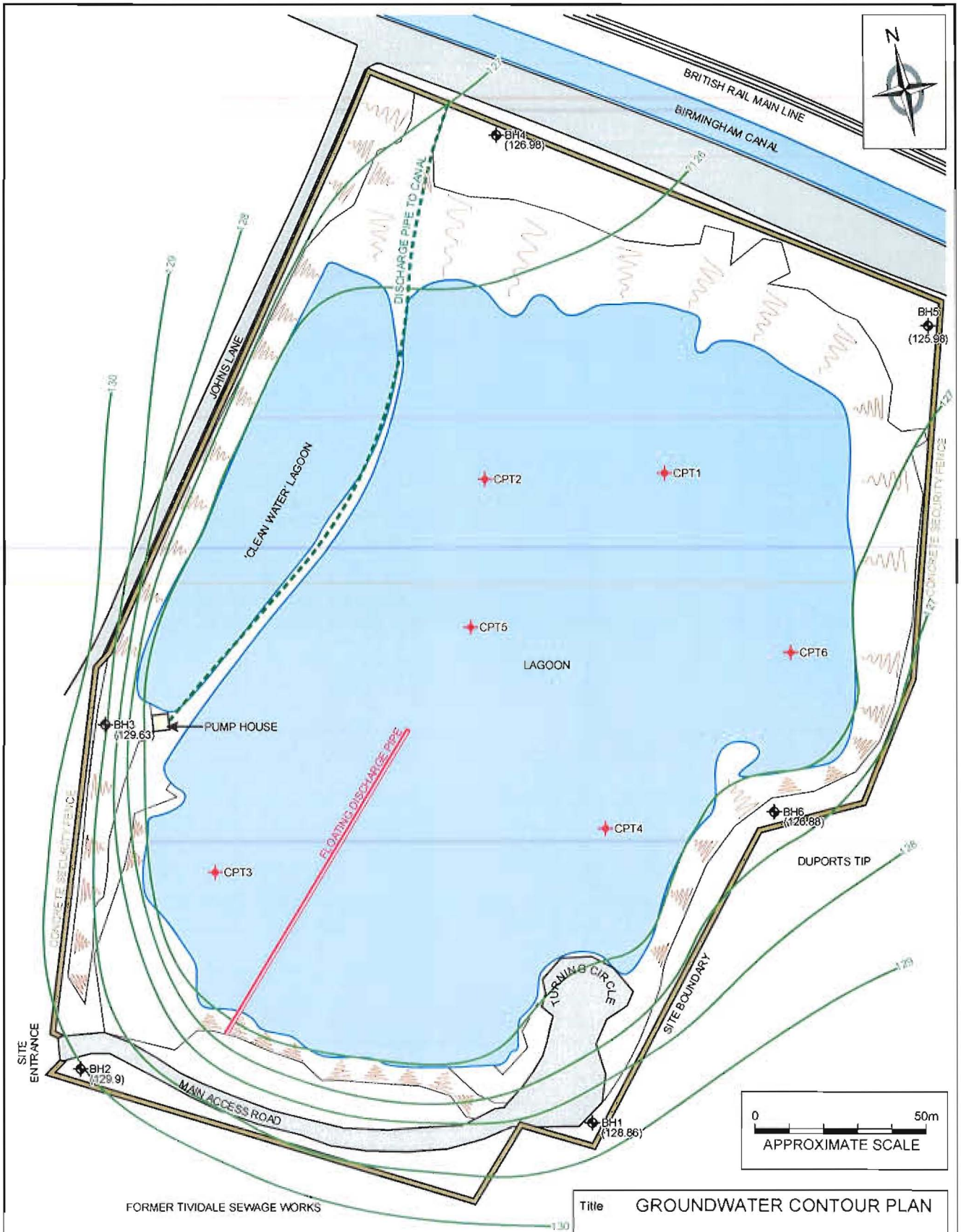
Title: CLAY PIT FLOOR CONTOUR PLAN

Location: RATTLECHAIN LAGOON, OLDBURY

Client: RHODIA

URS

App'd	Drawn	Date
RC	AR	OCT 2004
		Ref. RC/LDS/SQ/MCH
Scale. AS SHOWN		Job No 44557-041-787
Drg. Size: A4		FIGURE 4



KEY:

- CONTOUR OF GROUNDWATER LEVEL (mAOD)
- (129.9) REDUCED GROUNDWATER LEVELS IN PIEZOMETERS RECORDED 22/02/1991
- HISTORICAL BOREHOLE LOCATION
- HISTORICAL CONE PENETRATION TEST LOCATION

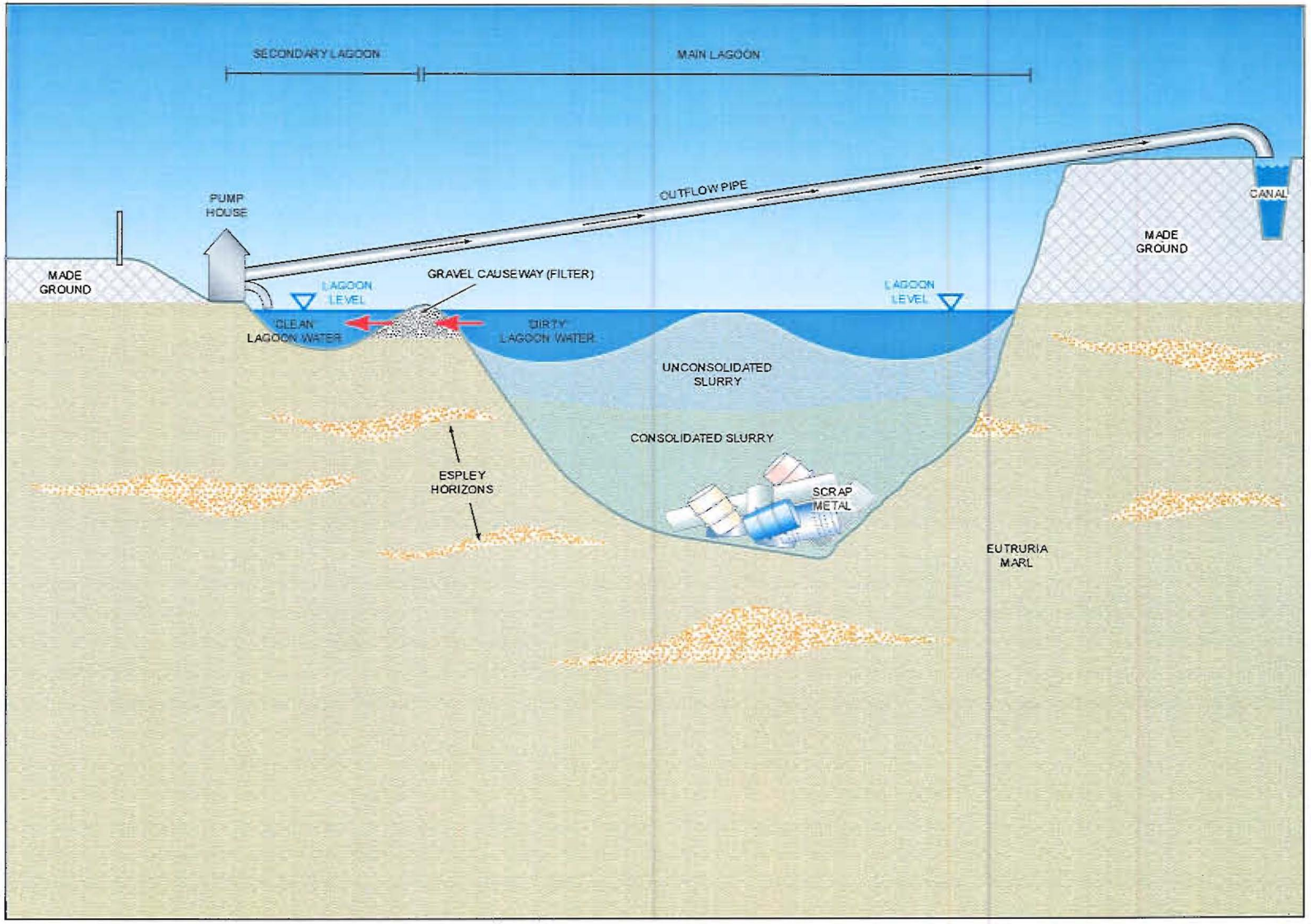
Title GROUNDWATER CONTOUR PLAN

Location RATTLECHAIN LAGOON, OLDBURY

Client RHODIA

URS

App'd	Drawn.	Date:
RC	AR	OCT 2004
		Ref: RC/LDS/SQ/MCH
Scale: AS SHOWN		Job No. 44557-041-787
Drg. Size: A4		FIGURE 5



Title	CONCEPTUAL SITE MODEL
Location	OLDBURY, RATTLECHAIN LAGOON
Client	RHODIA

URS

Appd.	Drawn.	Date
RC	AAF	OCT 2004
		Ref. RC/LDS/AAF/MCH
Scale: AS SHOWN		Job No. 44557-041-787
Drg. Size: A3		FIGURE 6

Photographs

Title	PHOTO 1.0
Location	RATTLECHAIN LAGOON, OLDBURY
Client	RHODIA

URS

App'd: RC	Drawn: SQ	Date: SEPT 2004
Status: DRAFT		Ref: MM/AR/LON
Scale: AS SHOWN		Job No: 44557-020-420
Drg. Size: A4		PLATE