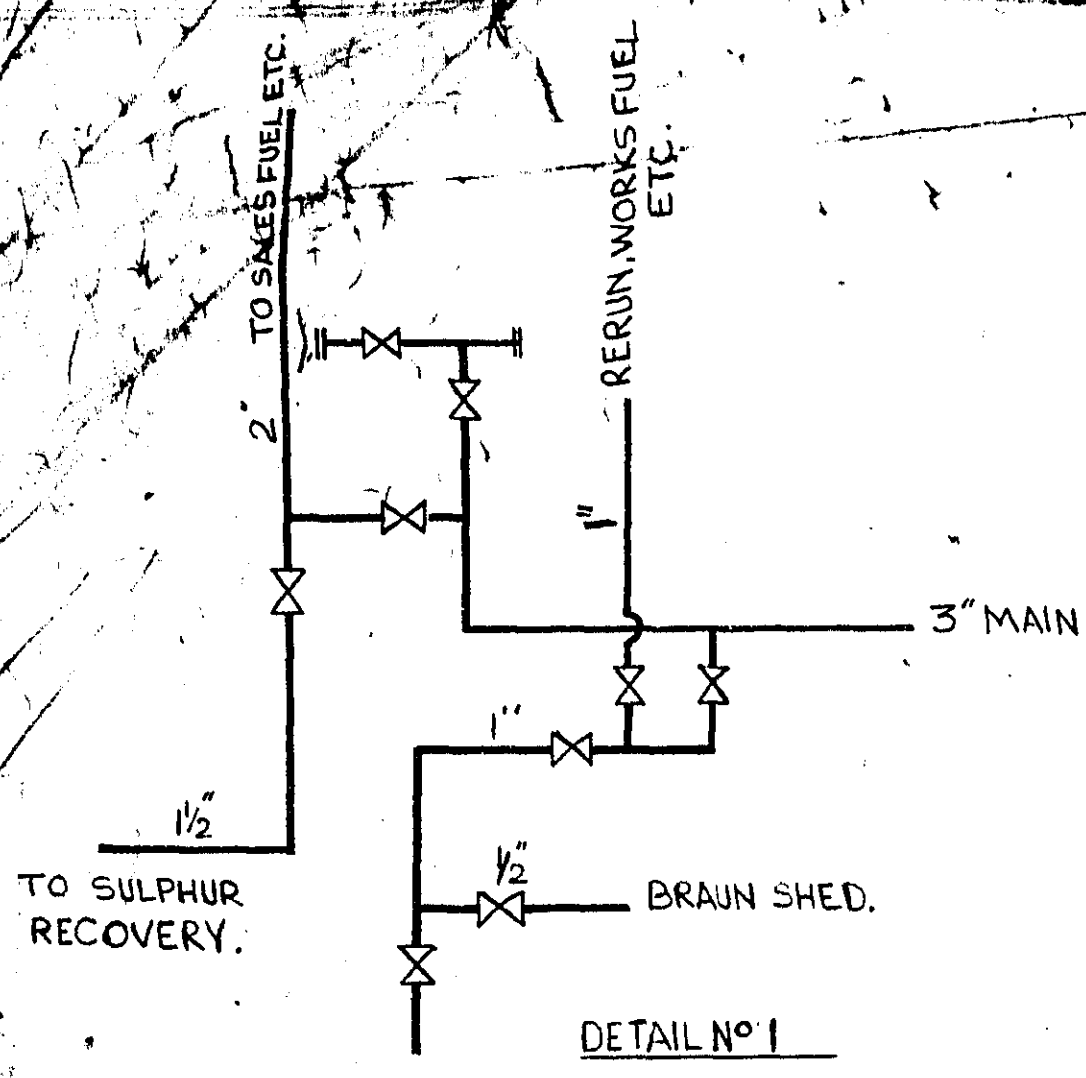
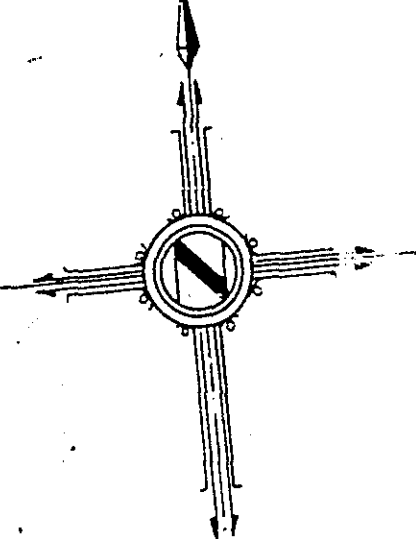


DRAWING NO 30701

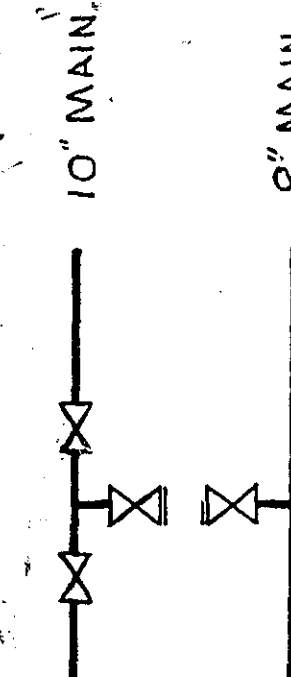


DETAIL No 1

B.S. PLANT ETC.



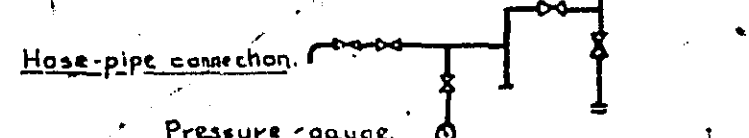
Tally-few Farmhouse



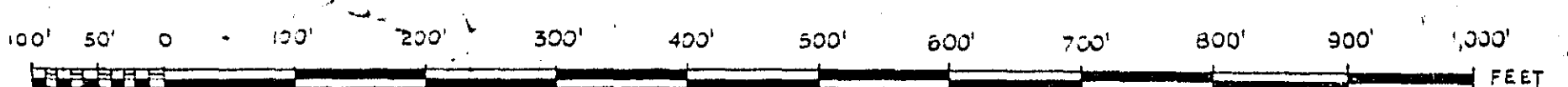
DETAIL No 2



DETAIL OF STANDPIPE

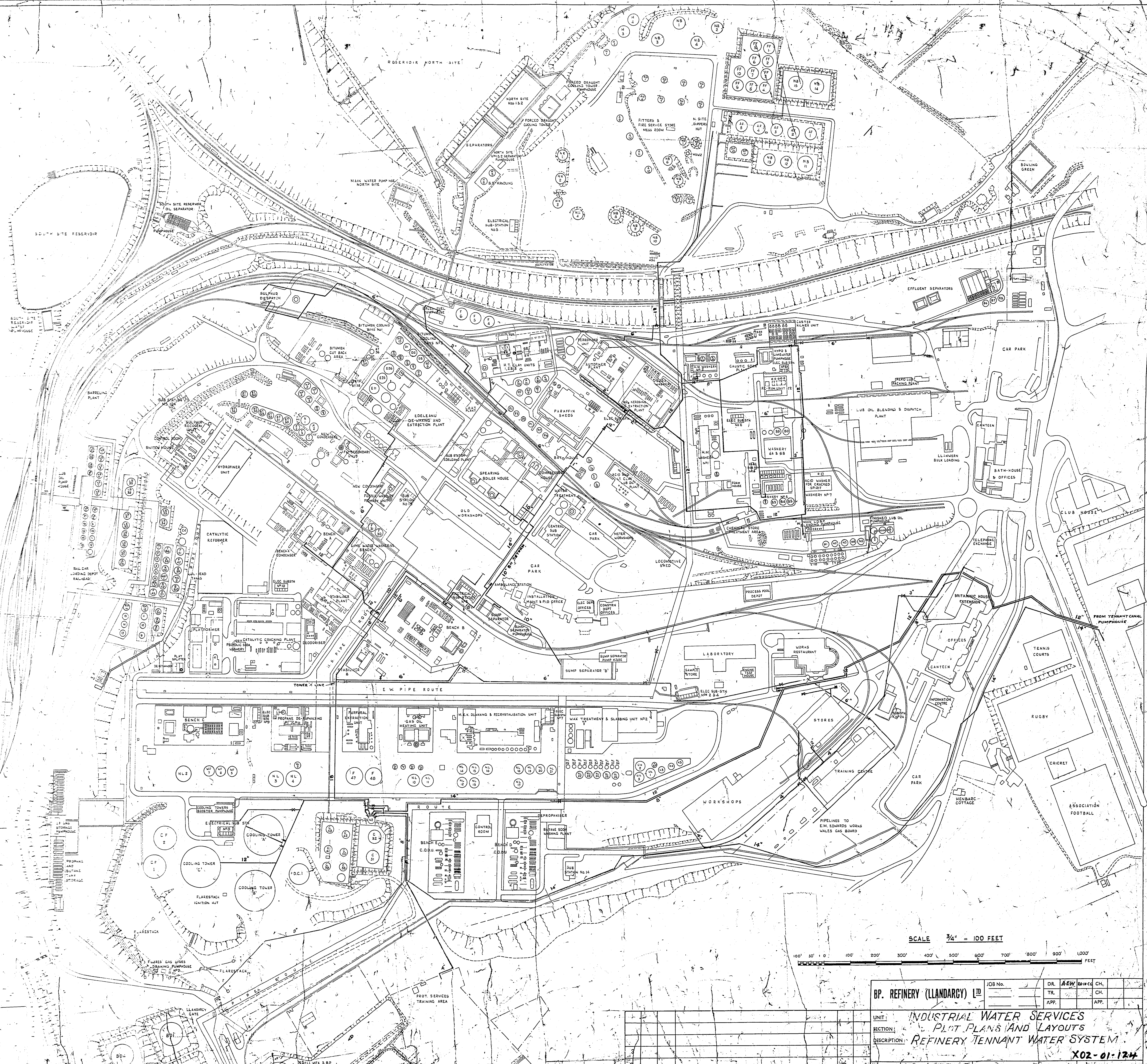


SCALE 3/4" = 100 FEET

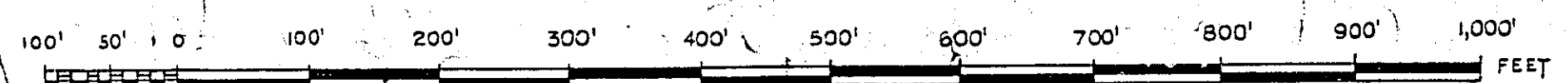


BP. REFINERY (LANDARCY) LTD		JOB No.	DR.	C.F.C.	26/6/58	CH.	27/7/58
SECTION: NEATH WATER SERVICES			TR.				
DESCRIPTION: LAYOUT OF REFINERY NEATH WATER SERVICES			APP.				
DRAWING NUMBER 30701		X02-01-123		DRAWING NUMBER 30701		DRAWER NUMBER 274	

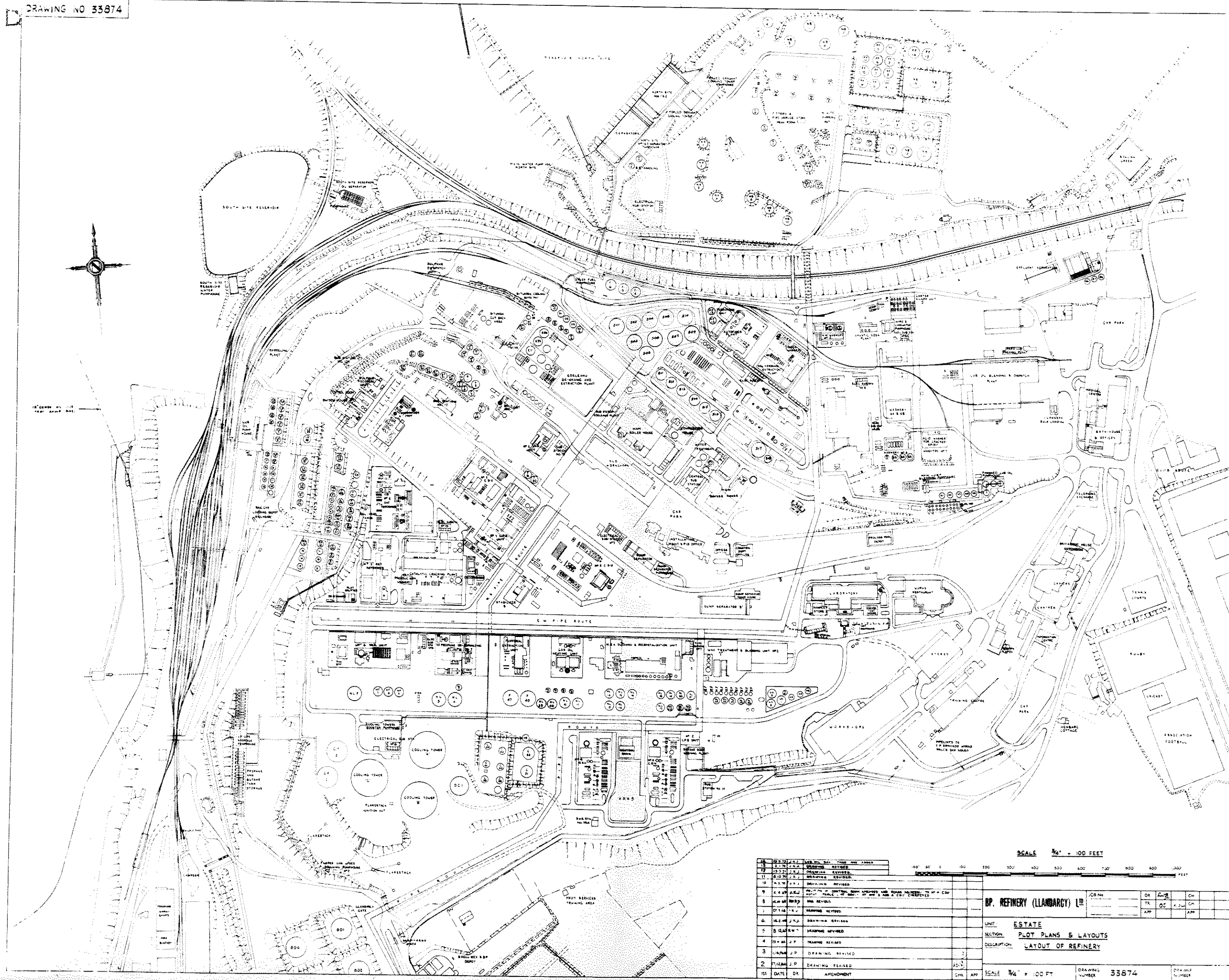
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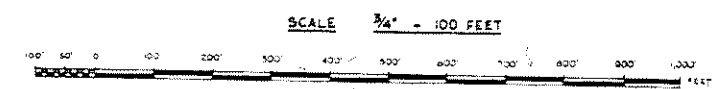
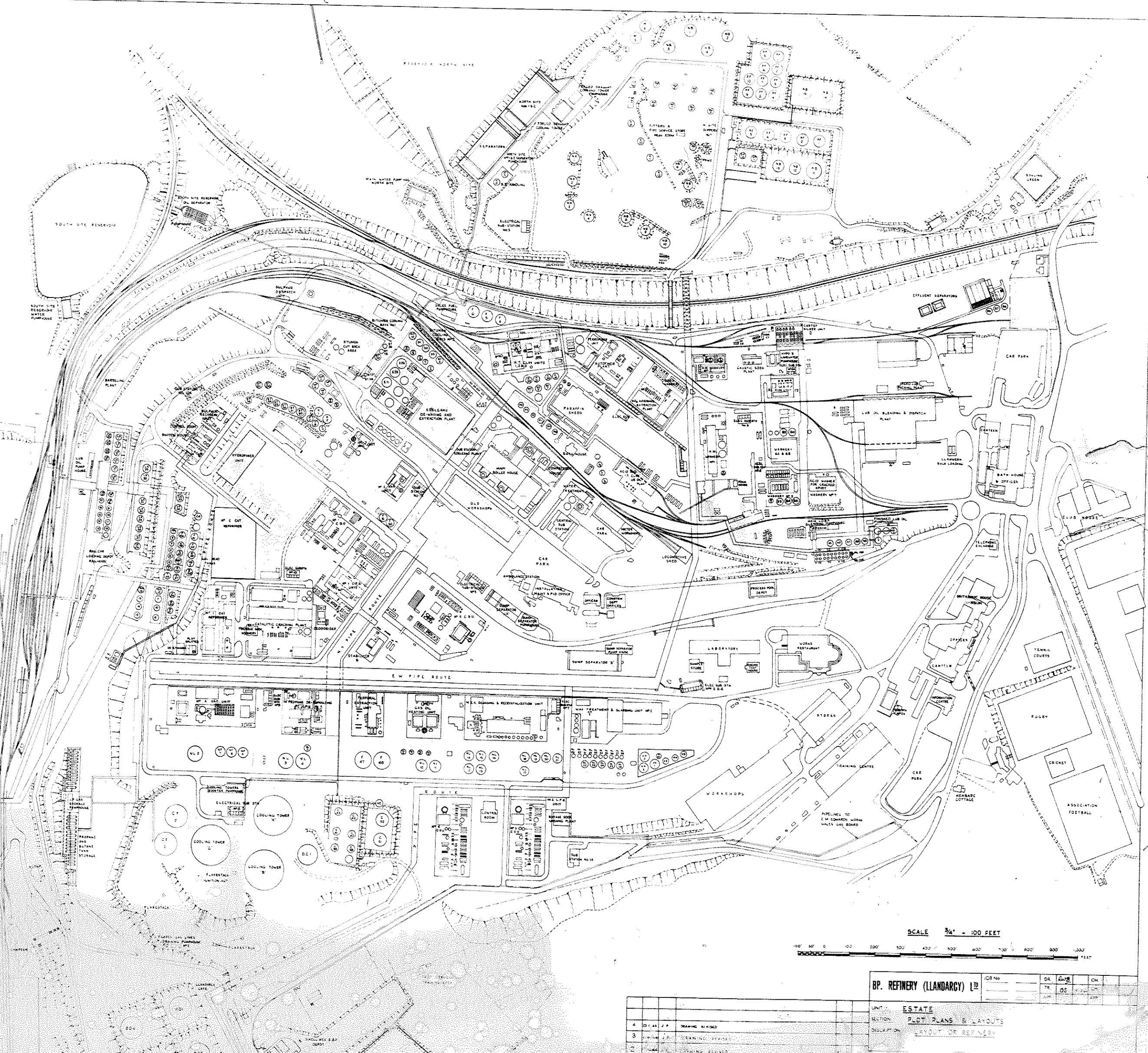
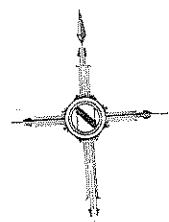
SCALE 3/4" = 100 FEET



BP. REFINERY (LLANDRUGY) LTD		JOB No.	DR. AEW	CH.
		TR.		
		APP.		
UNIT: INDUSTRIAL WATER SERVICES				
SECTION: PLANT PLANS AND LAYOUTS				
DESCRIPTION: REFINERY TENNANT WATER SYSTEM				
		X02-01-124		
IS.	DATE	DR.	APP.	SCALE 3/4" = 100 FT
				DRAWING NUMBER 35027
				DRAWER NUMBER

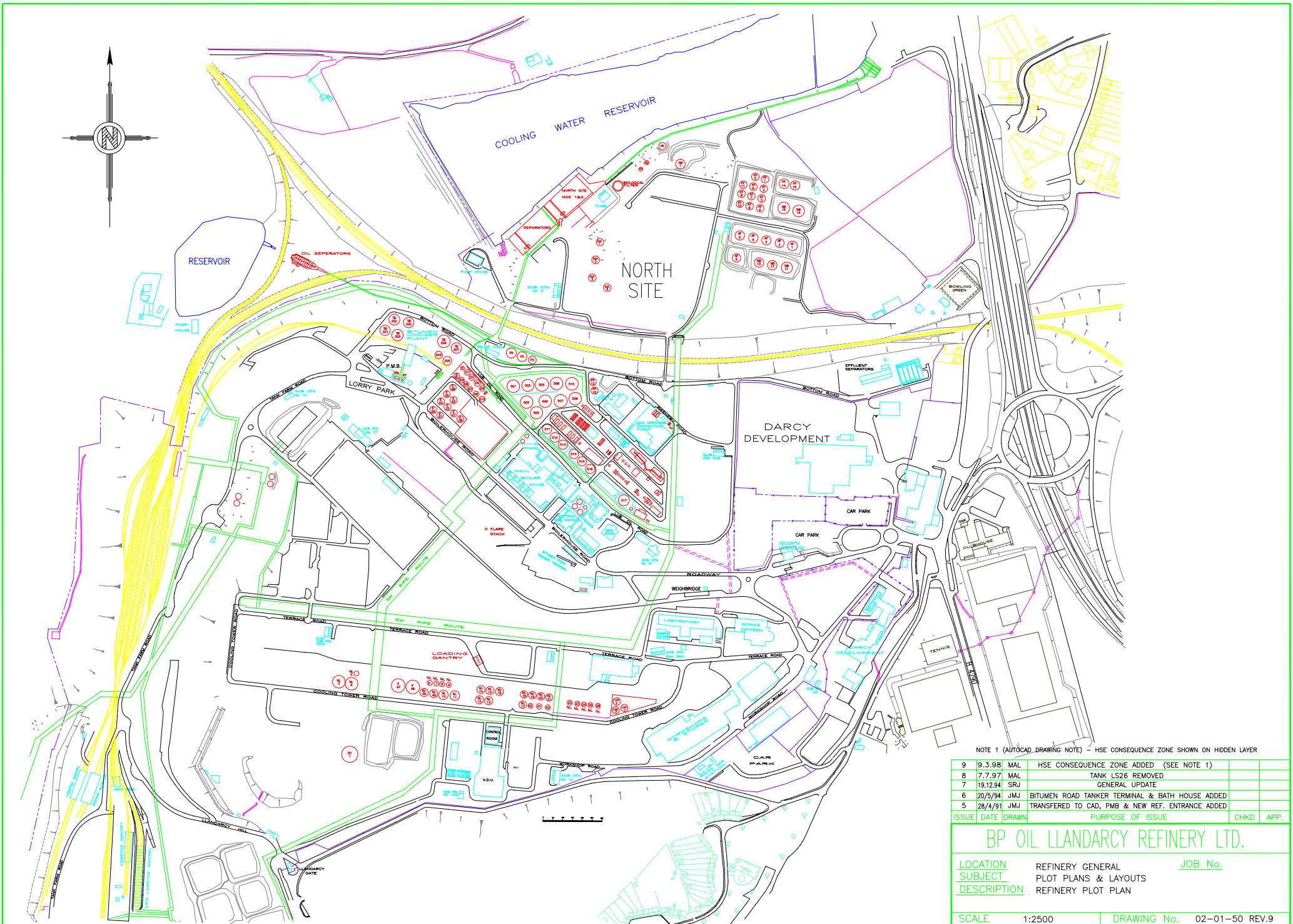


10	10/10/74	J.P.	FINAL APPROVED	100	50	0	100	200	300	400	500	600	700	800	900	1000	FEET
9	10/10/74	J.P.	DRAWING REVISED														
8	10/10/74	J.P.	DRAWING REVISED														
7	10/10/74	J.P.	DRAWING REVISED														
6	10/10/74	J.P.	DRAWING REVISED														
5	10/10/74	J.P.	DRAWING REVISED														
4	10/10/74	J.P.	DRAWING REVISED														
3	10/10/74	J.P.	DRAWING REVISED														
2	10/10/74	J.P.	DRAWING REVISED														
1	10/10/74	J.P.	DRAWING REVISED														
DATE	DR	APP	CHK	APP	SCALE	1/4" = 100 FT	DRAWING NUMBER	33874	DRAWING NUMBER								



BP. REFINERY (LLANDARCY) LTD			
UNIT	ESTATE	JOB No.	DA 1008
SECTION	PLOT PLANS & LAYOUTS	TR	DS
DESCRIPTION	LAYOUT OF REFINERY	CH	1

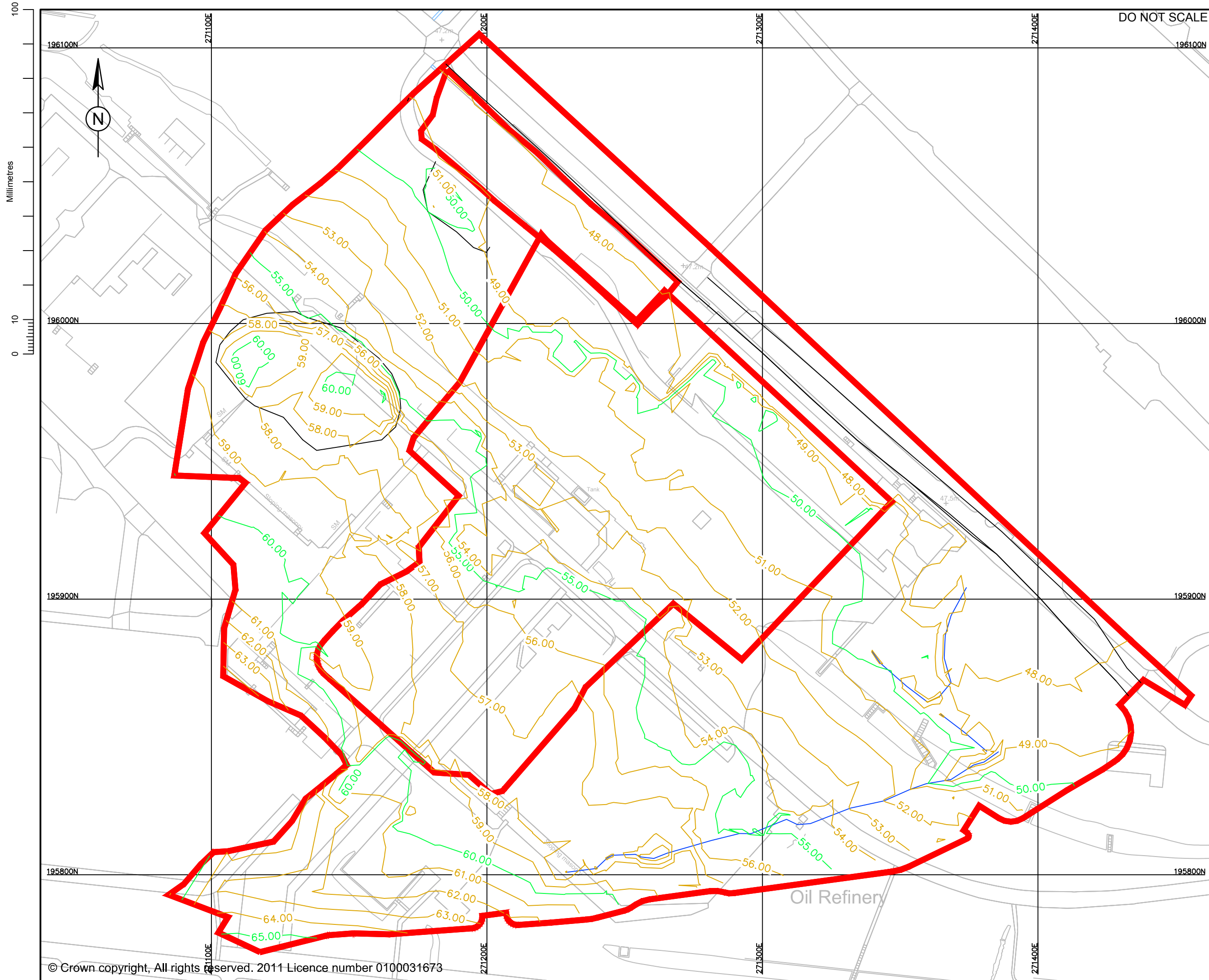
NO.	DATE	BY	REVISION
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2	1955.01.10	J.P.	DRAWING REVISED
3	1955.01.10	J.P.	DRAWING REVISED
4	1955.01.10	J.P.	DRAWING REVISED
5	1955.01.10	J.P.	DRAWING REVISED



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DO NOT SCALE

KEY:

- MONITOR PHASE BOUNDARY
- MAJOR CONTOUR
- MINOR CONTOUR

P2	02/02/16	TOPOGRAPHIC SURVEY REVISED	MJ	BI	ML
P1	13/10/15	FIRST ISSUE	MJ	MM	ML
Rev.	Date	Description	By	Chk'd	App'd

Drawing Status	S2
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Client

ST.MODWEN

Project Title

COED DARCY

Drawing Title

MONITOR PHASE 70
POST-WORKS TOPOGRAPHIC SURVEY

Scale	Designed	Drawn	Checked	Authorised
1:1250	DH	MJ	BI	MP
Original Size	Date	Date	Date	Date
A3	13/10/15	13/10/15	13/10/15	13/10/15
Drawing Number	Revision			
5041216-ATK-DR-C-REM-DWG-2076	P 2			

*A E I CO ARISO OF RBSL
A RTC T RES OL S*

Contaminant	RTC (mg/l)
TPH aliphatic C10-C12	>sat
TPH aliphatic C12-C16	>sat
1,2-Dichloroethane	4.80E+00
1,1,1-Trichloroethane	>sat
Tetrachloroethene	>sat
Trichloroethene	2.85E+01
Vinyl chloride	3.38E-01
Dichloromethane	1.98E+03
Cis-1,2 Dichloroethene	7.40E+01
Trans-1,2 Dichloroethene	8.91E+01
1. Where the lower of the vapour or aqueous saturation limits has been exceeded by the RTC calculated, the hazard quotient is considered to be less than 1 and as such >sat has been presented 2. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation 3. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins 4. The potential presence of free product should be assessed in accordance with information in the S106 (Ref. 1).	

4. Comparison of RBSLs and RTC

As an objective of these works was to establish whether the RBSLs were health protective, the commercial RBSLs and RTC have been compared. This comparison is presented in the tables in this section of the report. As per the approach adopted for the residential and recreational RTC, within the tables within this section, the lower of the RBSL/RTC has been bolded. Therefore where the RBSL has been bolded, it is protective in comparison to the RTC:

- If the RBSL and the RTC are equal, the RBSL is bolded.
- If the RTC is lower than the RBSL, the RTC is bolded⁹.
- If the RBSL is lower than the RTC, the RBSL is bolded.

Where the RTC are greater than the RBSL or the RTC are equal to the RBSL, the values have been marked as final to illustrate that the RBSL is protective. Where the RTC are lower than the RBSL, further site specific modifications could be considered to establish whether the RTC is unnecessarily conservative and these have been marked as draft. Further site specific modifications have not been considered at the present stage.

The RBSL should be used in all cases, except where the RTC is bolded. In this event, the relevant RTC should therefore be adopted.

The background soil concentration and Soil Code have not been considered within the metals RTC presented and therefore the values presented for metals may not be protective of phytotoxic

⁹ In some cases there may be two RTC, where one RTC is higher than the RBSL and the other lower: one may be bolded and the other not and therefore they remain as draft.

effects. The soft landscaping areas should therefore be suitably designed at the remediation design stage, once such areas are defined.

4.1 Comparison of commercial RBSLs and RTC (shallow soil)

The commercial RBSLs and RTC for a shallow soil source are compared in Table 4.1 below.

Table 4.1 – Comparison of commercial RBSLs and RTC for shallow soil (0.65m below FFL)

Contaminant	S106 RBSL (mg/kg)	RTC 1% Sand (mg/kg)	RTC 3% Sandy loam (mg/kg)	Draft/Final
Arsenic	5.00E+02	6.35E+02	6.35E+02	final
Chromium	5.00E+03	3.65E+02	3.65E+02	draft
Cadmium	1.40E+03	2.43E+02	2.43E+02	draft
Mercury (inorganic)	4.80E+02	3.71E+03	3.71E+03	final
Nickel	5.00E+03	1.99E+03	1.99E+03	draft
Selenium	8.00E+03	1.30E+04	1.30E+04	final
Lead	7.50E+02	5.45E+03	5.45E+03	final
Vanadium	1.60E+04	7.59E+03	7.59E+03	draft
Copper	-	1.15E+05	1.15E+05	draft
Zinc	-	9.18E+05	9.18E+05	draft
Benzo(a)pyrene	2.90E+01	2.47E+01	2.48E+01	draft
Benzene	5.00E+00	1.78E+01	9.98E+01	final
Toluene	1.16E+03	4.18E+05 a	4.22E+05 a	final
Ethylbenzene	1.22E+05	1.83E+05 a	1.87E+05 a	final
Xylene	1.21E+05	2.93E+05 a	3.27E+05 a	final
TPH aromatic C7-C8	1.84E+03	4.18E+05 a	4.22E+05 a	final
TPH aromatic C8-C10	9.13E+02	6.21E+04 a	6.62E+04 a	final
TPH aromatic C10-C12	2.65E+04	6.83E+04 a	6.84E+04 a	final
TPH aromatic C12-C16	6.49E+04	6.84E+04 a	6.57E+04	final
TPH aliphatic C6-C8	>1.00E+06	≤1.00E+06 a	≤1.00E+06 a	draft
TPH aliphatic C8-C10	1.59E+05	1.69E+05 a	1.70E+05 a	final
TPH aliphatic C10-C12	1.63E+05	1.71E+05 a	1.71E+05 a	final
TPH aliphatic C12-C16	1.69E+05	1.71E+05 a	1.71E+05 a	final
TPH aromatic C16-C21	5.14E+04	2.85E+04	2.85E+04	draft
TPH aromatic C21-C35	5.14E+04	2.85E+04	2.85E+04	draft
TPH aliphatic C16-C21	>1.00E+06	≤1.00E+06	≤1.00E+06	draft
TPH aliphatic C21-C35	>1.00E+06			draft
Total TPH (Phase 1)	8.14E+04	Not calculated (see note 8)		
Total TPH (Process Area)	4.43E+04			
Total TPH (North Tank Farm)	2.59E+04			

Contaminant	S106 RBSL (mg/kg)	RTC 1% Sand (mg/kg)	RTC 3% Sandy loam (mg/kg)	Draft/Final
Total TPH (South Tank Farm)	3.72E+04			
1,2-Dichloroethane	2.00E+00	4.01E-01	2.15E+00	draft
1,1,1-Trichloroethane	5.77E+05	4.43E+02	3.14E+03	draft
Tetrachloroethene	1.05E+03	1.03E+02	7.88E+02	draft
Trichloroethene	8.40E+01	7.48E+00	5.49E+01	draft
Vinyl chloride	4.00E+00	4.50E-02	1.74E-01	draft
Dichloromethane	1.65E+03	1.58E+02	7.34E+02	draft
Cis-1,2-Dichloroethene	2.73E+02	8.70E+00	5.30E+01	draft
Trans-1,2 Dichloroethene		1.38E+01	8.77E+01	draft
Notes				
a) based on a value produced from following the approach outlined in SR4 for substances at saturation				
1. It is assumed that no visible free product is present within the top 1.0m of soil The presence of free product should be assessed in accordance with information in the S106 (Ref. 1).				
2. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation				
3. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins				
4. In the S106 (Ref. 1), only one value was presented for 1,2-dichloroethene of 273 mg/kg				
5. 'Total' TPH RBSL derived for an area of development, based on individual RBSL and available mass fraction TPH data in soil at time of derivation, using the inverse weighted average approach.				
6. Benzo(a)pyrene RBSL to be compared against sum of 16 US EPA Priority List PAHs using Toxicity Equivalence approach				
7. No RTC was produced for total TPH as this will be considered further at validation stage				
8. Asbestos has not been considered here as it is being considered in a separate report				
9. Additivity for TPHs and PAHs to be undertaken in line with guidance in this report				
10. In the S106 (Ref. 1), “-“ was presented for the RBSLs for copper and zinc for a commercial land use				
11. The values for metals may not be protective of phytotoxic effects				

4.2 Comparison of commercial RBSLs and RTC (deep soil)

The commercial RBSLs and RTC for a deep soil source are compared in Table 4.2 below.

Table 4.2 – Comparison of commercial RBSLs and RTC for deep soil (1m below FFL)

Contaminant	S106 RBSL (mg/kg)	RTC 1% Sandy loam (mg/kg)	RTC 3% Sandy loam (mg/kg)	Draft/final
Benzo(a)pyrene	None	>sat	>sat	final
Benzene	5.00E+00	7.10E+01	1.52E+02	final
Toluene	3.89E+02	>sat	>sat	final
Ethylbenzene	None	>sat	>sat	final
Xylene	None	>sat	>sat	final

Contaminant	S106 RBSL (mg/kg)	RTC 1% Sandy loam (mg/kg)	RTC 3% Sandy loam (mg/kg)	Draft/final
TPH aromatic C7-C8	6.17E+02	>sat	>sat	final
TPH aromatic C8-C10	5.47E+02	>sat	>sat	final
TPH aromatic C10-C12	None	>sat	>sat	final
TPH aromatic C12-C16	None	>sat	>sat	final
TPH aliphatic C6-C8	None	>sat	>sat	final
TPH aliphatic C8-C10	None	>sat	>sat	final
TPH aliphatic C10-C12	None	>sat	>sat	final
TPH aliphatic C12-C16	None	>sat	>sat	final
TPH aliphatic C16-C21	None	Not calculated (see note 3)		
TPH aliphatic C21-C35	None			
TPH aromatic C16-C21	None			
TPH aromatic C21-C35	None			
Total TPH (Phase 1)	8.20E+04	Not calculated (see note 9)		
Total TPH (Process Area)	3.50E+04			
Total TPH (North Tank Farm)	1.40E+04			
Total TPH (South Tank Farm)	3.48E+04			
1,2-Dichloroethane	6.50E-01	1.73E+00	2.75E+00	final
1,1,1-Trichloroethane	3.25E+03	>sat	>sat	final
Tetrachloroethene	3.68E+02	3.98E+02	1.06E+03	final
Trichloroethene	2.80E+01	2.88E+01	7.07E+01	final
Vinyl chloride	1.60E+00	1.54E-01	2.14E-01	draft
Dichloromethane	6.65E+02	6.77E+02	9.76E+02	final
Cis-1,2-Dichloroethene	9.10E+01	3.51E+01	6.70E+01	draft
Trans-1,2 Dichloroethene		5.34E+01	1.11E+02	draft
Notes				
1. Where the lower of the vapour or aqueous saturation limits have been exceeded by the RTC calculated, the hazard quotient is considered to be less than 1 and as such >sat has been presented				
2. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation				
3. TPH >C16 are not considered to be volatile according to the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). Consequently the inhalation of vapour pathways have not been considered and therefore no RTC value has been presented here				
4. “None” indicates theoretical RBSL greater than solubility limit				
5. In the S106 (Ref. 1), only one value was presented for 1,2-dichloroethene of 91 mg/kg				
6. ‘Total’ TPH RBSL derived for an area of development, based on individual RBSL and available mass fraction TPH data in soil at time of derivation, using the inverse weighted average approach.				
7. Benzo(a)pyrene RBSL to be compared against sum of 16 US EPA Priority List PAHs using Toxicity Equivalence approach				

Contaminant	S106 RBSL (mg/kg)	RTC 1% Sandy loam (mg/kg)	RTC 3% Sandy loam (mg/kg)	Draft/final
8. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins				
9. No RTC was produced for total TPH as this will be considered further at validation stage				
10. Asbestos has not been considered here as it is being considered in a separate report				
11. Additivity for TPHs and PAHs to be undertaken in line with guidance in this report				
12. The potential presence of free product should be assessed in accordance with information in the S106 (Ref. 1).				

4.3 Comparison of commercial RBSLs and RTC (groundwater)

The commercial RBSLs and RTC for a groundwater source are compared in Table 4.3 below.

Table 4.3 – Comparison of commercial RBSLs and RTC for groundwater (1m below FFL)

Contaminant	S106 RBSL (mg/l)	RTC (mg/l)	Draft/Final
Benzo(a)pyrene	None	>sat	final
Benzene	6.00E+00	1.15E+01	final
Toluene	2.29E+02	>sat	final
Ethylbenzene	5.06E+02	>sat	final
Xylene	6.07E+02	>sat	final
TPH aromatic C7-C8	9.70E+01	>sat	final
TPH aromatic C8-C10	None	>sat	final
TPH aromatic C10-C12	None	>sat	final
TPH aromatic C12-C16	None	>sat	final
TPH aromatic C16-C21	None	Not calculated (see note 6)	final
TPH aromatic C21-C35	None		final
TPH aliphatic C6-C8	None	>sat	final
TPH aliphatic C8-C10	None	>sat	final
TPH aliphatic C10-C12	None	>sat	final
TPH aliphatic C12-C16	None	>sat	final
TPH aliphatic C16-C21	None	Not calculated (see note 6)	final
TPH aliphatic C21-C35	None		final
1,2-Dichloroethane	8.20E-01	4.80E+00	final
1,1,1-Trichloroethane	9.89E+02	>sat	final
Tetrachloroethene	1.15E+02	>sat	final
Trichloroethene	1.30E+01	2.85E+01	final
Vinyl chloride	3.00E-01	3.38E-01	final
Dichloromethane	6.24E+02	1.98E+03	final

Contaminant	S106 RBSL (mg/l)	RTC (mg/l)	Draft/Final
Cis-1,2 Dichloroethene	6.80E+01	7.40E+01	final
Trans-1,2 Dichloroethene	6.80E+01	8.91E+01	final
Notes			
1. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation			
2. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins			
3. "None" indicates theoretical RBSL greater than solubility limit			
4. In the S106 (Ref. 1), only one value was presented for 1,2-Dichloroethene of 68 mg/l.			
5. Where indoor and outdoor values were presented by RBCA, these have been integrated in line with SNIFFER (2003). Where both indoor and outdoor values derived by RBCA were greater than the saturation limit, >sat has been presented. Where indoor values were presented by RBCA, and the outdoor values were >sat, only the indoor values have been presented. Therefore >sat indicates that the theoretical RTC is greater than solubility limit.			
6. TPH >C16 are not considered to be volatile according to TPHCWG. Consequently the inhalation of vapour pathways have not been considered			
7. The potential presence of free product should be assessed in accordance with information in the S106 (Ref. 1).			

5. Conclusions and Recommendations

5.1 Commercial RTC

5.1.1 Conclusions

RTC have been derived for a shallow and deep soil source for a commercial land use. As can be seen in Section 4, some RTC were higher than the RBSL and thus the RBSLs would be protective and suitable for use.

In other cases, the RTC were lower than the RBSL and therefore may not be protective of human health based on the assumptions underpinning the RTC. In such cases the RTC have been marked as draft and may require further assessment.

5.1.2 Recommendations

The lower of the RTC/RBSL is recommended for use in order to be protective for the receptor at the site. It is also recommended that the land use assumptions used to develop the CSM are compared to the development plans to establish whether the RTC are suitable for use. For instance, a less permeable soil type than the sand/sandy loam used within the RTC modelling, may result in a higher RTC and less remediation being required. Information regarding the application of the RTC/RBSL is understood to be presented within the remedial strategy and validation plans (as appropriate).

Should exceedances of the RTC/RBSL be reported, it is recommended that the guidelines outlined in the validation plan (in preparation) are followed.

A number of approaches could be considered for those contaminants where the RTC is lower than the RBSL. The recommended approaches include:

- consideration of building development plans on plot specific basis (e.g. areas of hard standing) versus exceedances of RTC/RBSL;

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B31 2UQ

01/07/2021
Your Ref:
Our Ref: 4020 PJA 21 XX LE 054

Dear Sirs

Monitor Phase 72 Completion Certificate

On behalf of Coed Darcy Limited this letter provides a Monitor Phase Completion Certificate for Monitor Phase 72 at Coed Darcy.

Specifically this letter provides the:

- Redevelopment Remediation Works Completion Certificate (RRWCC), and,
- Remediation Action Plan Works Completion Statement (RAPWCS)

The certification is made with reference to the requirements set out in:

Section 106 Agreement dated 8 February 2008 between Neath Port Talbot Borough Council ("NPTCBC"), St Modwen Developments Limited ("SMD"), St Modwen Properties Plc ("SMP"), BP Oil Llandarcy Refinery Limited ("BPLR") and Coed Darcy Limited ("CDL");

1 The Site

The declared Monitor Phase 72 comprises two parcels of land as shown on the accompanying plan (4020-A-SK901-P0).

Monitor Phase 72 covers a total of approximately 5.4 hectares in the north-east of the Coed Darcy redevelopment site. The Phase is divided into two land parcels, a northern parcel (2.9 hectares) and a southern parcel (2.5 hectares).

Both parcels were located within the BP Llandarcy Oil Refinery.

2 Declared Land Use

Both parcels within Monitor Phase 72 comprise existing developed land for **commercial purposes**.

The northern parcel is currently used for a variety of commercial and light industrial purposes:

- Llancoed Court
- Llancoed House
- Darcy Business Park
- The Courtyard

Buildings comprise one or two story structures with associated hardstanding car parking areas and connecting roadways. Landscaping is limited to local shrub borders and small areas of grass adjacent buildings.

The southern parcel includes the following areas used for commercial purposes:

- Britannic House
- NRW building
- William Knox House
- Heritage House

It is understood William Knox House and Heritage House (predominantly office accommodation) are vacant. Buildings are surrounded by hardstanding car parking areas and grassed landscaped areas.

3 Assessment Guidelines

The requirements of the Remediation Action Plan are set out in Schedule 7 '*The RAP Works*' of the S106 for Coed Darcy. The RAP comprises a number of required actions across the former refinery site although only the RAP works relevant to Monitor Phase 72 are assessed as part of this certificate.

The requirements for Redevelopment Remediation are set out in Schedule 8 '*Redevelopment Remediation Works*' of the S106.

A part of this certification it is assumed that no change of land use or redevelopment of any part of the Monitor Phase 72 is currently proposed.

4 RAP Works

By reference to Table 1 of Schedule 7 no RAP works have been performed on Monitor Phase 72. Similarly there is no reliance on the land within Monitor Phase 72 to enable RAP works to be delivered.

It is also considered that:

- given its existing land use there has been no reasonable opportunity to address Pre-Transfer Date Contamination at, in, or under any such part Monitor Phase 72 since the transfer of the land to St Modwen, and,

- no Environmental Authority requires such works or measures to be performed.

PJA concludes that in its professional opinion the RAP Works have been satisfactorily completed for Phase 72 in accordance with the purpose, objectives and requirements of Schedule 7 of the Section 106 Agreement having regard to the existing developed status of the Phase.

5 Redevelopment Remediation Works

An assessment of Monitor Phase 72 and a validation against the requirements under Section 8 of the S106 for Coed Darcy is provided in:

Ref 1 - Coed Darcy – Monitor Phase 72, Geoenvironmental Validation Report, by PJA – July 2021. Doc re 4020-PJA-21-RP-R-0053

5.1 Site Assessment

The site assessment provided in ref 1 provides the following key elements:

- Desk Study. A comprehensive previous desk study compiled by URS on behalf of BP is used to determine past land uses and the likely geoenvironmental influences.
- Historic Investigations and Remediation Works. The report provides a summary of previous works which have included physical site investigation and soils analysis. Historic investigations informed the scope of localised remediation on the more recently development plots within Monitor Phase 72 (Llancoed House, Llancoed Court).
- Assessment Update. Ref 1 provides the results of an updated environmental assessment for both parcels within Monitor Phase 72 undertaken between May and July 2021. A conceptual site model is formulated based on historic data and the profile of potential contaminants identified. An physical investigation was undertaken in May 2021 to fill data gaps and increase the sampling density. The investigation included probe holes, soil sampling and chemical analysis. Results were compared to the requirements set out in Schedule 8 of the S106 for a commercial end use including the sampling frequencies indicated.
- The observations and results were broadly consistent with previous investigations indicating localised areas of contaminant impact by metals and hydrocarbons including exceedance of the indicative guidelines for a commercial end use.
- The risk assessment indicated that given the current use of the land, which includes significant hardstanding cover, the likelihood or harm from residual contamination was low.

5.2 Remediation

Based on the results of the updated assessment no remediation was considered necessary.

5.3 Conclusion

For the purposes of certification it is considered that the site validation provided in Ref 1 provides a robust assessment of historic and recent data to enable a conclusion to be reached that the site is generally suitable for its on-going use as a commercial business park.

Despite the limitations on access the works are considered to provide a suitable assessment of the site in general accordance with the requirements of Schedule 8 of the S106.

If redeveloped in the future further assessments are likely to be required as part of the planning process and which may require additional works to mitigate localised risks depending on the form of development proposed.

A handwritten signature in black ink, appearing to read 'Mike Poland'.

Yours sincerely

For and behalf of PJA

Mike Poland

Land Development Director

Appendix K RAP Works Reports and Monitor Completion Certificates

St. Modwen Developments Ltd

Coed Darcy Urban Village

RAP Feature 21 – South Site Reservoir

Verification Report

October 2011

Coed Darcy Urban Millage

RA Feature South Site Reservoir Phase Verification Report

October

Notice

This report was produced by *Atkins Ltd* for *St Modwen Developments Ltd* for the specific purpose of verifying the validation of the Remedial Action Plan sludge removal works at South Site Reservoir, Coed Darcy.

This report may not be used by any person other than St.Modwen Developments Ltd without St.Modwen Developments Ltd express permission. In any event, Atkins accepts no liability for any costs, liabilities or losses arising as a result of the use of or reliance upon the contents of this report by any person other than St Modwen Developments Ltd].

Atkins Limited

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Glossary of Terms

Term	Meaning / Definition
ACM	Asbestos Containing Material
EA	Environment Agency
FFL	Finished Floor Level
AOD	Above Ordnance Datum
RAP	Remedial Action Plan
RTC	Remedial Target Criteria
SSSI	Site of Special Scientific Interest
TPH	Total Petroleum Hydrocarbons
V/O	Visual/Olfactory Observations
VOC	Volatile Organic Compounds
SSR	South Site Reservoir

1. Introduction

1.1 Background

The purpose of this report is to document the verification by Atkins of remediation works undertaken and validated by Celtic Technologies Ltd (Celtic) at the South Site Reservoir, at the former Llandarcy Oil Refinery, Neath, South Wales.

Atkins Limited was commissioned by St. Modwen Developments Ltd to provide consultancy advice with regards to the works and in general for the re-development of the former Llandarcy Oil Refinery into the Coed Darcy Urban Village.

The works to South Site Reservoir were commissioned as part of the Remedial Action Plan (RAP) for the Coed Darcy site and in particular as part of a programme of hydrocarbon impacted sludge removal in various water bodies across site. A key objective of the works was to demonstrate environmental improvement in accordance with the requirements of the Section 106 Deed of Planning Conditions for the Coed Darcy development for RAP Remediation.

A RAP specification report (Ref. 1) was prepared by Atkins for the South Site Reservoir (RAP Feature 21). The scope of the works as set out in the S106, Schedule 7, Table 1 is as follows:

- ‘1) Design and implement programme of sludge removal and treatment*
- 2) Prevent / mitigate hydrocarbon seepage from walls and floor of reservoir (150m)*
- 3) “Soften” walls and landscape to satisfaction of CCW to enhance ecological value’*

Items 1 and 2 are relevant to this phase of remedial works carried out by Celtic. Item 3 will be addressed as part of the redevelopment of the South Site Reservoir. The performance criteria for the remedial works, relevant to this phase of works, as set out in the S106 are as follows:

Retain significant portion of South Reservoir as a “clean” water feature

Reduction of hydrocarbon seepage from walls of reservoir as far as possible to satisfaction of EA

All works to be protective of future public health and safety assuming unrestricted recreational use.’

The works were wholly undertaken and controlled by Celtic as set out in their Remediation Strategy (Ref 2). Detailed information on the works is presented within the Celtic South Site Reservoir Verification Report (Ref. 3).

The location of RAP Feature 21 (South Site Reservoir) is shown on a reproduction of the RAP drawing within the S106 and presented as Drawing No. 5041216-RAP-DWG-538 (Appendix A). The South Site Reservoir is within an area of site intended for recreational use within the final development.

1.2 Sources of Information

The previous works and supporting data are summarised in this report and set out in detail in the following documentation:

- Ref 1 - Atkins Ltd Report, ‘Coed Darcy Urban Village Development – ‘Remedial action plan specification. South site Reservoir, East Bay and API Separators’ August 2010, Ref 5041216 – RAP-SPEC-000359
- Ref 2 - Celtic, ‘Coed Darcy Urban Village Development – SSR, EB and API Separators Remediation Strategy’ February 2011, Ref R1434/10/3960.
- Ref 3 - Celtic South Site Reservoir Validation Report (R1434/11/4092), September 2011
- Ref 4 URS Report no. 4438274/BRRP0001 ‘BP Llandarcy Refinery Desk Study’ dated 5th July 2007.

- Ref 5 URS Report no. FR1287 '*Final Factual Report for Whole Site Investigation – BP Llandarcy Refinery*', dated 12th August 2005.
- Ref 6 BGS Sheet 247, 1:50,000 'Swansea' and Sheet 79 NW, 1:10.560

1.3 Parties Involved

The following parties are referred to in this Specification and Contract and the Contractor shall liaise with these parties as necessary prior to commencement of the works and during the works.

- Employer: St Modwen Developments Ltd
- Nominated Client Representative (NR): Prosurv
- Nominated Engineering Representative (NER): Atkins Ltd
- The Monitor: URS Scott Wilson Ltd
- Contractor: Celtic Technologies Ltd

2. Review of Available Information

2.1 General

The South Site Reservoir (SSR) is located to the north west of the former BP Llandarcy Oil Refinery and the sludge removal works cover an area of approximately 1500m². The area of works is defined as Phase 11 for the purpose of Monitor completion. Drawing 5041216-RAP-DWG-001044 shows the Phase boundary, which comprises the area across which the remediation of hydrocarbon impacted sludges was undertaken.

A number of previous investigations have been undertaken by former owners BP across the former refinery. The information from the investigations procured by BP is summarised in section 2.4.

2.2 Site History

South Site Reservoir was constructed at the start of the refineries operation to supply a source of water in the case of potential fires on site.

The reservoir was historically fed by water from the triangular separators. The reservoir is no longer connected to the site drainage infrastructure and is believed to be fed by perched water and groundwater via basal flow. The outfall of the reservoir has been artificially lowered by a break in the former wall, in order to reduce the capacity so that it is no longer classified as a reservoir.

The depth of water across the SSR during the sludge investigation carried out by Celtic in 2010 was 0.8m.

2.3 Site Features

The SSR is listed in the S106 as a RAP feature identified as requiring remedial works due to the presence of hydrocarbon impacted materials and hydrocarbon seepages from the walls of the reservoir.

The reservoir is no longer connected to the site drainage infrastructure but does still contain an emergency draw down feature (as shown in Appendix E).

2.4 Baseline Condition

The baseline condition was established following a number of investigations within and around the South Site Reservoir. The investigation data was used by Atkins to confirm the local geology, groundwater regimes and contaminant profile.

Historic Data

A review of historical ground investigation information identified 24 exploratory holes (see drawing 5041216-RAP-DWG-1034) around the periphery of the SSR. Boreholes to the south and east of the South Site Reservoir recorded Made Ground thicknesses, where encountered, ranging from 0.2m (RHRW028) to 3.5m (MSTP215). Made ground was not encountered to the west of South site reservoir. Natural geology was encountered underlying the Made Ground or from ground level consisting of sand, silts, and gravels. The glacial material ranged in thickness from 2.8m (RHRW025B) in the east to 13.0m (MSMW103D) in the west. Sandstone bedrock was encountered at depths ranging from 2.2mbgl to 9.9mbgl and was proven to a depth of 13mbgl (MSMW217D).

Instances of free product were recorded in two of the exploratory holes during either drilling or subsequent monitoring. Product was encountered during drilling on the groundwater at 3.4m (MSTP260) and in the Made Ground at 0.5m (WSMW005).

Free product has been recorded during monitoring of the wells on the east side of the SSR. In 2008 three of the ten wells monitored recorded thicknesses of free product ranging from trace/

1cm (RHRW028/ RHRW029) to 29cm (RHRW035). In 2010 free product was monitored in the same wells but the recorded thickness had reduced ranging from 1cm (RHRW028) to 10cm (RHRW035). The monitoring results are presented in Appendix C.

Copies of the relevant logs are shown in Appendix B and the available monitoring data for the exploratory holes is shown in Appendix C.

Celtic Investigation 2010

Celtic carried out an investigation on SSR in September 2009 to assess the thickness and composition of the material at the base of the reservoir. The investigation works included the recovery of samples at 11 locations within South Site Reservoir. The results from the five samples sent for chemical analysis recorded TPH concentrations ranging from 170,000mg/kg to 1,100,000mg/kg (the result is higher than the samples dry mass but is attributed to measurement uncertainty in each fraction banding by the laboratory). The findings of the investigation are summarised within the remediation strategy, R1434-10-3960, dated 11st February 2011.

Atkins Investigation 2010

Atkins excavated three pits to the east of the SSR boundary. The three pits (WM09, WM10 and WM11) were installed with 600mm diameter HDPE slotted pipe to allow for monitoring of the groundwater and potential product recovery if required. No samples were taken during the excavation of these pits. A summary of the monitoring information is shown in Table 2.1 below.

Table Summary of monitoring sumps

Sump Number	Strata installed in	Depth	24 Monitoring Rounds Complete (started 25 th Feb 2010 to Present Day)	Water range encountered
WM09	Natural soils. Sump removed to allow access for sludge removal works	1.5m	No product recorded encountered	No water encountered
WM10	Natural soils	3.0m	One instance of free product recorded • droplets noted on March 24 th 2010 No evidence of oil since other than a sheen noted on 7 th Sept 2010	1.7m to 3.0m Sump dry when SSR had been dewatered
WM11	Natural soils	2.5m	Free product recorded • droplets noted between 25 th Feb & 7 th April 2010 No evidence of oil since other than slight sheens on 12 th May 2010 & 24 th Jan 2011	0.3m to 1.0m Sump dry when SSR had been dewatered

The monitoring carried out indicates that the surrounding ground can be discounted as a potential source of free product. The monitoring of the exploratory holes will continue as part of the general site supervision works.

Five sludge samples were taken by Celtic from SSR prior to the removal of the hydrocarbon impacted sludge and screened against the Recreational RTC for shallow soils. The samples recording concentrations in excess of the Recreational RTC for shallow soils are shown in Table 2.2 below. The locations of the sludge samples are shown on D1357/3730/A3 in Ref 2.

Table re remediation Sludge Sample E eedances

Determinant	Arsenic	Cadmium	Copper	Lead	Mercury	Nickel	Zinc	Aliphatic Hydrocarbons				Aromatic Hydrocarbons				B(a)A
In mg/kg								C8 – C10	C10 – C12	C12 – C16	C21 – C35	C10 – C12	C12 – C16	C16 – C21	C21 – C35	
Recreational RTCs**	64	2.6	143	337	1	50	478	5740	5800	159000	159000	2300	2330	1450	1450	20.8
SSR 4 sludge	-	12	170	-	3.1	81	2300	19000	41000	77000	-	14000	56000	75000	96000	71
SSR 5 sludge	-	9.5	-	-	2.3	68	2000	29000	65000	130000	-	19000	110000	83000	120000	64
SSR 6 sludge	82	17	220	370	1.9	120	3100	26000	61000	160000	230000	13000	100000	120000	200000	-
SSR 7 sludge	-	22	150	340	3.4	120	3300	14000	52000	170000	-	12000	110000	51000	33000	-
SSR 10 sludge	-	2.8	-	-	-	-	530	-	8000	13000	-	-	8300	8600	22000	-

*Benzo(a)Anthracene

**Samples were screened against Recreational RTCs the final land use is likely to be managed public access

3. Works Summary and Verification

Chapter 3 summarises the remediation work undertaken and presents the information collected by Atkins to independently verify the data provided within Celtic's validation report.

3.1 Summary of Remedial Works

Celtics works comprised:

- Production of a remediation strategy for the removal of sludge (Ref 2)
- Preparation of Hydrocarbon impacted sludge reception area, including leachate collection system,
- Construction of access road to the SSR and haul road to the treatment area,
- Sludge removal equipment mobilisation, including long reach excavator,
- Dewatering of SSR by pumping the water into the North Site Reservoir API separators,
- In situ inclusion of wood chip with sludge to improve stability of basal materials and allow excavation by machine,
- Removal of stabilised sludges by long reach excavator,
- transport of excavated sludges to the treatment area,
- Construction of bio-piles within designated treatment area for bio-remediation,
- Monitoring and removal of hydrocarbon seepage from the walls and floor of the reservoir,
- Validation sampling of remediated base,
- Production of Contractors Validation Report.

Sludge removal works commenced on 3rd March 2011 and were complete by 5th July 2011.

The treatment of the sludge is being undertaken on part of the railhead area and is ongoing at the time of writing. The validation and verification of the bio-remediation operation will be subject to separate reporting and will not be covered further within this report.

The volume of hydrocarbon impacted material removed from the South Site Reservoir to the treatment area was approximately 8,000m³ (including approximately 4,000m³ of wood chip and compost). The full details of the sludge removal works are included within the validation report produced by Celtic (Ref 3).

3.2 Remediation Standards

Within the works Specification the Contractor was required to demonstrate the removal of 'all' hydrocarbon impacted material, including impacted sludge from the base and sides of the South Site Reservoir. The remedial works also monitored and, where necessary, removed hydrocarbon seepages from the walls and floor of the reservoir (Ref. 3). Notwithstanding the need to achieve the general performance criteria set out in the S106 Agreement Atkins monitoring and verification of the works were undertaken with recognition of the possible impracticality of the removal of 'all' impacted materials (i.e. minor oil stains and sheening). It was considered impractical to excavate through the structure of the reservoir to confirm the absence of free product as it may have compromised the stability of the structure.

The key aim was therefore to achieve a restoration quality for a retained water body whereby; i) the de-sludged profile would contribute to a significant environmental and aesthetic improvement and ii) the residual contamination profile was considered unlikely to adversely impact future use or amenity value.

To achieve a degree of assurance that the works has broadly achieved the requirements of the contract Atkins criteria for verification were as follows:

- Visual and olfactory evidence of removal by inspections of the base and sides following sludge removal
- Selected trial excavations in the base of the de-sludged South Site Reservoir.
- Obtaining selected samples for detailed inspection and analysis
- Observations of the base materials including evidence that underlying non impacted material was exposed
- Observations of base seepages prior to backfilling
- Observations of the quality of water following refilling and the nature of continuing inputs from surrounding sources of water.

3.3 Verification of Remedial Works

Trial Excavations and Sampling

Prior to the South Site Reservoir being allowed to refill with water Atkins collected eight verification samples from the remediated profile at the same time as Celtic recovered their 51 validation samples. A total of 59 validation and verification samples were collected and sent for chemical analysis.

The samples were recovered by an excavator and were collected from the surface of the remediated profile. Excavations to confirm the absence of hydrocarbon impacted material underlying the remediated profile were undertaken and extended from approximately a depth ranging from ground level to 0.3mbgl.

In the absence of specific human health remediation criteria the results were screened against surface recreational remedial target criteria (RTCs). Concentrations recorded in the samples from the remediated profile were not in exceedance of the relevant RTCs.

As these soils will be submerged within the final development, this will help to further reduce any risks upon future users of this area of the site.

Basal Inspection

Prior to allowing the SSR to refill Atkins undertook a general inspection of the remediated profile. The inspection was undertaken from the base of the South Site reservoir. The following observations were made:

- Basal soil comprised dense, silty, sandy, gravel.
- Ochreous groundwater seepages were evident on the base in the eastern side of the remediated profile.
- The base appeared free of material considered to comprise hydrocarbon impacted sludge.
- Localised sheens were noted associated with ochreous seepages

The visual condition of the remediated profile appeared to be clean with rare instances of light staining and no evidence of significant hydrocarbon residues including free phase oil. A photographic record of the works and sludge removal works shows the remediated profile within the SSR (Appendix E). Table 3.1 shows the V/O criteria and Table 3.2 shows the V/O scores for

the samples collected and Drawing 5041216-DWG-RAP-001044 shows the locations of the sample positions.

Table Aesthetic Criteria (as defined within the S106 Schedule 8, Table 3 “Scale of aesthetic criteria”).

AEST ETIC CRITERIA		
Rating	isual	Olfactory
0	No Staining	No Odour
1	Occasional Discolouration	Faint Odour
2	Frequent Discolouration	Distinct but not strong
3	Small amounts of heavy staining	Strong odour
4	Heavy black staining	Strong odour discernable in ambient air
5	Visible product	Very strong odour very discernable in ambient air

Table Validation Verification isual and Olfactory Assessment

Sample name	Celtic V/O	Atkins V/O	Sample name	Celtic V/O	Atkins V/O
SSR 1	0/0		SSR 27	0/0	
SSR 2	1/1		SSR 28	0/0	
SSR 3	0/0		SSR 29	1/0	
SSR 4	0/0		SSR 30	0/0	0/0
SSR 5	0/0		SSR 31	0/0	0/0
SSR 6	1/2	0/1	SSR 32	0/0	0/0
SSR 7	0/0	0/1	SSR 33	1/1	
SSR 8	0/0	0/1	SSR 34	0/0	
SSR 9	0/0	0/1	SSR 35	0/0	0/1
SSR 10	0/0		SSR 36	0/1	0/1
SSR 11	0/0		SSR 37	0/2	0/1
SSR 12	0/0		SSR 38	0/0	0/0
SSR 13	1/1	1/ 2	SSR 39	1/1	
SSR 14	0/0		SSR 40	0/0	
SSR 15	1/1	0/0	SSR 41	0/0	0/0
SSR 16	1/1	0/0	SSR 42	0/0	
SSR 17	1/1	2/2	SSR 43	0/0	
SSR 18	0/0	0/0	SSR 44	0/0	
SSR 19	0/0		SSR 45	0/0	
SSR 20	0/0	0/0	SSR 46	0/0	
SSR 21	0/0		SSR 47	1/1	
SSR 22	0/0		SSR 48	1/1	
SSR 23	0/0	2/3	SSR 49	0/0	
SSR 24	1/1		SSR 50	0/0	
SSR 25	0/0		SSR 51	1/1	
SSR 26	0/0	1/ 2			

3.4 Reinstatement and Post Remediation Observations

Following the remedial works no evidence of hydrocarbon seepage was present within the SSR. General observations of the South Site Reservoir undertaken at varying periods following completion of the works are as follows:

- Visual appearance of the South Site Reservoir is considered much improved over the pre-remediation condition (Appendix E)
- Seepages of water entering the reservoir are ochreous with no evidence of free product

Sampling – Water

The main source of water to the SSR is thought to be from groundwater seepages; there are no known surface water discharges into the SSR at this time. Therefore, recharge of water to the SSR is solely from groundwater. Water discharges from the SSR via a break along the north of the retaining wall, where it enters Crymlyn Brook at the EA discharge consent point (W1). Groundwater flows in a roughly east to west direction from the site around the SSR (see URS report FR1287; Figure 10).

The groundwater entering the SSR following the completion of the sludge removal was iron rich (as visualised from the precipitation of ochre) and had no evidence of free product. In order to assess the quality of water within the remediated reservoir, samples were collected from two seepages present in the south eastern section of the reservoir where the slope meets the reservoir floor (as indicated on Drawing 5041216-RAP-DWG-1044) and two samples were collected from the main body of water. The samples were sent for chemical analyses for TPHs. A summary of the results for the seepages and groundwater in the area are presented in Table 3.3. The laboratory reports are included in Appendix D. The discoloration of the SSR by ochreous precipitate is not considered significant in terms of water quality. However, ochreous discolouration is not beneficial to aquatic life and solutions to improve the water colour will be considered as part of the redevelopment of the SSR.

In order to put the groundwater quality data into context, with regard to hydrocarbons, data from a range of boreholes and sumps from around the SSR (see Drawing 5041216-RAP-DWG-1034) has been compared against the reported concentrations of the samples taken from the SSR. The results of the groundwater analyses indicate that the groundwater quality entering the SSR is better than or equal to the groundwater quality along the eastern margin of the SSR, specifically similar to the water sumps. This is consistent with the groundwater flow in the area of east to west.

The water quality to the south of the SSR does not appear to impact the water quality in or around the SSR and is consistent with the hydrogeology in the area. The seepages sampled within the SSR are below the Residential Remedial Target Criteria for groundwater. The surface water samples collected from within the SSR when compared with relevant EQS criteria show that all concentrations recorded are less than the relevant EQSs for freshwater. The groundwater quality entering the SSR and the surface water quality within the SSR are considered to be clean with regard to criteria set for the site and for wider environment.

The results of the water samples are also well below the concentration for total oils (10mg/l) at the EA discharge consent at W1 (refer to Drawing 1044) and it is therefore not anticipated that discharge from the SSR will impact on the quality of the water at the EA discharge consent point.

Table T **sum of aliphatic and aromatic summary of the water quality in and around the SSR**

Sample ref	ate	C C	C C	C C	C C	C C	C C	C C
		g l	g l	g l	g l	g l	g l	g l
WMS 9	03/10	10	30	20	20	211	570	810
WMS 10	03/10	10	30	20	20	20	20	20
WMS 11	03/10	10	30	20	20	403	952	1452
WSMW005	03/10	88.3	1520	3510	4850	10330	31700	72100
WSMW006	03/10	19.3	136	93.3	331	2403	1127	6050
MSMW103D	11/09	10	30	20	20	24	130	190
MSMW103D	02/10	10	30	20	20	20	20	20
MSMW103D	04/10	10	30	20	20	20	20	20
MSMW103D	12/10	10	30	20	20	20	20	20
MSMW104	11/09	460	1236	300	310	172	160	239
MSMW104	02/10	143	1780	393	545	369	31	20
MSMW104	04/10	753	1840	509	633	672	220	195
MSMW104	12/10	677	2280	793	873	920	239	170
SSR POOL 1	07/11	10	40	27	32	20	20	20
SSR POOL 2	07/11	10	30	20	28	25	45	20
SSR SEEP 1	07/11	77	677	256	552	349	585	1247
SSR SEEP 2	07/11	10	33	53	129	20	20	20
SSR Surface	09/11	10	10	10	10	10	30	91

4. Conclusion

In the context of the proposed end use of the site and the surrounding area it is considered that a suitable restoration standard has been achieved within the confines of the South Site Reservoir which has led to a significant improvement in water, land and aesthetic quality at this location.

External Hydrocarbon Impacts

The sources external to South Site Reservoir include occasional ochrous seepages into the south site reservoir which can create isolated sheening. The progression of the redevelopment of the remainder of the former refinery to the east is considered to further lead to an overall reduction in the mobilisation of dissolved hydrocarbon residues towards SSR.

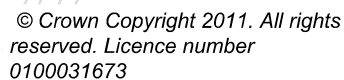
Residual Basal Quality

Overall the base of the South Site Reservoir has been demonstrated to be free of significant hydrocarbon impacted material. Water quality monitoring and observations by Atkins indicate that the water entering the SSR is better than or consistent with the surrounding groundwater and demonstrates a local environmental improvement in accordance with the objectives of the remediation.

Based on the observations and activities summarised in preceding sections it is considered that the works undertaken by Celtic have achieved the requirements of the RA in relation to the removal of hydrocarbon impacted materials and removal of hydrocarbon seepages from the walls of the South Site Reservoir RA feature as set out in the Section Agreement for the Coedarcy development

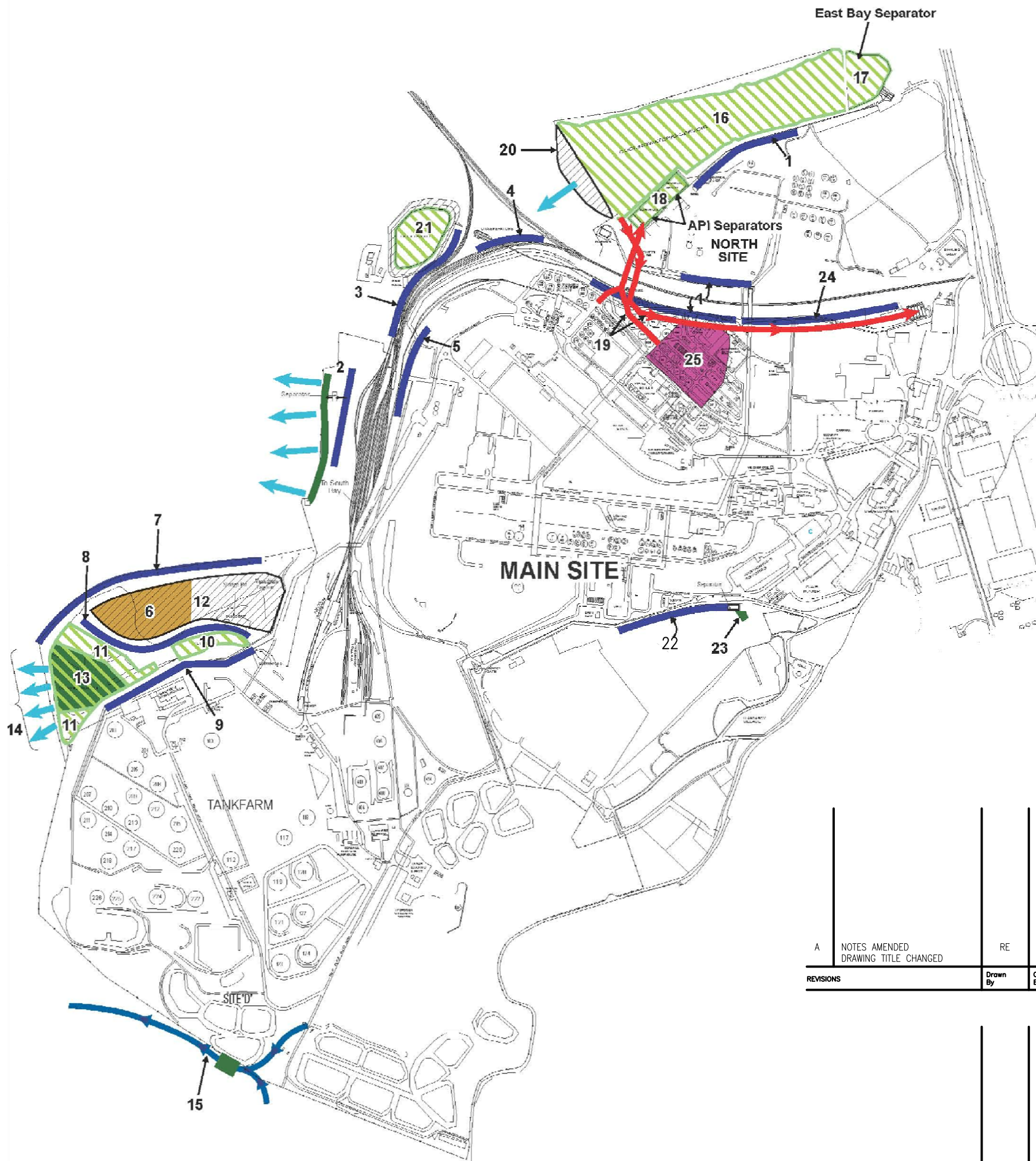
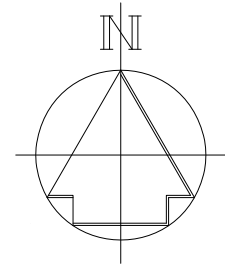
Further it is considered that Celtic's contractual obligations with respect to the removal of impacted material have been achieved to a degree considered satisfactory to Atkins

Appendix A Drawings



Celtic pre-remediation sample locations

DRAWING NO	REV
5041216-REM-DWG-1034	-



NOTES

1. THE FOLLOWING HAS BEEN AMENDED BY ATKINS – REFERENCE NUMBER 27 HAS BEEN REPLACED BY 22 FROM ORIGINAL DRAWING PROVIDED IN S106.

Key

- Diffuse Discharge
- Free product monitoring/interception
- Free product source reduction
- Oily sludge removal & treatment
- Constructed wetland
- Earthwork/capping/landscaping
- Remove/reconfigure drainage
- Source reduction/containment

A	NOTES AMENDED DRAWING TITLE CHANGED	RE	ML	10/03/10
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REVISIONS	Drawn By	Checked By	Date
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LLANDARCY BOG RAP REPORT	–	MP	02/09/09
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PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
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THIS DRAWING IS NOT TO BE SCALED

CLIENT

ST.MODWEN

PROJECT
COED DARCY URBAN VILLAGE

DRAWING TITLE
RAP FEATURES PLAN

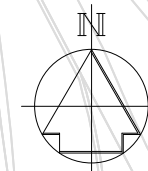
SCALES	DRAWN	CHECKED	CO-ORD CHECK
1:10,000	AJ	SB	
DATE	DATE	DATE	DATE
02/09/09	02/09/09		

0	SHEET	PLOT DATE
	A3	10/03/10

DRAWING NO	REV
5041216-RAP-DWG-538	A

KEY:

- PHASE BOUNDARY 11
- ① ATKINS SEEPAGE SAMPLE LOCATIONS
- SSR46 VALIDATION SAMPLE LOCATION
- SSR41 VALIDATION & VERIFICATION SAMPLE LOCATION
- + EMERGENCY DRAIN FOR RESERVOIR
- BANK PROTECTION (PLACED STONE)
- REDUNDANT PIPEWORK
- W1 EA DISCHARGE CONSENT POINT



OUTLET POINT

FORMER SITE
DRAINAGE
INLET POINT

REVISIONS	Drawn By	Checked By	Date
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PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
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PROJECT
COED DARCY URBAN VILLAGE

DRAWING TITLE
SOUTH SITE RESERVOIR VERIFICATION WORKS

SCALES	DRAWN	CHECKED	CO-ORD CHECK
1:1000	JSD	HM	
	DATE	DATE	DATE
	10/10/11	10/10/11	

DRAWING NO	SHEET	PLOT DATE	REV
5041216-RAP-DWG-1044	A3	10.10.11	-

Appendix B Exploratory Hole Logs

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW106		PAGE 1 of 1	
	NUMBER	TYPE					START DATE: 9/3/99	DRILLING METHOD: CABLE PERCUSSION	FINISH DATE: 9/3/99	BOREHOLE DIAMETER: 150 mm
							DESCRIPTION	COMMENTS		
							Soft brown silty CLAY with occasional fine gravel	No odour	0	
							Soft orange, slightly silty CLAY with occasional fine gravel	No odour		
							Moderately dense blue-grey coarse sandstone GRAVEL with cobbles and silty clay		1.0	
							Soft brown and orange mottled slightly gravelly silty CLAY			
							Soft brown very gravelly (medium to coarse sub-rounded) SILT with some clay. Becoming more gravelly with depth	No odour	2.0	
							Medium dense grey-brown sandstone COBBLES with gravel	Water strike at 2m No odour from bailed water	3.0	
								Borehole productive from 2.5m Predominantly gravel returns from 2m	4.0	
							Borehole terminated 4.4mbgl		5.0	
									6.0	
									7.0	
									8.0	
									9.0	
									10	

LOCATION / NOTES: 1. All measurements in m below ground level (mbgl)		LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table		BOREHOLE LOG Job Title SOIL & GROUNDWATER INVESTIGATION Location LLANDARCY REFINERY Client BP LLANDARCY LTD App'd DRAFT Ref. CR/MC/BRS Date MAY 99 Job No. 39991-004-401		DAMES & MOORE GROUP	
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BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW104		PAGE 1 of 1	
	NUMBER	TYPE					START DATE: 9/3/99	DRILLING METHOD: CABLE PERCUSSION		
							FINISH DATE: 9/3/99		BOREHOLE DIAMETER: 150 mm	
							DRILLER: CP1		SCREEN TYPE & DIAMETER: 50 mm ID UPVC	
							LOGGED BY: SG APPR'D BY:		SCREEN SLOT SIZE: 0.5 mm	
							DESCRIPTION		COMMENTS	
					0		Soft brown silty CLAY becoming orange-brown at 0.3m		No odour	0
			*15.3		1.0		occasional to frequent medium sub-angular sandstone gravel at 1m			1.0
			*11.1		2.0		Soft brown sandy silty CLAY		No odour	2.0
			*14.0		3.0					3.0
			*9.7		4.0		Soft grey slightly gravelly SILT		No odour	4.0
			*7.9		5.0					5.0
			*9.6		6.0		Medium dense grey-brown silty fine to coarse GRAVEL with some coarse sand and frequent sandstone cobbles		Damp at 5.8m Slight hydrocarbon odour from returns Water strike at 6.1m	6.0
			*>2000		7.0					7.0
					8.0				Blowing sand and gravel at	8.0
					9.0					9.0
					10					10

LOCATION / NOTES: 1. All measurements in m below ground level (mbgl)		LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table		BOREHOLE LOG Job Title SOIL & GROUNDWATER INVESTIGATION Location LLANDARCY REFINERY Client BP LLANDARCY LTD App'd DRAFT Ref. CR/MC/BR5 Date MAY 99 Job No. 39991-004-401			
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BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW103S		PAGE 1 of 1	
	NUMBER	TYPE					START DATE: 8/3/99		DRILLING METHOD: CABLE PERCUSSION	
							FINISH DATE: 9/3/99		BOREHOLE DIAMETER: 150 mm	
							DRILLER: CP1		SCREEN TYPE & DIAMETER: 50 mm ID UPVC	
							LOGGED BY: SG APPR'D BY:		SCREEN SLOT SIZE: 0.5 mm	
					DESCRIPTION		COMMENTS			
*1048 *1317 					0 Soft dark brown slightly gravelly SILT with some white flecks		No dour		0	
					1.0 Loose brown, slightly sandy SILT with occasional cobbles		No dour Chiselling at 1m Chasing boulder from 0-1m		1.0	
					2.0 Soft brown, slightly silty CLAY with occasional fine gravel		No returns from 1-2m		2.0	
					4.0 Medium dense, brown, medium to coarse GRAVEL with some clay and frequent cobbles		Water strike at 4m rising to		4.0	
					6.0					6.0
					7.0					7.0
					8.0					8.0
					9.0					9.0
					10					10

LOCATION / NOTES:

- All measurements in m below ground level (mbgl)
- Soil vapour results appear to be natural and not hydrocarbon caused
- No soil vapour results from 1.5m due to poor returns

LEGEND

- Disturbed Sample
- Undisturbed Sample
- * Headspace Analysis
- † Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title **SOIL & GROUNDWATER INVESTIGATION**

Location **LLANDARCY REFINERY**

Client **BP LLANDARCY LTD**

App'd **DRAFT**

Ref. **CR/MC/BRS**

Date **MAY 99**

Job No. **39991-004-401**

DAMES & MOORE
GROUP

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW103D		PAGE 1 of 2	
	NUMBER	TYPE					START DATE: 23/3/99		DRILLING METHOD: ROTARY AIR FLUSH	
							FINISH DATE: 24/3/99		BOREHOLE DIAMETER: 165 mm	
						DRILLER: R3		SCREEN TYPE & DIAMETER: 50 mm ID UPVC		
						LOGGED BY: JC APPR'D BY:		SCREEN SLOT SIZE: .05 mm		
							DESCRIPTION	COMMENTS		
							Soft dark brown slightly gravelly SILT with some white flecks	Dry. No hydrocarbon odour		
							Loose brown, slightly sandy SILT with occasional cobbles			
							Soft brown, slightly silty CLAY with occasional fine gravel			
							Medium dense, brown, medium to coarse GRAVEL with some clay and frequent cobbles	damp at 3.4m Water strike at 4m		
							Brown-grey clayey SILT with frequent gravel			
							Brown-grey silty CLAY with frequent gravel	Dry to slightly damp		
							becoming more gravelly at 9.4m	No hydrocarbon odour		
							Grey very gravelly silty CLAY			
LOCATION / NOTES: 1. All measurements in m below ground level (mbgl)						LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table		BOREHOLE LOG Job Title SOIL & GROUNDWATER INVESTIGATION Location LLANDARCY REFINERY Client BP LLANDARCY LTD App'd DRAFT Ref. CR/MC/BRS Date MAY 99 Job No. 39991-004-401		



DAMES & MOORE

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW103D		PAGE 2 of 2		
	NUMBER	TYPE					START DATE: 23/3/99		DRILLING METHOD: ROTARY AIR FLUSH		
							FINISH DATE: 24/3/99		BOREHOLE DIAMETER: 165 mm		
							DRILLER: R3		SCREEN TYPE & DIAMETER: 50 mm ID UPVC		
				LOGGED BY: JC APPR'D BY:		SCREEN SLOT SIZE: 0.5 mm					
						DESCRIPTION		COMMENTS			
						10		Grey very gravelly silty CLAY		Dry at depth but water at 10.9m after 30 mins standing time	
						11					
						12		clay content decreasing, gravel content increasing at 12m			
						13					
						14					
						15					
						16					
						17					
						18					
						19					
						20				20	

LOCATION / NOTES:

1. All measurements in m below ground level (mbgl)

LEGEND

- Disturbed Sample
- Undisturbed Sample
- Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title **SOIL & GROUNDWATER INVESTIGATION**

Location **LLANDARCY REFINERY**

Client **BP LLANDARCY LTD**

App'd **DRAFT**

Ref. **CR/MC/BRS**

Date **MAY 99**

Job No. **39991-004-401**

DAMES & MOORE
GROUP