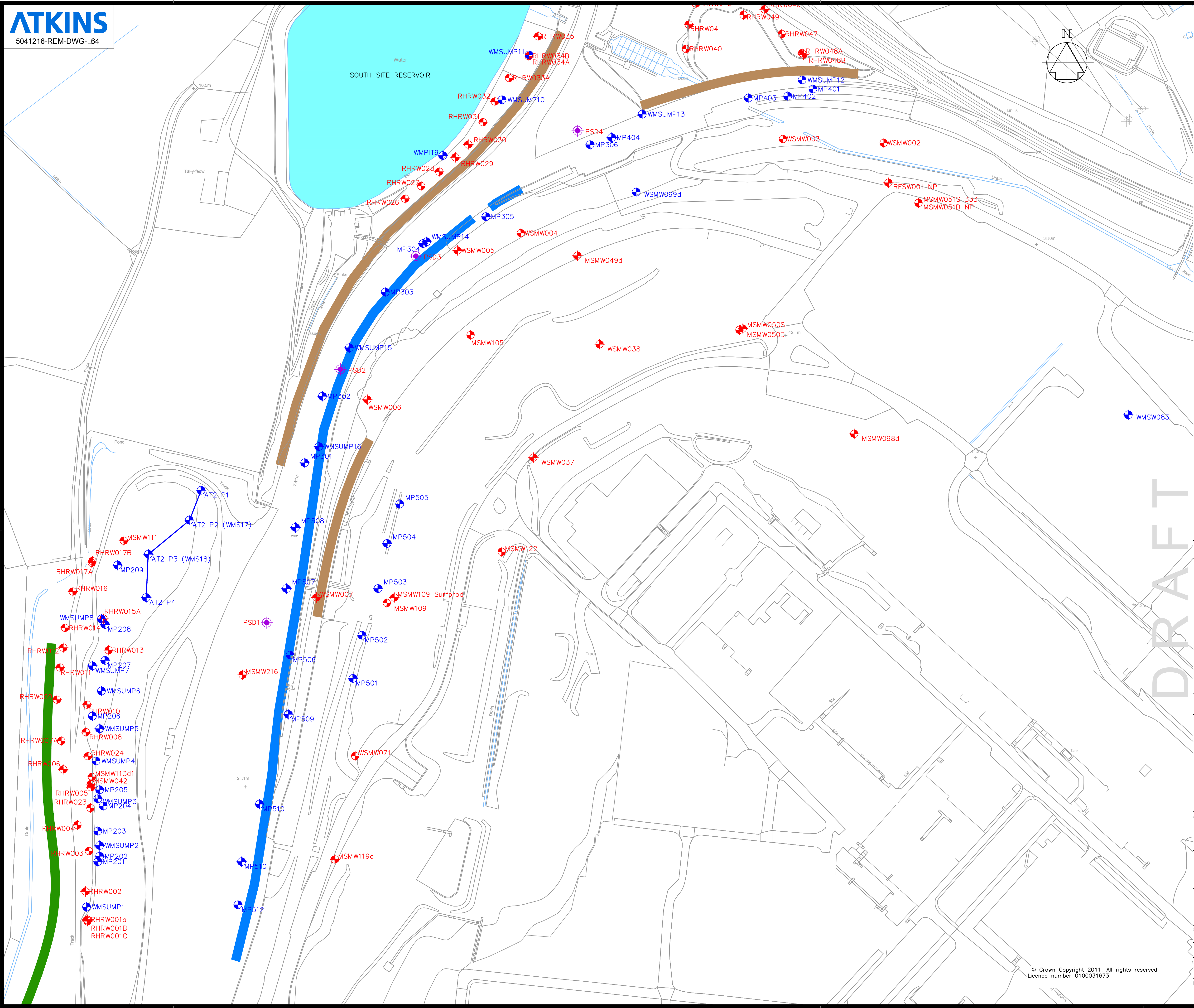


Key

- Planning boundary
- Surface flow
- Through flow
- Sandstone scree
- Artesian borehole
- Cut
- Fill
- Approximate area remediated by Churngold (2006/2007)

SOUTH SITE
RESERVOIR

DRAFT		Drawn By	Checked By	Date
PURPOSE OF ISSUE		Rev.	Authorised for issue	Date
Atkins Limited Telford Office Cornerstone House Stafford Park 13 Telford TF3 3AZ Tel 01952 201234 Fax 01952 200981				
Birmingham Office The Axis, 10 Holliday Street Birmingham West Midlands B1 1TF Tel 0121 483 5000 Fax 0121 483 5252				
THIS DRAWING IS NOT TO BE SCALED				
CLIENT ST.MODWEN				
PROJECT Coed Darcy Development				
DRAWING TITLE Western Margin ground and surface water flow				
SCALES 1:2000	DRAWN MJ	CHECKED HM	CO-ORD CHECK	
DATE 26.01.11	DATE 26.01.11	DATE	DATE	
DRAWING NO 5041216 - REM - DWG - 63		SHEET A3	PLOT DATE 26.06.13	
REV		A		



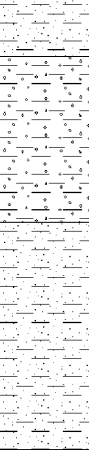
- KEY
- MP TRIAL PIT LOCATION
 - TRENCH
 - AT2 TRIAL PIT LOG? AT2P1-4
 - PSD SOIL SAMPLING FOR PSD TEST
 - WMS MONITORING SUMP
 - RHRW DRAW DOWN TESTS UNDERTAKEN AT EACH HISTORICAL BOREHOLE LOCATION
 - FREE PRODUCT MONITORING/INTERCEPTION
 - CONSTRUCTED WETLAND
 - SURFACE WATER MONITORING TRENCH
- NOTE
- WMS17 INSTALLED AT AT2P2
 - WMS18 INSTALLED AT AT2P3

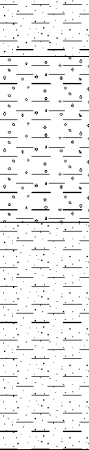
REVISIONS				Drawn By	Checked By	Date
PURPOSE OF ISSUE				Rev.	Authorised for issue	Date
Telford Office				Birmingham Office		
Cornerstone House				The Axis, 10 Holiday Street		
Stafford Park 13				Birmingham		
Telford TF3 3AZ				West Midlands B1 1TF		
Tel 01952 201234				Tel 0121 483 5000		
Fax 01952 200981				Fax 0121 483 5252		
THIS DRAWING IS NOT TO BE SCALED						
CLIENT				ST.MODWEN		
PROJECT				COED DARCY URBAN VILLAGE		
DRAWING TITLE				COMPOSITE EXPLORATORY HOLE LOCATION PLAN		
Scale	1:1000	DRAWN	M.J.	CHECKED	T.A.	CO-ORD CHECK
		DATE	27.01.11	DATE	27.01.11	DATE
0				SHEET A1		PLOT DATE 02.03.12
DRAWING NO				REV		
5041216-REM-DWG-164				-		

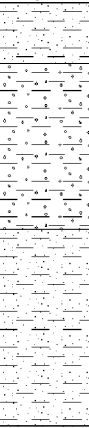
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23 November 2010	Product	PS	PS	NP
	Depth to water	3.6	1.3	1.9
24 January 2011	Product	PS	PS	NP
	Depth to water	2.9	GL	1.2
17 February 2011	Product	NP	NP	NP
	Depth to water	0.8	0.8	1.3
11 March 2011	Product	SS	SS	NP
	Depth to water	2.87	0.61	1.21
27 April 2011	Product	SS	SS	NP
	Depth to water	3.5	2.63	1.89
29 November 2011	Product	NP	NP	NP
	Depth to water	1.39	1.45	2.78
04 January 2012	Product	NP	NP	NP
	Depth to water	1.41	1.21	2.22
26 January 2012	Product	NP	NP	NP
	Depth to water	1.34	1.45	2.64
30 April 2012	Product	NP	SS	NP
	Depth to water	0.2	1.2	1.9
18 July 2012	Product	NP	NP	NP
	Depth to water	0.2	0.2	1.8
29 August 2012	Product	Could not	NP	NP
	Depth to water	find	0.835	2.024
17 September 2012	Product	NP	NP	NP
	Depth to water	1.41	1.16	2.08
10 October 2012	Product	NP	NP	NP
	Depth to water	0.75	0.31	1.745
18 December 2012	Product	NP	NP	NP
	Depth to water	0.64	0.56	1
24 January 2013	Product	NP	NP	NP
	Depth to water	0.64	0.48	1.38
06 February 2013	Product	NP	NP	NP
	Depth to water	0.71	0.56	1.07
22 February 2013	Product	NP	NP	NP
	Depth to water	1.09	0.3	1.22
06 March 2013	Product	NP	NP	NP
	Depth to water	2.09	0.5	1.32
18 March 2013	Product	NP	NP	NP
	Depth to water	0.57	1.2	1.6
16 April 2013	Product	NP	NP	NP
	Depth to water	0.56	1.56	1.78
13 May 2013	Product	NP	NP	NP
	Depth to water	3.01	2.76	2.04

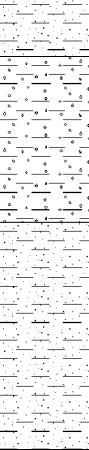
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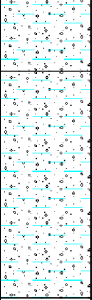
PS	Product Sheen
SS	Slight Sheen
NP	No Product/Sheen

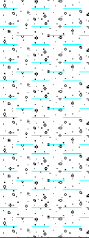
Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 28/05/2009 End Date: 28/05/2009		Site Level (mAOD): Easting: 270837.00 Northing: 195980.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.40		0.40	Soft brown sandy CLAY (Glacial Till).	
			1.10			Firm stained grey (2) with light hydrocarbon odour (2) gravelly CLAY. Gravel is subangular to subrounded coarse of quartz and sandstone (Glacial Till).	
			1.50			Firm grey/brown very sandy gravelly CLAY. Gravel is subangular to subrounded medium and coarse of sandstone with frequent cobbles of sandstone and quartz (Glacial Till).	
					3.00	End of Trial Pit at 3.00 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: No groundwater encountered.				Stability: Trial pit stable.		General Remarks: Pit terminated at 3.0m. No samples taken. Backfilled with arisings. No groundwater encountered. Visual rating 2 - frequent discolouration. Olfactory rating 2 - distinct but not strong odour.	

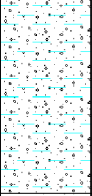
Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 28/05/2009 End Date: 28/05/2009		Site Level (mAOD): Easting: 270842.00 Northing: 196004.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.40		0.40	Soft brown sandy CLAY (Glacial Till).	
			1.10			Firm stained grey (3) with light hydrocarbon odour (2) gravelly CLAY. Gravel is subangular to subrounded coarse of quartz and sandstone (Glacial Till).	
			1.50			Firm grey/brown very sandy gravelly CLAY. Gravel is subangular to subrounded medium and coarse of sandstone with frequent cobbles of sandstone and quartz (Glacial Till).	
					3.00	End of Trial Pit at 3.00 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: Groundwater ingress from surface.				Stability: Trial pit stable.		General Remarks: Pit terminated at 3.0m. No samples taken. Pit backfilled with arisings. Groundwater ingress from surface. Visual rating 3 - small amounts of heavy staining. Olfactory rating 2 - distincy but not strong odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 28/05/2009 End Date: 28/05/2009		Site Level (mAOD): Easting: 270851.00 Northing: 196030.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.40		0.40	Soft brown sandy CLAY (Glacial Till).	
			1.10			Firm stained grey (3) with light hydrocarbon odour (2) gravelly CLAY. Gravel is subangular to subrounded coarse of quartz and sandstone (Glacial Till).	
			1.30			Firm grey/brown very sandy gravelly CLAY. Gravel is subangular to subrounded medium and coarse of sandstone with frequent cobbles of sandstone and quartz (Glacial Till).	
			0.00		2.80	SANDSTONE bedrock encountered at base. End of Trial Pit at 2.80 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: No groundwater encountered.				Stability: Trial pit stable.		General Remarks: Pit was terminated at 2.8m in bedrock. No samples taken. Pit backfilled with arisings. No groundwater encountered. Visual rating 3 - small amounts of heavy staining. Olfactory rating 2 - distincy but not strong odour.	

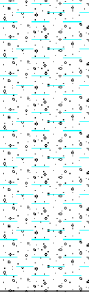
Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 28/05/2009 End Date: 28/05/2009		Site Level (mAOD): Easting: 270856.00 Northing: 196055.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.40		0.40	Soft brown sandy CLAY (Glacial Till).	
			1.10			Firm stained grey (3) with light hydrocarbon odour (2) gravelly CLAY. Gravel is subangular to subrounded coarse of quartz and sandstone (Glacial Till).	
			1.50			Firm grey/brown very sandy gravelly CLAY. Gravel is subangular to subrounded medium and coarse of sandstone with frequent cobbles of sandstone and quartz (Glacial Till).	
			0.00		3.00	SANDSTONE bedrock encountered at base. End of Trial Pit at 3.00 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: No groundwater encountered.				Stability: Trial pit stable.		General Remarks: Pit was terminated at 3.0m in bedrock. No samples taken. Pit backfilled with arisings. No groundwater encountered. Visual rating 3 - small amounts of heavy staining. Olfactory rating 2 - distincy but not strong odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 28/05/2009 End Date: 28/05/2009		Site Level (mAOD): Easting: 270863.00 Northing: 196077.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.50		0.50	Firm light brown very sandy gravelly CLAY. Gravel is subangular to subrounded medium and coarse gravel of quartz and sandstone (Glacial Till).	
			1.50			Firm slightly stained grey (1) very sandy gravelly CLAY. Gravel is subangular to subrounded coarse of sandstone with occasional cobbles (Glacial Till).	
			0.00		2.00	SANDSTONE bedrock encountered at base. End of Trial Pit at 2.00 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: No groundwater encountered.				Stability: Trial pit stable.		General Remarks: Pit was terminated at 2.0m in bedrock. No samples taken. Pit backfilled with arisings. No groundwater encountered. Visual rating 1 - occasional discolouration.	

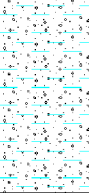
Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 18/06/2009 End Date: 18/06/2009		Site Level (mAOD): Easting: 270802.00 Northing: 195993.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel.	
			0.10		0.30	MADE GROUND: Black slightly clayey sandy subangular medium and coarse gravel of ash and clinker.	
			1.70			Firm light brown, stained grey (3) with moderate hydrocarbon odour (3) sandy gravelly CLAY. Gravel is subangular to subrounded coarse of sandstone (Glacial Till).	
					2.00	End of Trial Pit at 2.00 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: Ingress at various locations around the pit between 0.2-0.4m of oily water. Free product noted pooling at base of pit.				Stability: Trial pit unstable at 2.2m.		General Remarks: Pit terminated at 2.2 due to pit instability. No samples taken. Pit left open for observation/monitoring. Ingress at various locations around the pit between 0.2-0.4m of oily water. Free product noted pooling at base of pit. Visual rating 3 - small amounts of heavy staining. Olfactory rating 3 - strong odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 18/06/2009 End Date: 18/06/2009		Site Level (mAOD): Easting: 270800.00 Northing: 196030.00	
Trial Pit Length:				Trial Pit Width:		Excavation Method:	
Logged By: Alex Mann				Checked By: T Agapakis		Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel.	
			1.30			Light brown stained grey (3) with moderate odour (3) clayey sandy subangular to subrounded coarse GRAVEL of sandstone with occasional cobbles and boulders of sandstone (Glacial Till).	
					1.50	End of Trial Pit at 1.50 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: Groundwater seepage noted at 0.5m. Free product noted pooling at base of pit.			Stability: Trial pit unstable at 1.5m.			General Remarks: Pit terminated at 1.5 due to pit instability and presence of sandstone boulder at 1.5m. No samples taken. Pit left open for observation/monitoring. Groundwater seepage noted at 0.5m. Free product noted pooling at base of pit. Visual rating 3 - small amounts of heavy staining. Olfactory rating 3 - strong odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 18/06/2009 End Date: 18/06/2009		Site Level (mAOD): Easting: 270805.00 Northing: 196064.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel. MADE GROUND: Heavily stained black (4) with light hydrocarbon odour (2) clayey sandy subangular to subrounded medium gravel of quartz and sandstone with frequent ash. Firm lightly stained grey (2) with light hydrocarbon odour (2) sandy gravelly CLAY. Gravel is subangular to subrounded coarse of sandstone (Glacial Till). Firm light brown sandy gravel CLAY. Gravel is subangular to subrounded coarse of sandstone (Glacial Till). End of Trial Pit at 1.60 m	
			0.10		0.30		
			0.90		1.20		
			0.40		1.60		
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: Groundwater seepage noted from surface.			Stability: Trial pit unstable at 1.6m.			General Remarks: Pit terminated at 1.6 due to pit instability. No samples taken. Pit left open for observation/monitoring. Groundwater seepage noted from surface. Visual rating 2 - frequent discolouration, 4 - heavy black staining. Olfactory rating 2 - distinct but not strong odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 18/06/2009 End Date: 18/06/2009		Site Level (mAOD): Easting: 270801.00 Northing: 195960.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel.	
			0.10		0.30	MADE GROUND: Black slightly clayey sandy subangular medium and coarse gravel of clinker and ash.	
			2.20			Firm light brown occasionally stained grey (2) with faint hydrocarbon odour (1) gravelly sandy CLAY. Gravel is subangular to subrounded coarse of sandstone (Glacial Till).	
					2.50	End of Trial Pit at 2.50 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: No groundwater recorded.			Stability: Trial pit unstable.			General Remarks: Pit terminated at 2.5m. Pit collapsed and backfilled with arisings. No samples taken. No groundwater recorded. Visual rating 2 - frequent discolouration. Olfactory rating 1 - faint odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH			Start Date: 09/07/2009 End Date: 09/07/2009		Site Level (mAOD): Easting: 270785.00 Northing: 195910.00	
Trial Pit Length:			Trial Pit Width:		Excavation Method:	
Logged By: Alex Mann			Checked By: T Agapakis		Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests			Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel.
			0.10		0.30	
			0.70			MADE GROUND: Black slightly clayey sandy subangular medium and coarse gravel of clinker and ash.
			1.00		1.00	Firm light brown occasionally stained grey (2) with faint hydrocarbon odour (1) gravelly sandy CLAY. Gravel is subangular to subrounded coarse of sandstone (Glacial Till).
			1.00		2.00	Firm brown clayey gravelly sand. Gravel is subangular to subrounded coarse of sandstone with occasional cobbles (Glacial Till).
						End of Trial Pit at 2.00 m
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.						
Groundwater Observations: Groundwater ingress at 0.5m.			Stability: Trial pit stable.		General Remarks: Pit terminated at 2.0. No samples taken. Pit left open for observation/monitoring. Groundwater ingress at 0.5m. Visual rating 2 - frequent discolouration. Olfactory rating 1 - faint odour.	

Site: Coed Darcy Urban Village			Start Date: 09/07/2009		Site Level (mAOD):	
Client: St. Modwen Developments Ltd			End Date: 09/07/2009		Easting: 270775.00	
Project No: WM RAP TRENCH			Northing: 195878.00			
Trial Pit Length:			Trial Pit Width:		Excavation Method:	
Logged By: Alex Mann			Checked By: T Agapakis		Plant: Komatsu PC210	
Samples & Tests			Shoring/Support:			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel.
			0.20		0.40	MADE GROUND: Black slightly clayey sandy subangular medium and coarse gravel of clinker and ash.
			1.60			Firm light brown occasionally stained grey (2) with faint hydrocarbon odour (1) gravelly sandy CLAY. Gravel is subangular to subrounded coarse of sandstone.
					2.00	End of Trial Pit at 2.00 m
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.						
Groundwater Observations: Groundwater ingress at 0.3m.			Stability: Trial pit stable.		General Remarks: Pit terminated at 2.0. No samples taken. Pit left open for observation/monitoring. Groundwater ingress at 0.3m. Visual rating 2 - frequent discolouration. Olfactory rating 1 - faint odour.	

Site: Coed Darcy Urban Village Client: St. Modwen Developments Ltd Project No: WM RAP TRENCH				Start Date: 09/07/2009 End Date: 09/07/2009		Site Level (mAOD): Easting: 270773.00 Northing: 195854.00	
Trial Pit Length: Logged By: Alex Mann				Trial Pit Width: Checked By: T Agapakis		Excavation Method: Plant: Komatsu PC210 Shoring/Support:	
Samples & Tests				Strata Details			
Depth (m)	Type	HSV (m-kPa)	Thk	Legend	Depth	Description	
			0.20		0.20	MADE GROUND: Grey subangular to subrounded coarse sandstone gravel.	
			0.20		0.40	MADE GROUND: Black slightly clayey sandy gravel with strong hydrocarbon odour (4). Gravel is subangular medium and coarse of clinker and ash.	
			1.60			Light brown occasionally stained grey (2) with faint hydrocarbon odour (1) gravelly sandy CLAY. Gravels is subangular to subrounded coarse of sandstone (Glacial Till).	
					2.00	End of Trial Pit at 2.00 m	
General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.							
Groundwater Observations: Groundwater ingress at 0.3m.				Stability: Trial pit stable.		General Remarks: Pit terminated at 2.0. No samples taken. Pit left open for observation. Groundwater ingress at 0.3m. Visual rating 2 - frequent discolouration. Olfactory rating 1 - faint odour.	

Coed Darcy

RAP Implementation Report
Sentinel Wells
St Modwen Developments Ltd

November 2015



Coed Darcy

RAP Implementation Report Sentinel Wells

November 2015

Notice

This report was produced by *Atkins Limited* for St. Modwen Developments Ltd (SMD) for the specific purpose of providing an update on the implementation of the RAP works, as outlined in the S106. This report relates specifically to the Sentinel Wells.

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Atkins Limited

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0	Draft	MJT	ML	MP	MP	Nov 2015
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

[Plan Design Enable](#)

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Drawings

Drawing 5041216/RAP/DWG/220
Drawing 5041216/RAP/DWG/243 Rev F

Appendices

Appendix A Exploratory Hole Logs
Appendix B Monitoring Data

Glossary of Terms

Term	Meaning / Definition
CSM	Conceptual Site Model
RBSL	Risk Based Screening Level
TPH	Total Petroleum Hydrocarbons
PAH	Polycyclic Aromatic Hydrocarbons
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
RAP	Remediation Action Plan
VO	Visual/Olfactory Observations
BGL	Below Ground Level

1. Introduction

1.1 Client Brief & Scope of Works

Atkins Limited (Atkins) has been commissioned by St. Modwen Developments Ltd (SMD) to provide consultancy advice with regard to the redevelopment of the former Llandarcy Oil Refinery as Coed Darcy Urban Village.

This report has been prepared to provide a completion statement with respect to the sentinel wells and previously proposed product interception trenches as set out in Schedule 7, Part 1, Table 1 of the S106 'Deed of Planning Obligations' for the site. This report relates specifically to RAP features 1 and 24, as detailed in the S106.

The report provides an overview of the works undertaken and provides details of the previous works relating to these RAP requirements. This report updates and supersedes the previous Atkins reports "RAP implementation report, Sentinel wells" dated January and September 2010 (ref 5041216-RAP-RPT-00421).

1.2 Background

The RAP works are defined in the S106 as a 'programme of ongoing voluntary remedial action in relation to Pre Transfer Date Environmental Matters at or in the vicinity of the property'.

The general purpose and objectives of the RAP works are the 'carrying out of appropriate remedial action necessary and sufficient in the context of both the current use of the Property and the intended use, or such other use as may be determined from time to time' (Schedule 7, Part 1, Paragraph 1.3 of the S106).

Paragraphs 1.3.1 and 1.3.2 of the S106 state the following specific objectives for the defined RAP works;

- To prevent (or where this is not possible, minimise, remedy or mitigate as far as is reasonably practicable the effects of) migration from the Property of Pre Transfer Date Contamination and any Developer Contamination; and
- To assess with a frequency agreed as sufficient by the relevant Environmental Authorities and keep under review;
 - a) The condition of the Environment at and in the vicinity of the Property, including any controlled waters that are or may be affected by such condition, and any land adjoining or adjacent to the property; and
 - b) The progress and effectiveness of natural attenuation processes.

URS Report DR869r3 (refer to section 1.4) indicates the sentinel wells to comprise a series of wells placed at regular intervals, for monitoring, approximately 15m from boundaries considered potentially vulnerable from product migration. Depending on the results from the sentinel wells, the RAP then requires the installation of a product interception trench at each location.

For ease of reference, the following document is divided into a discussion of RAP features 1 and 24, as per the S106. The specific RAP requirements, as defined within the S106, are discussed in Section 2.2.

1.3 Limitations

This report has been prepared based upon the information available at the time of writing. Where further investigation, testing and/or monitoring is required, this is highlighted as part of the following report.

Recorded groundwater levels are based on the available monitoring data, but may be subject to variation due to atmospheric, seasonal or other effects.

1.4 Sources of Information

The following sources of information have been reviewed as part of the preparation of this report:

- URS Report DR869r3 'Draft Report, Remedial Action Plan', dated March 2000
- URS Report 6767 'Results of Sentinel Well Product Mobility', dated September 2002
- URS Report ref 39991-037-785/DR1144 'Draft Factual Report DiMe Area', dated July 2003
- URS Letter ref 39991-032-785/DR1161/LT/7205 re Rail Cutting Inspection, dated 06/08/03
- URS Report no FR1287 ' Final Factual Report for Whole Site Investigation – BP Llandarcy Refinery, dated 12th August 2005
- URS Report no. 4438274/BRRP0001 'BP Llandarcy Refinery Desk Study' dated 5th July 2007.
- S106 'Deed of Planning Obligations', ref GNP/NJR/13773-2, dated February 2008.
- Atkins Technical Note 19 'RAP Implementation – Sentinel Wells'
- Borehole logs SBH1, SBH04 to SBH07 and SBH12 to SBH14 (REC Report ref 80132p1r0, dated August 2009)
- Atkins monitoring data (2008 and 2009)
- Atkins Sentinel wells RAP Implementation Report dated January 2010, ref "5041216/Sentinel wells" 00421.
- Monitor comments "RFI0052 Review of Sentinel Well Implementation Report" dated March 2010

Significant investigation, remediation, reclamation and monitoring works have been undertaken in the contamination source areas in the vicinity of the sentinel wells and proposed interception trenches since the completion of the above works. The results of these works have been incorporated into the following assessment (refer to Section 6).

2. Remedial Action Plan (RAP)

2.1 Historical Contamination

Previous assessment by the former site owners (BP) indicated a potential for seepage of contamination (free product) from the Main and North site areas of the former refinery (refer to Drawing 5041216/RAP/DWG/220) into an existing railway cutting and also into North Site Reservoir in the northern part of the site.

A number of monitoring wells were, therefore, installed along these boundaries in order to track the presence and abundance of any free product. These wells formed part of a wider site monitoring network known as RAP monitoring. Monitoring of this existing network was formally undertaken bi-annually by Atkins on behalf of SMD (refer to section 5.2). A location plan showing the location of remaining viable wells is presented on Drawing 5041216-RAP-DWG-243 Rev F.

An assessment of the mobility of the identified free product within the existing sentinel wells, in 2002 (URS Report 6767), concluded that 'the data suggests that there may not be much mobile free product in the adjacent formation' and that 'the volume and mobility of the oil observed in the sentinel wells may be limited'.

BP also undertook a preliminary inspection of the rail cutting in 2003 (URS Letter ref 39991-032-785/DR1161/LT/7205), during which visual observations were made of the presence of seeps, odours, vegetative dieback and bedrock outcrops. Selected soil and water samples were taken for lab analysis from samples using a hand auger and of seeps and from water in drains along the base of the cutting. The inspection generally indicated 'no evidence of severe contamination egress', however, self-boring identified a few locations where contamination and localised vegetative dieback was noted. The extent of the impacted area associated with this former spillage was described as being 'limited' and was suggested as being associated with a known historic lube oil spill from overhead pipes, rather than as a result of contaminant movement through subsurface soils.

The inspection concluded that 'at the time of the visit, no significant discharge of contamination from the rail cutting was entering the stream down gradient of the Wern Andrew separator', which lies at the end of the eastern end of the railway cutting to the east of the M4.

An appraisal of various remedial options during this previous assessment highlighted that the removal of existing sources of hydrocarbons was not a viable option, due to their frequency within the wider refinery site. The potential use of trenches to intercept the migration of contamination was therefore suggested as the most suitable remedial option.

2.2 Recommended Works within the S106

Schedule 7, Part 1, Table 1 of the S106 makes recommendations relating to RAP features 1 and 24. For ease of reference, this information is reproduced as Table 1 in this report.

A copy of the associated figure (Drawing 5041216/RAP/DWG/220) is presented in this document. It should be noted that the RAP works strategy was defined prior to proposals to re-develop the Coed Darcy site and hence did not take into account the subsequent reclamation and remediation of areas of contamination adjacent to the sentinel wells and proposed trenches.

Table 1 – Progress works and Performance Criteria as stated in the S106

Site Area/Potential Receptor	Key Issues	Scope of Currently envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Western Flank of main site/Crymlyn Bog/Boundary with North Reservoir	Potential for cross boundary free product migration at various locations along boundary Dissolved phase hydrocarbon migration	Monitor 30 'sentinel' wells along northwest and southeast boundaries of North Site for presence of free product. 2. Install permanent product interception trench system along boundary of North Site, if sentinel well data suggests a risk of down gradient product migration occurring and in any event install a product interception trench to, at a minimum, replace the current sentinel wells prior to redevelopment (300 x 4 metres minimum). Any interception trench must prevent further down gradient migration of free product and allow recovery of the intercepted product.	1	Continued six monthly monitoring of free product thickness, and assess potential for further down gradient migration. All works to be protective of future public health and safety assuming unrestricted recreational access.	Sentinel well installations complete on North Site and listed in semi-annual monitoring reports.
Eastern process area/Neath valley and river	Potential cross boundary free product migration into railway cutting	Monitor 30 'sentinel' wells for free phase product on six monthly basis. Install permanent product interception trench system along boundary of North Site, if sentinel well data suggests a risk of down gradient product migration occurring and in any event install such a trench to, at a minimum, replace the current sentinel wells prior to redevelopment (500 x 3 metres minimum). Any interception trench must prevent further downgradient migration of free product and allow recovery of intercepted product.	24	Install permanent interception feature to prevent free product migration down gradient and permit recovery of intercepted product.	Sentinel well installations complete. Groundwater monitoring only.

3. RAP FEATURE 1

3.1 Existing Wells

RAP feature 1 was shown to have comprised two trenches within the northern part of the former refinery (North Site). The northern most trench is shown to run roughly east-west, parallel to the southern shore of North Site Reservoir and was proposed to protect the reservoir from free product migration from the former refinery operations within North Site. The desk study for the former refinery indicates North Site to have been predominantly used for product storage.

The southern trench, associated with RAP feature 1, is shown to run roughly east-west, parallel to the existing railway cutting and was designed to intercept free product migrating down slope towards the cutting. Any free product entering the cutting would have the potential to migrate away from the site, via the Wern Andrew separator.

A total of twenty seven historic wells are believed to have existed within the vicinity of the proposed RAP feature 1 trenches, as shown on Drawing 5041216-RAP-DWG-243 Rev F as sections A1-A2 and B1 to B2. .

Copies of all exploratory hole logs for relevant installations referred to below are provided in Appendix A.

3.2 Historical Monitoring

The result of historical monitoring by BP from 1999-2003, suggests free product to have been recorded in four installations within the vicinity of the proposed northern trench (MSMW078s, MSMW079s, NSMW003 and RFSW038). Of these, only RFSW038 is considered to represent one of the sentinel wells previously installed.

Free product is recorded to have been identified in only one of the boreholes within the vicinity of the proposed southern trench. Details of the range of product thickness recorded at each location and the nature of the strata installed are presented in Table 2:

Table 2: Summary of historical monitoring data (RAP Feature 1)

Borehole Reference	Date	Product Thickness (m)	Range of recorded water levels (m)	Installed Strata
MSMW078s	Jan 1999 to Sep 2003	0.03 to 0.610	0.83 – 2.45	Natural
MSMW079s	Jan 1999 to Mar 2003	0.0001 to 0.001	2.33 – 3.11	Made Ground
NSMW003	Oct 2003	0.123	2.85	Natural
RFSW038	Mar 2001	0.001	1.57 – 1.88	Natural
MSMW093	Jan 1999	0.0001	0.24 – 1.18	Natural

3.3 Recorded Ground Conditions

The result of intrusive investigation, to date, along the line of these two proposed trenches indicates Made Ground to exist at shallow depth and described as comprising gravel sized fragments of brick and concrete fill, ashy gravel and clinker. Where encountered, the depth of Made Ground recorded was generally found to vary between 0.4m and 3.1m along the length of the northern trench and between 0.5m and 1.1m along the line of the southern trench.

Underlying natural soils in both areas were shown to comprise a variety of lower permeability sands, silts, clays and gravels.

Sandstone bedrock was proven to lie at depths of between 0.8m and 5.0m, being generally shallower beneath the northern trench. No bedrock was encountered close to the southern trench, the depth of natural soils being >4.5m bgl. This is consistent with the known depth of the sandstone bedrock to the south of the cutting.

3.4 Well Installation by Atkins

Two further wells (SBH07 and SBH14) were installed by Atkins in July 2009, the locations of which are shown on Drawing 5041216-RAP-DWG-243 Rev F. A hydrocarbon odour was noted in the natural soils during the drilling of SBH07 and SBH014.

In line with previous monitoring, the response zones for the new wells were installed within shallow soils and targeted to detect free phase hydrocarbons. Details of the installations are shown in Table 3.

Proposals for the installation of outstanding monitoring wells in this area are discussed in section 5.

Table 3: Summary of new installations RAP Feature 1 (Summer 2009)

BH no.	Installed between depths (m)	Reason for installation (location)	Comments
SBH07	2.0 – 5.0,	No Sentinel wells in this area as NSTP033 was not installed. (NSTP033 was not installed but logs record product globules to be present on water ingress).	Water strike during drilling at 2.9m and strong hydrocarbon odour was noted at 3.0m
SBH014	2.0 – 5.0	A replacement well for RFSW032 and RFSW033. (Hydrocarbon odour was noted at 2.5m during drilling of RFSW033).	Water strike during drilling at 3.0m and strong hydrocarbon odour was noted at 3.0m.

4. RAP FEATURE 24

4.1 Existing Wells

The previously proposed trench, associated with RAP Feature 24 is shown to run roughly east-west parallel to an existing railway cutting and was designed to intercept free product migrating downslope towards the cutting away from the former DiMe and Bitumen Plant area.

The DiMe represents the area of a former solvent extraction process at the refinery comprising the use of hot solvent to extract the waxy materials from lubricating oil. This is proposed as an area of sports pitches within the final development.

A total of thirty four historic wells are believed to have existed within the vicinity of the proposed RAP Feature 24 trench, as shown on Drawing 5041216-RAP-DWG-243 Rev F.

Copies of all exploratory hole logs for relevant installations referred to below are provided in Appendix A.

4.2 Historical Monitoring

The result of historical monitoring by BP from 1999-2003, suggests free product to have been recorded in only four of the previously installed sentinel wells (RFSW002, RFSW011, RFSW014 and RFSW018) within this area.

Details of the range of product thickness recorded at each location and the nature of the strata installed are presented in Table 4:

Table 4: Summary of historical monitoring data (RAP Feature 24)

Borehole Reference	Date	Product Thickness (m)	Range of recorded water levels (m)	Strata
RFSW011	Sep 2003	0.0001	0.96 – 2.16	Natural
RFSW014s	Sep 2001 to Sep 2003	0.0001 to 0.04	1.05 – 2.13	Natural
RFSW018	Sep 2001 to Sep 2003	0.074 to 0.5	1.36 – 3.15	Natural
RFSW002	Mar 2001 to Sep 2003	0.001 -1.04	2.67 – 4.04	MG/Natural

4.3 Recorded Ground Conditions

The result of intrusive investigation, to date, along the line of the proposed trench indicates Made Ground to exist at shallow depth and described as comprising gravel sized fragments of brick and concrete fill, ashy gravel and clinker. The depth of Made Ground recorded was generally found to vary between 0.4m and 3.5m along the line of the trench.

Underlying natural soils comprise a variety of lower permeability silts, clays and localised sands and gravels.

Where encountered, Sandstone bedrock was proven to lie at depths of between 3.0m and 22.0m being generally shallower beneath the eastern end of the trench and deepest within the immediate vicinity of the railway cutting.

4.4 Well Installation by Atkins

Five further wells were installed by Atkins within this area in 2009, the locations of which are shown on Drawing 5041216-RAP-DWG-243 Rev F. In line with the existing monitoring, the response zones were installed within shallow soils and targeted to detect free phase hydrocarbons (see Table 5).

Due to ongoing clearance works, a total of five sentinel wells have been destroyed over the last 12 months. This includes some of the new wells installed by Atkins in 2009. Proposals for replacements and the installation of outstanding wells in this area are discussed in the section 5.

Table 5: Summary of well installation RAP Feature 24 (Summer 2009)

BH no.	Installed between depths (m)	Reason for installation (location)	Comments
SBH04	1.0 – 4.5	Replacement for RFSW009 (RFSW009 was installed between 1.0-3.0m depth)	Water strike during drilling at 3.1m and strong hydrocarbon odour was noted at 3.0m (now destroyed)
SBH05	2.5 – 4.5	Replacement for RFSW015 (RFSW015 was installed between 1.5 – 4.0m depth)	Water strike during drilling at 4.8m and strong hydrocarbon odour was noted from 2.0m. (now destroyed)
SBH06	2.0 – 4.0	Gap between existing sentinel wells.	Water strike during drilling at 4.0m and strong hydrocarbon at 4.0m. (now destroyed)
SBH12	2.0 – 5.0	Gap between existing sentinel wells	Water strike during drilling at 5.0m on bedrock
SBH13	1.5 – 4.5	Replacement for RFSW017 and RFSW018 (18 later found) Product thicknesses found in RFSW018 (historic water monitoring shows water levels between 1.36 – 3.15m bgl)	Water strike during drilling at 4.2m. Hydrocarbon odour noted at 4.0m

5. Recent Monitoring

Monitoring of remaining viable wells was undertaken between August 2008 and September 2013. The number of monitoring rounds vary for each hole due damage from ongoing remediation and reclamation works or that the phase has been signed off (MP26/27) and no longer requiring further monitoring of the wells.

A summary of all monitoring undertaken by Atkins is presented in Appendix B.

Of the 54 recently monitored boreholes, five of the locations recorded product prior to them being destroyed and the borehole becoming unusable. These locations and thicknesses of oil are summarised in table 6. Only nine of the remaining 49 wells historically recorded product but were subsequently monitored without product present prior to being damaged/removed.

The location of wells is shown on Drawing 5041216-RAP-DWG-243 Rev F.

Table 6: Summary of wells recording product prior to damage/removal

Borehole Reference	Last Monitoring Round	Product Thickness (m)	Reason for Damage to Well
MSMW051s	June 2013	0.01	Monitor Phase 68 (Bitumen plant) remediation and reclamation works
DSB022 s1	July 2011	0.06	Monitor Phase 43 (DiMe) remediation and reclamation works
DSB024 s1	March 2010	0.01	Monitor Phase 43 (DiMe) remediation and reclamation works
DSB025 s1	November 2012	0.03	Monitor Phase 43 (DiMe) remediation and reclamation works
DSB027 s1	October 2009	4.45	Monitor Phase 43 (DiMe) remediation and reclamation works

6. Recent Site Wide Investigation and Remediation Works

Additional investigation and remediation works have been undertaken recently in areas immediately adjacent Rap features 1 and 24/. These works are summarised below.

6.1 Monitor Phase 12 (RAP Feature 18 API Separators)

Hydrocarbon contaminated sludge removal and residual cleaning works were carried out by Celtic Technologies in Monitor Phase 12 in 2011, details of which provided in Atkins Technical Note 5041216-REM-TN-1285 and Celtic's verification report R1434/11/4093. The sludge removal works excavated approximately 3,180m³ of hydrocarbon impacted material from the separators and the base of the structure subsequently cleaned using machine mounted brushes and jet washing. These works achieved RAP works certification (RAPWCS) of sign-off by the monitor in October 2011.

6.2 Monitor Phase 26 (North of Business Park)

Investigation and remedial works were carried out across Monitor Phase 26 in multiple phases between 2011 and 2013, details of which are provided in Atkins report 5041216-UTL-RPT-905. A total of 11 machine excavated trial pits, 10 service pits, two hand auger holes and two boreholes have been undertaken in MP26. This equates to approximately 1 location per 400m². The works intercepted granular Made Ground with a maximum Visual/Olfactory classification of 3 with the exception on one trial pit noting free product at 0.7m bgl. Specific validation relating to the free product identified during the initial GI was further investigated and no further free product was identified. Sentinel well SBH13 was monitored 6 times between February to November 2012 and did not exhibit any free product throughout the monitoring rounds. Monitor Phase 26 achieved RAPWCS and remediation and redevelopment works certification (RRWCS) of sign off in May 2013.

6.3 Monitor Phase 27 (North of Business Park)

Investigation and remedial works were carried out across Monitor Phase 27 in multiple phases between 2011 and 2013, details of which provided in Atkins report 5041216-UTL-RPT-915. A total of 23 machine excavated trial pits, 12 service pits and four boreholes have been undertaken (1 per 292m²) in MP27. The works intercepted deposits of granular Made Ground overlying natural deposits of Glacial Till. Free product was noted in sentinel well RFSW018 and BHPS103 during a number of monitoring rounds. Following further investigation to delineate the contamination around these holes, localised heavily impacted ashy clay materials (VO=5) were removed and two subsequent monitoring rounds undertaken. These rounds saw a significant reduction in product thickness from a maximum of 7mm before the works to approximately 1mm comprising mostly free product droplets. RFSW018 was later recorded three times without the presence of product. Monitor Phase 27 achieved RAPWCS and RRWCS in March 2014.

6.4 Monitor Phase 28 (Commercial area – south of Business Park)

Investigation and remedial works were carried out across Monitor Phase 28 in multiple phases between 2007 and 2013, details of which provided in Atkins report 5041216-PLOTS-RPT-1016. A total of 137 validation trial pits have been undertaken following three phases of significant reclamation and remediation works. These works comprised a 2m turnover of Phases 2 and 3 and subsequent excavation and removal of 15,070m³ of hydrocarbon impacted material. Whilst free product had historically been noted in a number of wells within Monitor Phase 28, these were predominately located in the western half of the site and subject to wholesale excavation during the main reclamation works.

6.5 Monitor Phase 43 (DiMe)

Investigation and remedial works were carried out across Monitor Phase 43 in multiple phases between 2009 and 2014, details of which provided in Atkins report 5041216-PLOTS-RPT-1405. The

initial ground investigation phases comprised a total of 21 boreholes and 74 trial pits to identify, and delineate where possible, the extents of contamination. Following a number of borehole monitoring rounds, a series of drawdown works were undertaken to remove the product noted in several wells in 2009. These works were undertaken to estimate if the historic observations of free phase within the well were representative of actual free phase within the wider ground. These works saw a significant reduction in product thickness and continued through to 2012 with a water management system, equipped with an oil/water separator, set up to regulate the depth of shallow groundwater and recover free phase hydrocarbons. As part of the multi-phase reclamation works undertaken between 2011 and 2014, approximately 54,000m³ of hydrocarbon and/or solvent impacted material was removed and taken for treatment elsewhere in the site. These works included the interception of bands of granular Made Ground which was shown to contain notable deposits of free phase. Post remediation and reclamation, 31 validation trial pits were excavated and recorded a visual and olfactory class of 3 for the retained soils in Monitor Phase 43.

6.6 Monitor Phase 54 (North site)

Investigation and remedial works were carried out across Monitor Phase 54 in 2014 to 2015, details of which are provided in Atkins report 5041216-REM-RPT-1345. Ground Investigation comprised 1087 machine excavated trial pits of which 45 locations noted either class 5 soils or free product.

Upon secondary investigation, only 10 locations required remedial works due to the presence of gross free phase contamination. Remediation comprised the removal of impacted soils and observations of excavations for continued seepage of residual free phase. Where no free product was identified on the reinvestigation, the laboratory data and soils descriptions (including VO) were used as further evidence against the need for any further remediation/investigation at these locations. A maximum VO classification of 4 was attributed to retained soils in Monitor Phase 54.

6.7 Monitor Phase 68 (Bitumen Plant and northern railhead)

Investigation and remedial works were carried out across Monitor Phase 68 in 2014 to 2015, details of which are provided in Atkins report 5041216-REM-RPT-1404. Ground Investigation comprised 439 machine excavated trial pits of which 13 locations noted either class 5 soils or free product. Upon reinvestigation only 8 locations required remedial works which comprised either complete removal or excavations left open for product collection and removal. Where no free product was identified on the reinvestigation, the laboratory data and soils descriptions (including VO) were used as further evidence against the need for any further remediation/investigation at these locations. A maximum VO classification of 4 was attributed to retained soils in Monitor Phase 68.

6.8 Monitor Phase 39

6.8.1 POS Zone A

Investigation works were carried out across POS Zone A between 2014 and 2015, details of which are provided in Atkins report 5041216-REM-TN-1363. Ground Investigation comprised 55 machine excavated trial pits and 14 hand dug pits. The majority of soils exhibited VO classifications of 0 to 2 with a maximum VO of 4. In the absence of free product, laboratory data and soils descriptions (including VO) were used as further evidence against the need for any further remediation/investigation at these locations.

6.8.2 POS Zone B

Investigation works were carried out across POS Zone B between 2014 and 2015, details of which are provided in Atkins report 5041216-REM-TN-1384. Ground Investigation comprised 7 machine excavated trial pits and 24 hand dug pits. The majority of soils exhibited no visual or olfactory indicators of hydrocarbon contamination with a maximum VO class of 2 in one location. In the absence of free product, laboratory data and soils descriptions (including VO) were used as further evidence against the need for any further remediation/investigation at these locations. The basal silts and remnant free phase oil has been removed from the triangular separators in 2015. As part of the ground investigation works, window sample holes RHRW040 to 49 were monitored and did not record free product on the interface meter.

7. Conceptual Site Model

7.1 RAP1

The existing topography of North Site varies, with a central 'high' area. Clearance works have been undertaken across this area and predominantly relate to the clearance of surface vegetation, removal of existing pipelines, structure removal and remedial excavations.

Historical groundwater monitoring across North Site, suggests groundwater flow in a radial in pattern within the shallow soils. "The ranges of groundwater fluctuation within shallow wells suggest that recharge originates from precipitation directly on the area, and that the deep groundwater is recharged by percolation through the overburden" (URS Report ref FR1287).

Due to the presence of lower permeability natural soils underlying the Made Ground, the majority of remnant hydrocarbon migration (if present) is anticipated to be via shallow, granular Made Ground towards the lower areas of North Site Reservoir and the existing railway cutting to the north and south respectively.

7.2 RAP24

Ground levels within the vicinity of the proposed trench are relatively flat lying but rise to the south towards a series of terraces cut into a sandstone ridge.

The result of previous investigation within the vicinity of the proposed trench suggests the presence of groundwater within each of the identified strata. Groundwater bodies within the natural soils have been shown to be localised and predominantly associated with isolated perched lenses/bands of more permeable soils. The depth and extent of groundwater across this area appears to vary, possibly relating to the presence of existing structures and relict foundations below ground associated with the redevelopment of this part of the refinery in the 1970s.

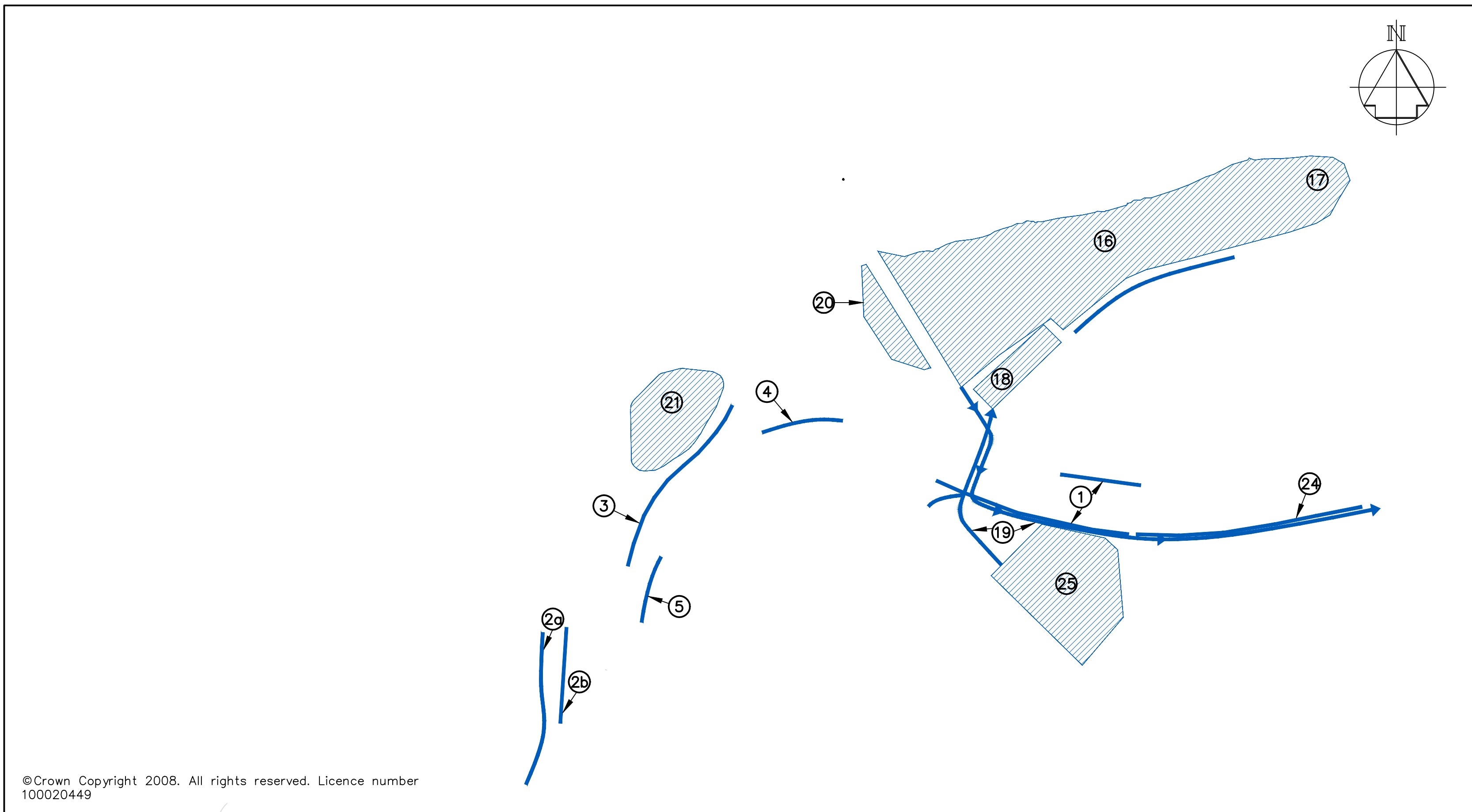
As such, if present the main pathway for the migration of mobile free product northwards into the railway cutting is considered to relate to movement through granular Made Ground and shallow (permeable) natural soils or historically via man made pathways such as pipework and/or drainage runs.

8. Conclusions

The sentinel wells were installed in order to monitor for the presence of free phase and the likelihood of product migration towards the railway and the North Site Reservoir. RAP Features 1 and 24 were proposed in order to capture any migration of free phase hydrocarbons to these areas.

It was originally proposed that a decision to install the product interception trenches would be based on the results of the monitoring of the sentinel wells. The results from the monitoring generally indicated that a significant mobile body of free phase was not present in areas surrounding RAP phases 1 and 24. These observations have now been supported by the extensive investigation, remediation and reclamation works in the adjacent Monitor Phases. . These works identified localised oil saturated soils. The most heavily impacted parts of the sites adjacent to the proposed trenches were subject to removal of hydrocarbon impacted materials which were taken for treatment elsewhere in the Coed Darcy site.

It is considered that the monitoring works supported by works undertaken in the Monitor Phases provide sufficient evidence that interception trenches (RAP 1& 24) are not required.



Feature	RAP Works	Start Date	Finish Date	Purpose of Works	Direct Link to SSSI/ SAC/ Ramsar	Risk to SSSI/ SAC/ Ramsar	Likelihood	Mitigation	Residual Risk to SSSI/ SAC/ Ramsar	Implication for SSSI/ SAC/ Ramsar
Note: The RAP works have been designed to enhance the water quality currently being discharged to the Crymlyn Bog by contaminant source removal and water polishing. The RAP works will not take place within the SSSI and measures will be taken to ensure that the works do not cause a detrimental impact to the SSSI. Details of the preventative measures taken will be provided within the Method Statement for each section of the works.										
1	Monitor 30 'Sentinel' wells	Six Monthly	Ongoing	Assess potential for cross boundary free product migration	No	n/a	-	-	-	
1	Install Permanent Product Trench(es)	TBC	TBC	Trench - to intercept/ collect product replace sentinel wells (a second trench should be constructed if well data suggests a risk of down gradient product migration)	No	Does not discharge directly to Crymlyn Bog. Trench may not be necessary following detailed assessment	-	-	-	Product collection and removal will improve water quality without affecting water flow.
2a	Western Margin - Interception Trench	Mar-09	Aug-09	Trench - to intercept and collect product migrating from Main Site	Yes	Trench may be breached or over top with free product. Pathway creation for product, increasing velocity and quantity of product near the Crymlyn Bog.	High	Interception trench should encourage product to flow away from Crymlyn Bog. Regular monitoring and removal of free product from interception trench.	Low	Product collection and removal will improve water quality without affecting water flow.
2b	Western Margin - Constructed Wetland	May-09	Aug-09	Wetland - to polish water discharged to Crymlyn Bog from trench.	Yes	Works to create wetland may temporarily increase suspended solids load in groundwater by the disturbance of potentially hydrocarbon impacted materials. Water discharge may be temporarily reduced when wetland is commissioned until capacity is reached.	Moderate	Method statements and performance requirements for the works will ensure the water quality does not worsen and that the switch of regime is managed to maintain water flows to the Crymlyn Bog. (During wetland commission)	Low	Water quality enhanced without reduction in discharge rate.
3	Railhead to South Reservoir Interception Trench	Feb-09	Aug-09	To reduce the migration of product from Main Site into south site reservoir and Crymlyn Bog	Yes	Trench may be breached or over top with free product. Pathway creation for product, increasing velocity and quantity of product near the Crymlyn Bog.	High	Interception trench should encourage product to flow away from Crymlyn Bog. Regular monitoring and removal of free product from interception trench.	Low	Product collection and removal will improve water quality without affecting water flow.
4	Interception Trench between North and South Reservoirs	Feb-09	Aug-09	To intercept and collect product migrating between North and South reservoirs	No	Currently overflows into drainage system which feeds the South Site Reservoir and Crymlyn Bog.	Low	Interception trench should encourage product to flow away from Crymlyn Bog. Regular monitoring and removal of free product from interception trench.	Low	Water quality enhanced without reduction in discharge rate.
5	Inland Free Product Interception Trench	Feb-09	Aug-09	To intercept and collect product migrating between the Main Site and the Railhead	No	Does not discharge directly to Crymlyn Bog	-	-	-	Reduction in contaminant source will enhance the quality of the underlying groundwater and down gradient receptors.
16	North Site Reservoir - Sludge and water removal with reconfiguration to pre-refinery conditions	2011	2013	Sludge removed, treated and reservoir site to be returned pre-refinery conditions so as to be suitable for uncontrolled recreational use. Water management programme implemented to be consistent with restored valley.	No	Removal of reservoir may cause slight temporary flow changes to water courses supplying the Crymlyn Bog. Existing outflow (east) to be re-routed to the west.	High	Post restoration water system to achieve discharge rates consistent with current regime.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.
17	East Bay Separator - Sludge and water removal with reconfiguration to pre-refinery conditions	2010	2010	Sludge removed, treated and reservoir site to be returned pre-refinery conditions so as to be suitable for uncontrolled recreational use. Water management programme implemented to be consistent with restored valley.	No	Removal of East Bay may cause limited temporary flow changes to water courses supplying the Crymlyn Bog. Existing outflow (east) to be re-routed to the west.	Low	Post restoration water system to achieve discharge rates consistent with current regime.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.

Feature	RAP Works	Start Date	Finish Date	Purpose of Works	Direct Link to SSSI/ SAC/ Ramsar	Risk to SSSI/ SAC/ Ramsar	Likelihood	Mitigation	Residual Risk to SSSI/ SAC/ Ramsar	Implication for SSSI/ SAC/ Ramsar
17	East Bay Separator - Sludge and water removal with reconfiguration to pre-refinery conditions	2011	2011	Sludge and water removed and treated, reservoir site to be returned pre-refinery conditions so as to be suitable for uncontrolled recreational use. Water management programme implemented to be consistent with restored valley.	No	-	Low	Post restoration water system to achieve discharge rates consistent with current regime.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.
18	API Separators - Sludge and water removal with reconfiguration to pre-refinery conditions	2010	2010	Sludge and water removed and treated, reservoir site to be returned pre-refinery conditions so as to be suitable for uncontrolled recreational use. Water management programme implemented to be consistent with restored valley.	No	-	Low	Separators to be infilled. Post restoration water system to achieve discharge rates consistent with current regime.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.
19	Isolate Reservoir from Site Drainage System	Jun-09	Sep-09	Remove pipe work that transports main site drainage to reservoir site.	No	May cause increase in drainage requirements on the Main Site.	Low	Alternative drainage system to accommodate additional load without increasing discharge to Crymlyn Bog	Low	Pathway reduction may improve removal of contaminant at source, improving quality of discharge.
20	Remove Dam	2013	2013	Return area to pre-refinery conditions.	No	Remodelling of North Site Reservoir (Features 16, 17, 18 & 20) subject to review. Eventual change in flow direction will have a discernable hydrological impact on the Crymlyn Bog following containment removal. Further studies are required to define acceptable flows.	Moderate / High	Works to remove sludge may temporarily increase hydrocarbon load in groundwater by the disturbance of potentially hydrocarbon impacted materials. Attenuation time for product reaching this area is reduced.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.
21	South Reservoir - Sludge removal and treatment	Mar-10	Jul-10	Sludge removed and treated	No	-	-	Method statements and performance requirements for the works will ensure the water quality does not worsen and that the switch of regime is managed to maintain water flows to the Crymlyn Bog.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.
24	Sentinel wells (Completed as Feature 1)	Six Monthly	Ongoing	Assess potential for cross boundary free product migration	No	n/a	-	-	-	
24	Install Permanent Product Trench - North Site	TBC	TBC	To intercept and collect product and to replace sentinel wells	No	Does not discharge directly to Crymlyn Bog. Trench may not be necessary following detailed assessment.	-	-	-	Product collection and removal will improve water quality without affecting water flow.
25	Containment or Source reduction of Hydrocarbon and Chlorinated Hydrocarbon in the DIME Area.	Feb-09	Sep-09	Containment or Source reduction of Hydrocarbon and Chlorinated Hydrocarbon in the DIME Area. Source reduction should render containment permanently unnecessary.	No	Discharges currently to the North Site Reservoir. This will be isolated and the drainage will be controlled and form part of the North Site drainage.	Low	Containment may cause changes in base groundwater flow. Groundwater discharge should remain consistent with current conditions.	Low	Contaminated materials reduced up gradient. Water quality likely to be enhanced without discernable change in discharge rate.

KEY

- Development Boundary
- Diffuse Discharge
- Free product monitoring/interception
- Oily sludge removal & treatment
- Constructed Wetland
- Earthwork/capping/landscaping
- Remove/reconfigure drainage
- Source reduction/containment
- Crymlyn Bog SSSI/Crymlyn Bog SAC/Ramsar (Boundary details supplied by CCW)

A TABLES REVISED SM HM 04/02/09

REVISIONS Drawn By Checked By Date

CLIENT INFORMATION

INFORMATION - CCW/NPT TO DEFINE AREAS OF RAP WORKS, RISKS AND TIMESCALES WITH REGARD TO THE CRYMLYN BOG SSSI/SAC/RAMSAR

PURPOSE OF ISSUE

Rev. Authorised for issue Date

Atkins Ltd
Consulting Engineers
The Axis, 10 Holliday Street
Birmingham West Midlands B1 1TF

THIS DRAWING IS NOT TO BE SCALED

CLIENT

PROJECT

COED DARCY URBAN VILLAGE DEVELOPMENT

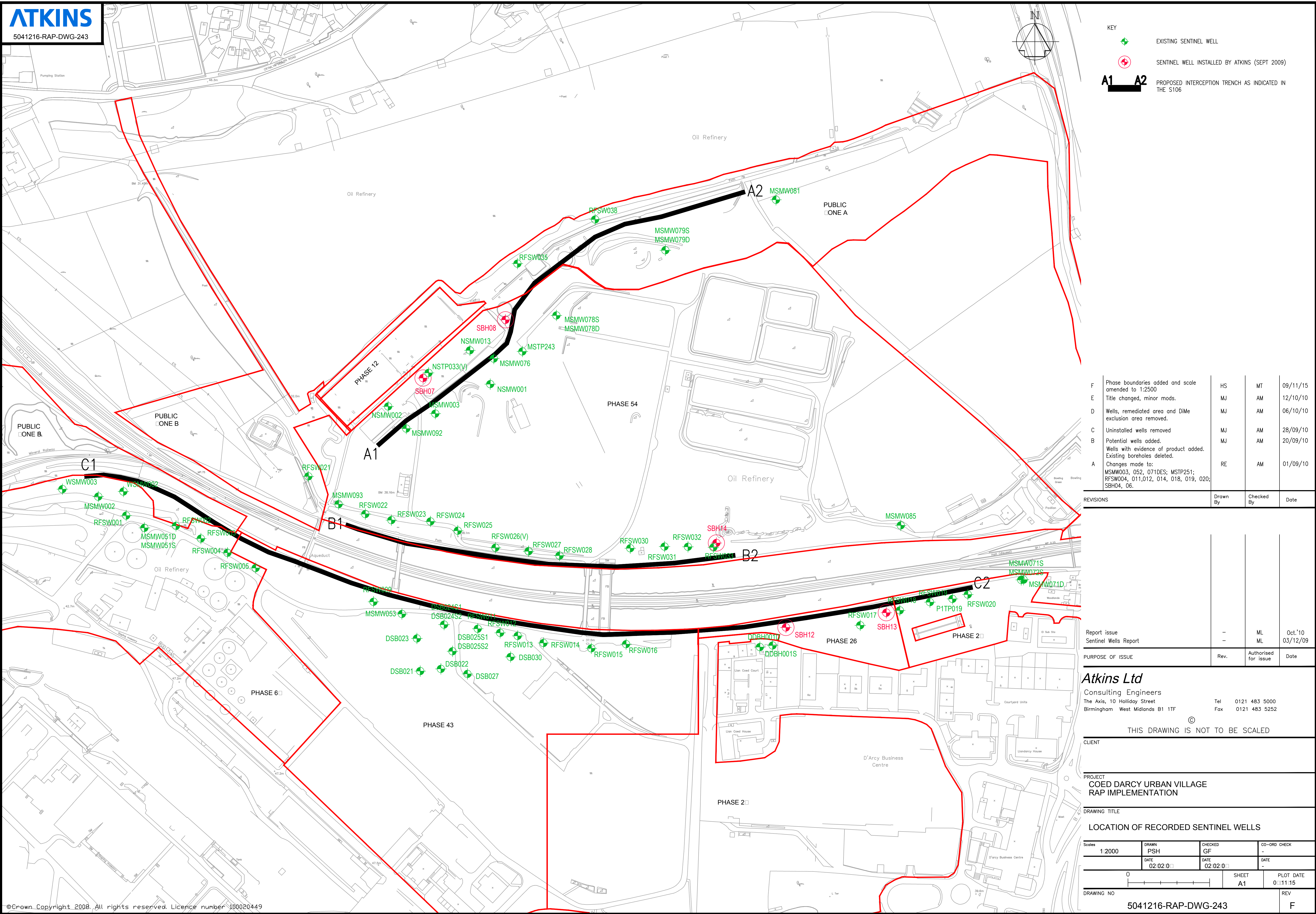
DRAWING TITLE
REMEDIATION ACTION PLAN WORKS
SHEET 1 OF 2

Scales 1:5000 DRAWN SM CHECKED - CO-ORD CHECK -

DATE 01/09 DATE - DATE -

0 SHEET A1 PLOT DATE 16/04/13

DRAWING NO 5041216/RAP/220 REV A

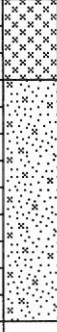


Appendix A

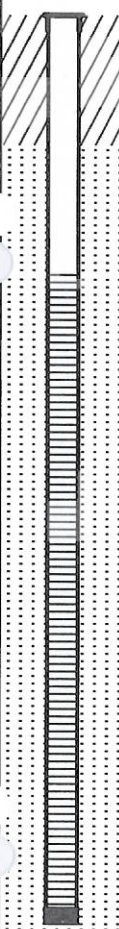
BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB024S1		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 23/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0		DESCRIPTION	COMMENTS	0.0	
					0.5		Loose, black angular fine-medium gravel of ash/clinker	Wet. Strong H/C and Solvent odour	0.5	
					1.0		Loose angular platy coarse gravel with silt. Soft grey mottled-brown silt with plant remains	Strong odour Decreasing solvent and H/C odour	1.0	
	DDMW02 -1.5m				2.0		Soft, sandy clayey grey silt with frequent rounded coarse gravel	Increasing solvent odour	2.0	
	DDMW02 -3.0m				3.0			Sheen very strong solvent odour from 2.6m	3.0	
				3.5		Loose, grey, silty and sandy, fine to coarse, sub-angular to sub-rounded gravel	Wet. Saturated 3.2-3.9	3.5		
				4.0		End of Borehole		4.0		
				4.5					4.5	
				5.0					5.0	

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery	
			App'd: _____ Date: July 2002 Drawn : _____ Ref: _____ Scale: _____ Job No: 39991-022 Drg. Size: _____ BOREHOLE LOG

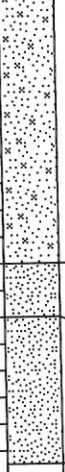
BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB024S2		PAGE 1 of 2	
	NUMBER	TYPE					DRILLING DATES: 23/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
	DDMW02 -1.5m				0.0		Loose, black angular fine-medium gravel of ash/clinker	and Solvent odour	0.0	
							Loose angular platy coarse gravel with silt. Soft grey mottled-brown silt with plant remains	Strong odour	0.5	
								Decreasing solvent and H/C odour	1.0	
							Soft, sandy clayey grey silt with frequent rounded coarse gravel	Increasing solvent odour.	2.0	
							Loose, grey, silty and sandy, fine to coarse, sub-angular to sub-rounded gravel	Sheen. Very strong solvent odour from 2.6. Wet Saturated 3.2-3.9	3.0	
DDMW02 -3.0m					3.0		Soft to firm grey-brown, slightly sandy silt with occasional medium, sub-rounded gravel. Grades to brown from 5.0m Sandy from 5.2m	Saturated. Very strong solvent odour. Odour rapidly decreases. No odour from 4.3m. Damp	4.0	
									4.5	
						5.0			5.0	
LOCATION / NOTES:						LEGEND		BOREHOLE LOG		
NVO = No visual or olfactory evidence						Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table		Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery		
								App'd:	Date: July 2002	
								Drawn :	Ref:	
								Scale:	Job No: 39991-022	
								Drg. Size:	BOREHOLE LOG	

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB024S2		PAGE 2 of 2					
	NUMBER	TYPE					DRILLING DATES: 23/01/02		DRILLING METHODS : Hydraulic Percussive					
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm					
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm					
							CHECKED BY :		SCREEN SLOT SIZE: 1mm					
	DDMW02 -5.5m			5.5		Dense, brown silty sand with occasional medium, sub-rounded gravel		COMMENTS Damp-Wet NVC. Dry-damp	5.5					
				6.0		End of Borehole				6.0				
				6.5				6.5						
				7.0					7.0					
				7.5							7.5			
				8.0								8.0		
				8.5									8.5	
				9.0										9.0
				9.5										
				10.0				10.0						

LOCATION / NOTES: NVO = No visual or olfactory evidence		LEGEND  Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table		BOREHOLE LOG Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery 			
				App'd:	Date: July 2002		
				Drawn :	Ref:		
				Scale:	Job No: 39991-022		
				Drg. Size:	BOREHOLE LOG		

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB025S1		PAGE 1 of 2	
	NUMBER	TYPE					DRILLING DATES: 11/01/02-14/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
	DDMW 01-2.0		*16.6		0.0	Loose to dense ground of clinker with ash and coarse, angular cobbles. (MG)	Irridescence. Strong solvent odour. Wet	0.0		
			*9.1		0.5	Soft, brown 'organic' silt		0.5		
			*4.6		1.0	Soft to firm grey, mottled brown clayey silt. Slightly sandy from 1.0m	NVC NCG Feint solvent odour 1.0m	1.0		
			*7.6		1.5	Increasing sand to sandy silt from 1.3m and coarse rounded gravel from 1.4m	Damp 1.5m Moderate odour damp - wet	1.5		
			*10.1		2.0			2.0		
			*14.2		2.5	Soft, light brown very sandy silt with occasional medium-coarse rounded gravel	Moderate odour. Wet from 2.5m	2.5		
	DDMW01 -2.9		*36		3.0	Loose, brown, medium sand	Irridescence. Strong solvent odour. Wet	3.0		
			*545		3.5	Loose brown, mottled grey-blue very silty fine-medium sand with occasional-frequent medium-coarse rounded gravel.	Moderate-Strong solvent. Wet	3.5		
			*247		4.0	Brown from 3.5m with patches of fine silty-clay. Gravel frequent from 4.0m with sandy layers becoming sandy silt.		4.0		
			*66.0		4.5	Dense from 5.3m		4.5		
		*47.4		5.0	Coring 5.9 - 6.1 (cobble)		5.0			

LOCATION / NOTES:		LEGEND		BOREHOLE LOG			
NVO = No visual or olfactory evidence		 Disturbed Sample		Job Title: DiMe Investigation			
		 Undisturbed Sample		Location: BP Llandarcy Refinery			
		 Headspace Analysis		Client: BP Oil Llandarcy Refinery			
		 Down Borehole Analysis				App'd:	Date: July 2002
		 Groundwater Table				Drawn : SS	Ref:
		 Perched Water Table				Scale: As scale	Job No: 39991-022
						Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB025S1		PAGE 2 of 2	
	NUMBER	TYPE					DRILLING DATES: 11/01/02-14/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
 			*3.9		5.5				Odour increases from 5.30m	5.5
			*4.9		6.0		Loose, medium to coarse sand with frequent rounded medium-coarse gravel Dense very silty sand with frequent cobbles.	Damp-Wet NVC	6.0	
					6.5		End of Borehole			6.5
					7.0					7.0
					7.5					7.5
					8.0					8.0
					8.5					8.5
					9.0					9.0
					9.5					9.5
					10.0					10.0

LOCATION / NOTES:	LEGEND	BOREHOLE LOG									
NVO = No visual or olfactory evidence	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery									
			<table border="1"> <tr> <td>App'd:</td> <td>Date: July 2002</td> </tr> <tr> <td>Drawn : SS</td> <td>Ref:</td> </tr> <tr> <td>Scale: As scale</td> <td>Job No: 39991-022</td> </tr> <tr> <td>Org. Size: A4</td> <td>BOREHOLE LOG</td> </tr> </table>	App'd:	Date: July 2002	Drawn : SS	Ref:	Scale: As scale	Job No: 39991-022	Org. Size: A4	BOREHOLE LOG
App'd:	Date: July 2002										
Drawn : SS	Ref:										
Scale: As scale	Job No: 39991-022										
Org. Size: A4	BOREHOLE LOG										

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB025S2		PAGE 1 of 2	
	NUMBER	TYPE					DRILLING DATES: 11/01/02-14/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
DESCRIPTION							COMMENTS			
	DDMW 01-2.0		*16.6	0.0		Loose to dense ground of clinker with ash and coarse, angular cobbles. (MG)	Moderate-strong solvent odour wet 0-0.2m	0.0		
			*9.1	0.5		Soft, brown 'organic' silt		0.5		
			*4.6	1.0		Soft to firm grey, mottled brown clayey silt. Slightly sandy from 1.0m	NVC NCG Feint solvent odour 1.0m	1.0		
			*7.6	1.5		Increasing sand to sandy silt from 1.3m and coarse rounded gravel from 1.4m	Damp 1.5m Moderate odour damp - wet	1.5		
			*10.1	2.0				2.0		
			*14.2	2.5		Soft, light brown very sandy silt with occasional medium-coarse rounded gravel	Moderate odour, damp-wet (iridescent?) Wet from 2.5m	2.5		
			DDMW01 -2.9			*36	3.0	Loose, brown, medium sand	Irridescence. Strong solvent odour. Wet	3.0
						*545	3.5	Loose brown, mottled grey-blue very silty fine-medium sand with occasional-frequent medium-coarse rounded gravel.	Moderate-Strong solvent. Wet	3.5
						*247	4.0	Brown from 3.5m with patches of fine silty-clay. Gravel frequent from 4.0m with sandy layers becoming sandy silt.		4.0
						*66.0	4.5	Dense from 5.3m		4.5
		*47.4	5.0		Coring 5.9 - 6.1 (cobble)		5.0			

LOCATION / NOTES:

NVO = No visual or olfactory evidence

LEGEND

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

BOREHOLE LOG

Job Title: DiMe Investigation

Location: BP Llandarcy Refinery

Client: BP Oil Llandarcy Refinery

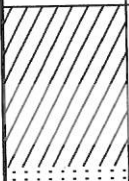
App'd:	Date: July 2002
Drawn : SS	Ref:
Scale: As scale	Job No: 39991-022
Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB025S2		PAGE 2 of 2	
	NUMBER	TYPE					DRILLING DATES: 11/01/02-14/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
		CHECKED BY :		SCREEN SLOT SIZE: 1mm						
			*3.9		5.5				Odour increases from 5.30m	5.5
					6.0		Loose, medium to coarse sand with frequent rounded medium-coarse gravel		Damp-Wet NVC	6.0
			*4.9		6.5		Dense very silty sand with frequent cobbles.			6.5
					7.0		End of Borehole			7.0
					7.5					7.5
					8.0					8.0
					8.5					8.5
					9.0					9.0
					9.5					9.5
					10.0					10.0

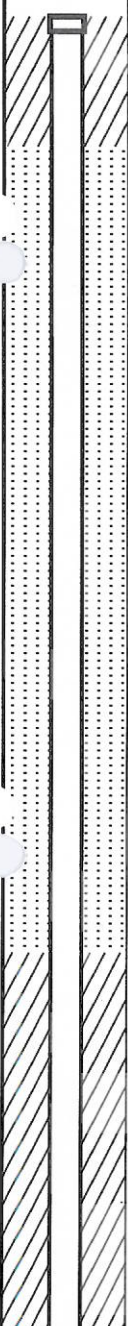
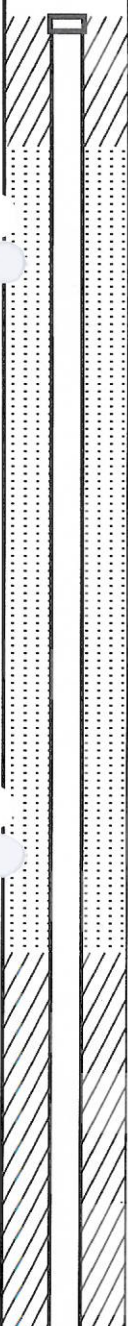
LOCATION / NOTES:		LEGEND		BOREHOLE LOG	
NVO = No visual or olfactory evidence		Disturbed Sample	Undisturbed Sample	Job Title: DiMe Investigation	
		Headspace Analysis	Down Borehole Analysis	Location: BP Llandarcy Refinery	
		Groundwater Table	Perched Water Table	Client: BP Oil Llandarcy Refinery	
					App'd: _____ Date: July 2002
					Drawn : SS Ref: _____
					Scale: As scale Job No: 39991-022
					Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB027S1		PAGE 1 of 2	
	NUMBER	TYPE					DRILLING DATES: 15/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
DESCRIPTION							COMMENTS			
	DSB027 2.0m	*182			0.0	Concrete. MADE GROUND	Moderate solvent odour and sheen	0.0		
					0.5	Loose gravel of ash, clinker and brick. MADE GROUND		0.5		
					1.0			1.0		
					1.5	Soft, grey-brown sandy SILT with frequent rounded, coarse gravel	Wet. Strong solvent odour	1.5		
					2.0	Loose COBBLES and rounded fine-med GRAVEL with med. sand		2.0		
2.5	Soft, grey, very sandy SILT with frequent coarse gravel and cobbles.	2.5								
3.0	Grades to brown colour from 3.0m	Wet. Strong solvent odour.	3.0							
3.5			3.5							
4.0			4.0							
4.5	With flat, angular sandstone from 4.5-4.6m	Wet. Mod-strong solvent odour	4.5							
5.0	Very silty sand from 4.8m		5.0							
	Becoming dense from 5.5m									

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	[-] Disturbed Sample ■ Undisturbed Sample ✱ Headspace Analysis ⬇ Down Borehole Analysis ≡ Groundwater Table ≡ Perched Water Table	Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery	
		URS	App'd: _____ Date: 18/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-022 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB027S1		PAGE 2 of 2		
	NUMBER	TYPE					DRILLING DATES: 15/01/02		DRILLING METHODS : Hydraulic Percussive		
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm		
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm		
							CHECKED BY :		SCREEN SLOT SIZE: 1mm		
 	DSB027 5.8m		*35.2		5.5				COMMENTS	Wet	5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
	DSB027 6.8m		*3300 *3552 *3667		6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0						

LOCATION / NOTES: NVO = No visual or olfactory evidence		LEGEND  Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table		BOREHOLE LOG Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery 			
				App'd:	Date: 18/09/2002		
				Drawn : SS	Ref:		
				Scale: As scale	Job No: 39991-022		
				Drg. Size: A4	BOREHOLE LOG		

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB027S2		PAGE 1 of 2	
	NUMBER	TYPE					DRILLING DATES: 15/01/02		DRILLING METHODS : Hydraulic Percussive	
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm	
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
DESCRIPTION							COMMENTS			
	DSB027 2.0m		*182		0.0		Concrete. MADE GROUND		Moderate solvent odour and sheen	0.0
							Loose gravel of ash, clinker and brick. MADE GROUND			0.5
							Soft, grey-brown sandy SILT with frequent rounded, coarse gravel			1.0
							Loose COBBLES and rounded fine-med GRAVEL with med. sand			1.5
							Soft, grey, very sandy SILT with frequent coarse gravel and cobbles.			2.0
	DSB027 4.0m		*216		2.0		Grades to brown colour from 3.0m		Wet. Strong solvent odour.	2.5
							With flat, angular sandstone from 4.5-4.6m			3.0
							Very silty sand from 4.8m			3.5
							Becoming dense from 5.5m			4.0
										4.5
							Wet. Mod-strong solvent odour		5.0	

LOCATION / NOTES:

NVO = No visual or olfactory evidence

LEGEND

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

BOREHOLE LOG

Job Title: DiMe Investigation
Location: BP Llandarcy Refinery
Client: BP Oil Llandarcy Refinery

URS

App'd:	Date: 18/09/2002
Drawn : SS	Ref:
Scale: As scale	Job No: 39991-022
Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: DSB027S2		PAGE 2 of 2		
	NUMBER	TYPE					DRILLING DATES: 15/01/02		DRILLING METHODS : Hydraulic Percussive		
							DRILLER : Geotechnical Engineering		BOREHOLE DIAMETER : 125mm		
							LOGGED BY : PEW		SCREEN TYPE & DIAM: HDPE 50mm		
							CHECKED BY :		SCREEN SLOT SIZE: 1mm		
	DSB027 5.8m	✖	*35.2		5.5				COMMENTS Wet	5.5	
			*3300		6.0					6.0	
			*3552		6.5						6.5
	DSB027 6.8m	✖	*3667		7.0		End of Borehole				7.0
					7.5						7.5
					8.0						8.0
					8.5						8.5
					9.0						9.0
					9.5						9.5
					10.0						10.0

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: DiMe Investigation Location: BP Llandarcy Refinery Client: BP Oil Llandarcy Refinery	
			App'd: _____ Date: 18/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-022 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: MSMW2		PAGE 1 of 2	
	NUMBER	TYPE					START DATE: 27/05/98		DRILLING METHOD: Cable Percussion/ Rotary	
							FINISH DATE: 28/05/98		BOREHOLE DIAMETER: 200mm / 115mm	
						DRILLER: CP1 / R2		SCREEN TYPE & DIAMETER: UPVC 50mm		
						LOGGED BY: SG/MC APPR'D BY:		SCREEN SLOT SIZE: 0.5mm		
						DESCRIPTION	COMMENTS			
						Loose light brown very gravelly silt with some fine sand and glass fragments (MADE GROUND)	No odour	0		
						Loose orange-brown very gravelly and slightly clayey sandy SILT	No odour	1.0		
						Loose brown very silty and sandy fine to medium GRAVEL Rotary drilling from 1.7m	No odour	2.0		
						Light grey sandstone and siltstone rounded and angular GRAVEL and cobbles (WEATHERED BEDROCK)	Very dense at 1.7m	3.0		
						ROCKHEAD: Light grey hard sandstone BEDROCK Borehole terminated at 7.0 mbgl	Returns are rockflour and sand only - no chips	4.0		
								8.0		
								10		
LOCATION / NOTES: 1. All measurements in m below ground level (mbgl) 2. Cable percussion to 1.7 mbgl, Rotary to 12.5 mbgl with odex to 4.5 mbgl 3. Water strike at 8m						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 App'd DRAFT Ref. MC/CR/BRS Date JUL 98 Job No. 39991-001-401		
								DAMES & MOORE		