

Remedial Targets Worksheet , Release 3.2



Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

User specified value for partition coefficient

Contaminant	Mercury
Target concentration	0.00007 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	2.98E-01	fraction	
Air filled soil porosity	θ_a	1.69E-01	fraction	
Bulk density of soil zone material	ρ	2.16E+00	g/cm ³	
Henry's Law constant	H	0.00E+00	dimensionless	

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	5.00E+02	l/kg	
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Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)	foc		fraction	
Organic carbon partition coefficient	Koc		l/kg	

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	
pH value	pH		pH units	
Acid dissociation constant	pKa			
Fraction of organic carbon (in soil)	foc		fraction	

Soil water partition coefficient used in Level Assessment Kd 5.00E+02 l/kg Specified value

Level 1 Remedial Target

Level 1 Remedial Target	3.50E-02	mg/kg	(for comparison with soil analyses)
	or		
	0.00007	mg/l	(for comparison with leachate test results)

Site being assessed: Southall
Completed by: Eoin O'Sullivan
Date: 09-Jun-17
Version: 0

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Mercury		from Level 1
Target Concentration	C _t	0.00007	mg/l	from Level 1
Dilution Factor	DF	1.75E+02		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks	Equations in HRA publication
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Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter source concentration			
Enter soil concentration	6	mg/kg	
Half life for degradation of contaminant in water	1.00E+100	days	
Calculated decay rate	6.93E-101	days ⁻¹	calculated
Width of plume in aquifer at source	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.06E+00	m	from Level 2
Bulk density of aquifer materials	1.80E+00	g/cm ³	
Effective porosity of aquifer	2.10E-01	fraction	
Hydraulic gradient	2.82E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	9.44E+01	m/d	from Level 2
Distance (lateral) to compliance point	1.50E+01	m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	5.00E+02	l/kg see options
Longitudinal dispersivity	ax	1.500	m see options
Transverse dispersivity	az	0.150	m see options
Vertical dispersivity	ay	0.015	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable		
Groundwater flow velocity	v	1.27E+01 m/d
Retardation factor	Rf	4.29E+03 fraction
Decay rate used	λ	1.62E-104 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	2.82E-02 fraction
Rate of contaminant flow due to retardation	u	2.95E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.71E-01 fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.15E+00 fraction
Calculated soil leachate concentration	Co	1.20E-02 mg/l

Remedial Targets

Level 3 Remedial Target	1.41E-02	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	7.03E+00	mg/kg	For comparison with measured soil concentration. This
	15	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.71E-01	fraction Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.00E+02 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} fraction

Organic carbon partition coefficient K_{oc} fraction

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{sc,i} l/kg

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer f_{oc} fraction

Soil water partition coefficient Kd 5.00E+02 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

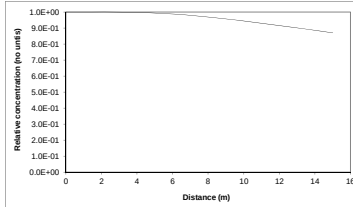
	Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	ax	1.50E+00	1.50E+00	m
Transverse dispersivity	az	0.00E+00	1.50E-01	1.50E-01 m
Vertical dispersivity	ay	0.00E+00	1.50E-02	1.50E-02 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)²⁺¹⁴; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	6.86E-05
0.8	1.00E+00	6.85E-05
1.5	1.00E+00	6.85E-05
2.3	1.00E+00	6.85E-05
3.0	1.00E+00	6.85E-05
3.8	9.98E-01	6.85E-05
4.5	9.96E-01	6.85E-05
5.3	9.93E-01	6.81E-05
6.0	9.88E-01	6.78E-05
6.8	9.82E-01	6.73E-05
7.5	9.74E-01	6.68E-05
8.3	9.66E-01	6.63E-05
9.0	9.57E-01	6.57E-05
9.8	9.48E-01	6.50E-05
10.5	9.38E-01	6.43E-05
11.3	9.27E-01	6.36E-05
12.0	9.16E-01	6.28E-05
12.8	9.05E-01	6.21E-05
13.5	8.94E-01	6.13E-05
14.3	8.82E-01	6.05E-05
15.0	8.71E-01	5.98E-05

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Southall
Completed by:	Eoin O'Sullivan
Date:	#####
Version:	0

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant	Naphthalene
Target concentration	0.002 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	2.98E-01	fraction
Air filled soil porosity	θ_a	1.69E-01	fraction
Bulk density of soil zone material	ρ	2.16E+00	g/cm ³
Henry's Law constant	H	4.90E-02	dimensionless

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd		l/kg
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Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)	foc	2.50E-02	fraction
Organic carbon partition coefficient	Koc	1.29E+03	l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		pH units
Acid dissociation constant	pKa		
Fraction of organic carbon (in soil)	foc		fraction

Soil water partition coefficient used in Level Assessment	Kd	3.22E+01	l/kg	Calculated value
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Level 1 Remedial Target

Level 1 Remedial Target	6.47E-02	mg/kg	(for comparison with soil analyses)
	or		
	0.002	mg/l	(for comparison with leachate test results)

Site being assessed:	Southall
Completed by:	Eoin O'Sullivan
Date:	24-May-17
Version:	0

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Naphthalene		from Level 1
Target Concentration	C _t	0.002	mg/l	from Level 1
Dilution Factor	DF	1.75E+02		from Level 2

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Soil water partition coefficient	K _d		l/kg
Organic carbon partition coefficient	K _{oc}	1.30E-02	fraction
Entry for non-polar organic chemicals (option)		1.29E+03	l/kg
Fraction of organic carbon in aquifer	f _{oc}		
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{sc,i}		l/kg
pH value	pH		
Acid dissociation constant	pK _a		
Fraction of organic carbon in aquifer	f _{oc}		fraction

Soil water partition coefficient K_d 1.67E+01 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

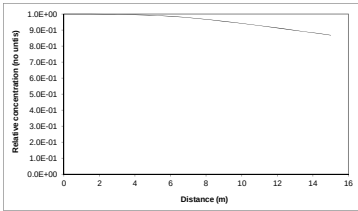
	Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	ax	0.00E+00	1.50E+00	0.00E+00 m
Transverse dispersivity	az	0.00E+00	1.50E-01	1.25E-01 m
Vertical dispersivity	ay	0.00E+00	1.50E-02	1.25E-02 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} \lambda)^{2.414}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration mg/l
0	1.0E+00	1.77E-04
0.8	1.00E+00	1.77E-04
1.5	1.00E+00	1.77E-04
2.3	9.99E-01	1.77E-04
3.0	9.99E-01	1.77E-04
3.8	9.98E-01	1.76E-04
4.5	9.95E-01	1.76E-04
5.3	9.92E-01	1.75E-04
6.0	9.86E-01	1.74E-04
6.8	9.80E-01	1.73E-04
7.5	9.73E-01	1.72E-04
8.3	9.64E-01	1.71E-04
9.0	9.55E-01	1.69E-04
9.8	9.46E-01	1.67E-04
10.5	9.35E-01	1.65E-04
11.3	9.25E-01	1.64E-04
12.0	9.14E-01	1.62E-04
12.8	9.03E-01	1.60E-04
13.5	8.91E-01	1.58E-04
14.3	8.80E-01	1.56E-04
15.0	8.68E-01	1.54E-04

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Southall
Completed by:	Eoin O'Sullivan
Date:	#####
Version:	0

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter source concentration			
Enter soil concentration	1	mg/kg	
Half life for degradation of contaminant in water	1.2E+02	days	
Calculated decay rate	2.69E-03	days ⁻¹	calculated
Width of plume in aquifer at source	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.06E+00	m	from Level 2
Bulk density of aquifer materials	1.80E+00	g/cm ³	
Effective porosity of aquifer	2.10E-01	fraction	
Hydraulic gradient	2.82E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	9.44E+01	m/d	from Level 2
Distance (lateral) to compliance point	1.50E+01	m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only

Parameters values determined from options

Partition coefficient	K _d	1.67E+01	l/kg	see options
Longitudinal dispersivity	ax	1.500	m	see options
Transverse dispersivity	az	0.150	m	see options
Vertical dispersivity	ay	0.015	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters Variable

Groundwater flow velocity	v	1.27E+01	m/d
Retardation factor	R _f	1.45E+02	fraction
Decay rate used	λ	1.86E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	2.82E-02	fraction
Rate of contaminant flow due to retardation	u	8.76E-02	m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.68E-01	fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.15E+00	fraction
Calculated soil leachate concentration	C ₀	3.09E-02	mg/l

Remedial Targets

Level 3 Remedial Target	4.03E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	1.30E+01	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.68E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99

Remedial Targets Worksheet , Release 3.2



Level 1 - Soil

Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant	Phenol
Target concentration	0.0077 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	2.98E-01	fraction
Air filled soil porosity	θ_a	1.69E-01	fraction
Bulk density of soil zone material	ρ	2.16E+00	g/cm ³
Henry's Law constant	H	1.89E-05	dimensionless

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd		l/kg
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Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)	foc	2.50E-02	fraction
Organic carbon partition coefficient	Koc	2.75E+01	l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		pH units
Acid dissociation constant	pKa		
Fraction of organic carbon (in soil)	foc		fraction

Soil water partition coefficient used in Level Assessment	Kd	6.89E-01	l/kg	Calculated value
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Level 1 Remedial Target

Level 1 Remedial Target	6.36E-03	mg/kg	(for comparison with soil analyses)
	or		
	0.0077	mg/l	(for comparison with leachate test results)

Site being assessed:	Southall
Completed by:	Eoin O'Sullivan
Date:	22-May-17
Version:	0

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant	Phenol			from Level 1
Target Concentration	C _t	0.0077	mg/l	from Level 1
Dilution Factor	DF	1.75E+02		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks	Equations in HRA publication
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Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter source concentration	2.9	mg/kg	
Half life for degradation of contaminant in water	2.80E+01	days	
Calculated decay rate	2.48E-02	days ⁻¹	calculated
Width of plume in aquifer at source	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.06E+00	m	from Level 2
Bulk density of aquifer materials	1.80E+00	g/cm ³	
Effective porosity of aquifer	2.10E-01	fraction	
Hydraulic gradient	2.82E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	9.44E+01	m/d	from Level 2
Distance (lateral) to compliance point	1.50E+01	m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	K _d	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.27E+01 m/d
Retardation factor	R _f	4.07E+00 fraction
Decay rate used	λ	6.08E-03 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	2.82E-02 fraction
Rate of contaminant flow due to retardation	u	3.11E+00 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.46E-01 fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.18E+00 fraction
Calculated soil leachate concentration	C ₀	3.51E+00 mg/l

Remedial Targets

Level 3 Remedial Target	1.9E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	15	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.46E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient	K _d		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}	1.30E-02	fraction
Organic carbon partition coefficient	K _{oc}	2.75E+01	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{sc,i}		l/kg
pH value	pH		
Acid dissociation constant	pK _a		
Fraction of organic carbon in aquifer	f _{oc}		fraction

Soil water partition coefficient	K _d	3.58E-01	l/kg
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Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

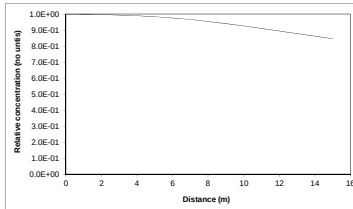
Longitudinal dispersivity	ax	Enter value	Calc value	Xu & Eckstein	m
Transverse dispersivity	az				m
Vertical dispersivity	ay				m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	2.01E-02
0.8	9.99E-01	2.00E-02
1.5	9.97E-01	2.00E-02
2.3	9.96E-01	2.00E-02
3.0	9.94E-01	1.99E-02
3.8	9.91E-01	1.99E-02
4.5	9.88E-01	1.98E-02
5.3	9.83E-01	1.97E-02
6.0	9.76E-01	1.96E-02
6.8	9.69E-01	1.94E-02
7.5	9.60E-01	1.93E-02
8.3	9.51E-01	1.91E-02
9.0	9.41E-01	1.89E-02
9.8	9.30E-01	1.87E-02
10.5	9.19E-01	1.84E-02
11.3	9.07E-01	1.82E-02
12.0	8.95E-01	1.80E-02
12.8	8.83E-01	1.77E-02
13.5	8.71E-01	1.75E-02
14.3	8.58E-01	1.72E-02
15.0	8.46E-01	1.70E-02

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Southall
Completed by:	Eoin O'Sullivan
Date:	#####
Version:	0

Remedial Targets Worksheet , Release 3.2



Level 1 - Soil

Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant	Total Ammonia
Target concentration	0.6 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	2.98E-01	fraction
Air filled soil porosity	θ_a	1.69E-01	fraction
Bulk density of soil zone material	ρ	2.16E+00	g/cm ³
Henry's Law constant	H	0.00E+00	dimensionless

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	1.20E+00	l/kg
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Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)	foc		fraction
Organic carbon partition coefficient	Koc		l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		pH units
Acid dissociation constant	pKa		
Fraction of organic carbon (in soil)	foc		fraction

Soil water partition coefficient used in Level Assessment	Kd	1.20E+00	l/kg	Specified value
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Level 1 Remedial Target

Level 1 Remedial Target	8.03E-01	mg/kg	(for comparison with soil analyses)
	or		
	0.6	mg/l	(for comparison with leachate test results)

Site being assessed:	Southall
Completed by:	Fraser Chamley
Date:	07-Jul-17
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Total Ammonia		from Level 1
Target Concentration	C _t	0.6	mg/l	from Level 1
Dilution Factor	DF	1.75E+02		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks	Equations in HRA publication
-------------	------------------------------

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter source concentration			
Enter soil concentration		mg/kg	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i		from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance (lateral) to compliance point	x	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable		
Groundwater flow velocity	v	1.27E+01 m/d
Retardation factor	Rf	1.13E+01 fraction
Decay rate used	λ	6.14E-102 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	2.82E-02 fraction
Rate of contaminant flow due to retardation	u	1.12E+00 m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.71E-01 fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.15E+00 fraction
Calculated soil leachate concentration	Co	0.00E+00 mg/l

Remedial Targets

Level 3 Remedial Target	1.20E+02	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.61E+02	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	15	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	8.71E-01	fraction Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 1.20E+00 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc}

Organic carbon partition coefficient K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n}

Sorption coefficient for ionised species K_{sc,i}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer f_{oc}

Soil water partition coefficient Kd 1.20E+00 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

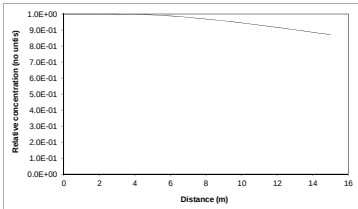
	Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	ax	0.00E+00	1.50E+00	0.00E+00 m
Transverse dispersivity	az	0.00E+00	1.50E-01	1.50E-01 m
Vertical dispersivity	ay	0.00E+00	1.50E-02	1.50E-02 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)²⁺¹⁴; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	0.00E+00
0.8	1.00E+00	0.00E+00
1.5	1.00E+00	0.00E+00
2.3	1.00E+00	0.00E+00
3.0	1.00E+00	0.00E+00
3.8	9.98E-01	0.00E+00
4.5	9.96E-01	0.00E+00
5.3	9.93E-01	0.00E+00
6.0	9.88E-01	0.00E+00
6.8	9.82E-01	0.00E+00
7.5	9.74E-01	0.00E+00
8.3	9.66E-01	0.00E+00
9.0	9.57E-01	0.00E+00
9.8	9.48E-01	0.00E+00
10.5	9.38E-01	0.00E+00
11.3	9.27E-01	0.00E+00
12.0	9.16E-01	0.00E+00
12.8	9.05E-01	0.00E+00
13.5	8.94E-01	0.00E+00
14.3	8.82E-01	0.00E+00
15.0	8.71E-01	0.00E+00

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Southall
Completed by:	Fraser Chamley
Date:	#####
Version:	1

APPENDIX F

Lagoon Temporary Stockpile Appraisal Report

(A720-E05-IW-CGL-EW-RP0002 P2)



FM Conway Limited

Southall Western Access

*Lagoon Temporary Stockpile
Appraisal – Revision 2*

A720-E05-IW-CGL-EW-RP-0002

June, 2017



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Issue Date		21/06/2017

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FIGURES

Figure 1 – A720-E05-IW-CGL-EW-DR-0001 P1 – Lagoon Stockpile Liner Schematic

APPENDICES

Appendix A – CGN03732I Southall Western Access: Lagoon Contaminant Migration Appraisal

Appendix B – Regulatory Correspondence

1. INTRODUCTION

The following summary report relates to the proposed stockpiling works at the Minet Tip 'lagoon' area as part of the Southall Waterside Western Access works. Outlined below is a concise options appraisal and proposed strategy, along with construction recommendations to facilitate the proposed temporary material stockpiling as part of the Southall Western Access earthworks phase. The temporary stockpiling of site-won materials is required prior to re-use within the proposed new western access road embankment which provides access to the adjacent Southall Waterside regeneration scheme. It is anticipated that this summary report will be used to obtain agreement from the statutory authorities of the proposed construction methodology.

1.1 Background

Clark Smith Partnership (CSP) and FM Conway (FMC) has requested a strategy and rationale for proposed protection measures within the lagoon stockpile. It is understood that this strategy is required in order to provide reassurance to the regulators that the potential creation and/or worsening of contamination migration pathways, to the identified key controlled waters receptors (the adjacent Yeading Brook and Grand Union Canal), associated with materials stockpiling, will be mitigated.

As part of the earthworks phase of the Western Access works, the current proposals comprise the temporary placement of approximately 4m high stockpiles of site-won natural and Made Ground soils, within the existing Minet Tip Lagoon Bund. The current construction methodology proposes that the stockpiled materials are to be mixed within the Lagoon Bund and treated using lime. The lime treated materials will then be transported from the temporary stockpile before being placed and stabilised using ground granulated ballast slag (GGBS) additives within the main road embankment.

During construction of the main embankment, the southern extent of the existing lagoon bund will be removed to facilitate the permanent alignment of the Western Access embankment. A report detailing the proposed permanent reconfiguration works has been completed by ARUP¹, which shows the final lagoon bund arrangement will comprise the reduction of the existing lagoon floor by approximately 500mm. This summary report relates only to the temporary stockpiling of material throughout the construction phase and does not aim to address the permanent reconfiguration of the lagoon bund following construction works.

¹ ARUP. (2017). Southall Waterside Development. *CRT Lagoon – Proposed reconfiguration works*. Dated 21st February 2017.

A separate report has also been produced by CGL² (presented in Appendix A) relating to the potential effects of surcharge loading of the stockpile materials on the existing deposits at the base of the lagoon and the potential mobilisation of contaminants towards the Yeading Brook. Reference should be made to this separate report in addition to this document.

² CGL (2017). *CGN03732I Southall Western Access – Lagoon Contaminant Migration Appraisal*. Rev0. Dated 9th June 2017.

2. SITE CONTEXT

2.1 Existing lagoon bund conditions

The historical lagoon bund materials are understood to derive from dredged material from the adjacent Grand Union Canal. The existing lagoon configuration comprises eastern and western bowl-shaped basins surrounded by a 3-4m high bund. Centrally, between the two basins is a further bund, or 'spine', that is to be maintained throughout the duration of the temporary stockpiling activities.

It is possible that some of the basin and bund materials originate from the former, adjacent *Southall Gasworks* site. Chemical laboratory testing of soils from material within the lagoon bund has recorded elevated concentrations of long-chain hydrocarbons (carbon chain length $>C_{10}$), polycyclic aromatic hydrocarbons (PAHs), metals and total cyanide.

2.2 Proposed stockpile material

It is understood that the materials to be temporarily stockpiled within the lagoon bund comprise Made Ground, Alluvium and River Terrace Deposits (RTD) from source areas including the existing Lagoon Bund, the Flood Alleviation Area and the proposed embankment alignment. Samples of the existing Lagoon Bund have recorded elevated concentrations of petroleum hydrocarbons, PAHs and asbestos fibres. A sample recovered from the southern part of the site identified elevated concentrations of petroleum hydrocarbons, PAHs and metals. However, the majority of the proposed materials to be stockpiled are anticipated to be sourced from the Flood Alleviation Area, where contaminant concentrations have been assessed to be low. A summary of the soil contamination testing completed to date is contained within a separate CGL reports^{3, 4 & 5}.

Overall, it is considered the majority of proposed source materials from the main Western Access site have lower contaminant concentrations than the lower quantities of source material expected to be obtained from the existing Lagoon Bund.

2.3 Site conditions and potential receptors

With regards to controlled waters receptors, several surface watercourses are present within the vicinity of the site. The Yeading Brook is situated approximately 15m to the north-west of the existing

³ CGL (2017). *CGN/03732C Southall advanced works*. Earthworks material acceptability and waste characterisation – (Pump Lane Bund). Rev1. May 2017. (A720-E05-IW-BR-CGL-EW-TS-0003 P1)

⁴ CGL (2017). *CGN/03732D Southall advanced works*. Earthworks material acceptability and waste characterisation – (Bridge Bund and Lagoon Bund). Rev1. May 2017. (A720-E05-IW-BR-CGL-EW-TS-0004 P1)

⁵ CGL (2017). *CGN/03732E Southall advanced works*. Earthworks material acceptability and waste characterisation – (Western Access Site). Rev1. May 2017. (A720-E05-IW-BR-CGL-EW-TS-0005 P1)

lagoon bund. The brook runs in a generally south-west to north-east orientation and flows towards the south-west.

The Grand Union Canal is present to the south-east of the existing lagoon bund and runs in a north-east to south-west orientation, flowing towards the south-west. It is understood that the Grand Union Canal is formed by concrete square piles with a capping beam, although details of the wall's permeability are not known. Furthermore, the structural integrity of the canal lining is not known and is beyond the scope of this document, however it is possible that surface water within the canal could be in hydraulic continuity with surrounding groundwater, which may provide a migration pathway for substances to impact the surface waters of the Grand Union Canal.

The River Crane, a partially culverted river, is present to the west of the existing lagoon bund and runs in a north-south orientation, flowing towards the south. It is understood that the river is formed in a 'C' section concrete channel. Ground investigation observations indicate the concrete sections may have leaked/are leaking at certain locations.

With regards to groundwater, the site is underlain by granular River Terrace Deposits (RTD), which are designated as a Principal Aquifer. Additionally, a Principal Aquifer is present at depth within the Thanet Formation and Chalk, however, information from historical British Geological Survey (BGS) boreholes and previous investigations indicate that these strata are present at depth, beneath a significant thickness (anticipated up to 20m) of the London Clay Formation, which acts as an aquiclude.

2.4 Potential risks from stockpiled materials

As outlined above, it is understood that materials within the existing lagoon bund are impacted with long-chain petroleum hydrocarbons and PAHs.

Preliminary groundwater and surface water monitoring, undertaken by Ramboll Environ, indicates no significant contaminant concentrations. Further pre-construction monitoring of groundwater is being undertaken by CGL to determine baseline conditions. However, based upon evidence obtained to date, it is anticipated that possible that surface water within the receptors may have been previously impacted by contamination associated within the adjacent former gasworks.

It is understood from the previous ARUP DQRA report that locally, groundwater within the RTD flows in a north-westerly direction, towards the Yeading Brook. Ground conditions beneath the existing lagoon bund are anticipated to comprise Alluvial soils and granular RTD, which are likely to provide a potential pathway to mobile contaminant migration to the Yeading Brook. Given that the River Crane and Grand Union Canal are lined, it is considered that a valid migration pathway to these

receptors, through groundwater migration, is unlikely to be present. Notwithstanding this, the proposed monitoring strategy (as outlined below) has been designed to assess risks to these receptors in addition to the Yeading Brook.

No evidence of free-product and/or free hydrocarbons has been observed within the existing lagoon bund materials or any of the sources materials tested to date on the site. Given the limited potential for mobile substances to be present within these materials, it is considered that stockpiling is unlikely to result in significant adverse effects to controlled waters. Notwithstanding this, controls will need to be implemented to mitigate potential leaching from the temporary stockpiles.

Current construction proposals indicate the stockpiling will be undertaken within the two basins of the lagoon (western and eastern) with access to be obtained through the central spine. The stockpiles will be approximately 4m high and have a total combined area of approximately⁶ 5,450m². Assuming a conservative bulk unit weight of 20kN/m² for stockpile materials, this may result in a surcharge load of 80kN/m² to the lagoon area, with potentially a further 20kN/m² from construction plant. This increase in surface total stress may result in increased pore water pressures within the lagoon bund materials, potentially resulting in increased leaching and migration of contaminants.

The separate CGL report² (presented in Appendix A) concludes that, should new contamination pathways be created due to the loading of the existing ground, then the risk to downstream controlled waters from contaminants migrating within groundwater is considered to be low. The relatively impermeable nature of the cohesive Made Ground, Alluvium and cohesive River Terrace Deposits restrict the migration of potential contaminants. In addition, the granular River Terrace Deposits, where migration of contaminants could readily occur, are not continuous beneath the site. Similarly, the groundwater encountered in the Alluvium is not considered to be laterally pervasive and it is considered unlikely that increased contaminant migration to downstream controlled waters receptors would occur.

⁶ Based upon the ARUP Reconfiguration Proposals showing a current bund volume of 16400m³ and an average bund height of 3m

3. MITIGATION MEASURES OPTIONS APPRAISAL

To limit the creation of pathways between the in-situ materials and the stockpiled materials and minimise leachate migration, mitigation measures are considered necessary prior to placement of stockpile materials. A preliminary mitigation options appraisal has been developed that is outlined in Table 1 below.

Based on a subsequent review of these options and discussions within the project team and with the regulators, the final proposed stockpile construction design is presented in Section 4.

The mitigation strategy has been separated into two phases. The first phase relates to the construction of mitigation to minimise surface water run-off, and migration of contaminants upwards or downwards between the stockpiled materials and the existing lagoon bund materials. The second phase relates to the strategy employed to monitor potential migration of contaminants within natural soils, during the construction phase.

3.1 Stockpile construction phase

Table 1 below outlines recommended measures and methods for stockpile construction and control.

Table 1. Stockpile mitigation measures options

Separation Option	Advantages	Disadvantages	Considered Viable?	Additional Recommended controls
Geomembrane	Provides an impermeable barrier between stockpile materials and the lagoon bund and prevents leachate migrating between material.	- Can be prone to rupturing and may have durability issues. Potential for ponding of leachate run-off. Difficulty in detecting rupturing beneath stockpile materials. - Drainage issues may occur and may be difficult to construct adequate drainage channels.	✓	- Rupture checks / protection of the membrane - Stockpile covers (plastic sheeting or other similar) - Drainage channels (including cross falls/drainage grips) - Collected leachate to be disposed of in controlled manner via trade effluent discharge consent or tankering off-site
Concrete Pad	- Provides an impermeable barrier between stockpile materials and the lagoon bund and prevents leachate migrating between. - Durable and unlikely to rupture. - Effective for construction of drainage channels and reduction of pore-	- Buildability and construction issues. Either cast in-situ slab or poured concrete likely to be expensive and may not be viable for site location. - If poured concrete, potential for run-off of concrete materials to surface watercourses.	✓	

	water pressure build-up in underlying soils.			
Stabilisation of first layer of lagoon-tip soils, With or without membrane	- Provides durable and robust hard-surface which may incorporate a membrane. - Efficient construction and buildability. - Provides a low permeability barrier between stockpile materials and the lagoon bund and prevents leachate migrating between.	By producing a hard and low permeability surface, there is a risk of an increased potential of pore-water pressure build-up within the underlying lagoon bund materials, potentially resulting in increased leaching and instability.	✓	
Granular platform	Cost-effective and easy installation, provides drainage channels	Does not provide an impermeable barrier between stockpiled materials and lagoon bund. May be feasible to be adopted in conjunction with other options listed above.	X	N/A
None (direct contact)	Low cost and simple	If no separation layer is adopted, soils will become mixed with the in-situ lagoon bund materials. Increased risk of leaching and pore-water pressure build-up as no drainage layer will exist.	X	N/A

Based on the above assessment, it is considered that either geomembrane with a granular drainage layer or stabilisation of the top layer of in-situ bund materials are viable mitigation options for mitigating the identified geo-environmental risks associated with stockpiling. A granular layer, placed above the geomembrane and below the stockpile, should provide an adequate drainage blanket to allow for the collection of leachate and surface water run-off, in combination with a perimeter drainage/collection system. The solution that would reduce any localised deformations of the geomembrane, and subsequent ponding of any leachate, would be to stabilise the upper layer of the existing bund formation with an appropriate cross-fall. A blinding layer of sand, or treated fine grained material, would be laid with a granular blanket above to minimise the occurrence of membrane rupture.

3.2 Monitoring phase

It is proposed to undertake monitoring of groundwater to assess the effectiveness of the proposed lagoon bund mitigation measures and act as an early warning to potential changes in ground and groundwater conditions which may be detrimental to the environment and the stockpile integrity.

As a result, it is proposed to install three boreholes within the lagoon bund on the periphery of the proposed stockpile. These lagoon 'source' boreholes would be installed in advance of the works and

would be monitored on a regular basis (see Table 2 below), initially to provide baseline conditions and subsequently to obtain data at regular intervals during the works.

The three boreholes would be installed in conjunction with four 'sentinel' groundwater monitoring boreholes (Phase B boreholes), three of which would be located down-gradient of the lagoon to monitor groundwater quality between the source and key receptor, Yeading Brook.

As part of these works, it is proposed to set 'trigger levels' to provide a warning that additional mitigation measures are required to minimise potential impact to the identified receptors. The 'trigger levels' will include water quality criteria for key contaminants of concern and, if breached, will require additional targeted measures. A separate plan will need to be prepared for discussion and agreement with the regulators, which will identify these trigger levels and measures to be implemented in the event trigger levels are breached.

The rationale and proposed monitoring strategy for these boreholes is outlined below.

Table 2. Proposed monitoring

Location ID	Rationale	Proposed Monitoring
BH1A	Boreholes are to be completed to facilitate the installation of a monitoring standpipe screened within the cohesive lagoon bund materials. The borehole will act as a source monitoring well throughout the works.	Undertake two baseline monitoring visits prior to surcharging to monitor groundwater levels and to recover groundwater samples to assess baseline conditions. During surcharging, weekly visits are proposed followed by monthly post works monitoring for three months, dropping to bi-monthly if no contamination is detected above trigger concentrations for up to one year following works completion.
BH2A	Within borehole BH2A, the same approach as BH1A will be adopted, with a piezometer installation within the lagoon bund materials.	
BH3A	Within borehole BH3A, the same approach as BH1A will be adopted, although the standpipe will be screened within the natural soils beneath the lagoon tip materials. Such installations will assess whether any non-aqueous phase liquids (NAPL) are present in the materials underlying the tip, and whether additional surcharge loading may affect this.	
BH1B	Down-gradient (sentinel) boreholes to be installed with monitoring standpipes, screened within the RTD, to facilitate groundwater sampling and monitoring. Allows for early identification of changes in groundwater quality between the source and receptor (Yeading Brook).	Undertake two baseline groundwater monitoring/sampling visits prior to surcharging, to define baseline conditions. During surcharging, weekly visits are proposed followed by monthly post works monitoring for three months, dropping to bi-monthly if no contamination is detected above trigger concentrations for up to one year following works completion.
BH2B		
BH3B		
BH4B	Up-gradient borehole to facilitate groundwater sampling and monitoring of up-gradient groundwater levels and chemistry within the RTD and potential for localised groundwater flow to the Grand Union Canal.	

The full monitoring strategy details, along with the temporary stockpiling proposals, will be identified and incorporated within an addendum to the Arup Remediation Strategy, to be issued at a later date by CGL.

4. LAGOON STOCKPILE CONSTRUCTION DESIGN

4.1 Lagoon stockpile detail and design

A drawing has been produced, which outlines the proposed stockpile construction details and sections. The stockpile schematic (A720-E05-IW-CGL-EW-DR-0001 P1) is presented as Figure 1 to this report.

As outlined on Drawing A720-E05-IW-CGL-EW-DR-0001 P1, the finalised design will include:

- Configuration and access arrangements – access to the western bowl is to be from the south-west and to the eastern bowl via a cutting through the existing central spine;
- Basal separation layer and compacted granular fill – the lagoon basins will be laid to existing falls utilising site-won material to raise the basin formation level above the existing ground level. A geotextile (Terram) will be placed on the existing ground surface prior to placement and compaction of this layer;
- Basal liner geomembrane – an impermeable membrane (HDPE, LLDPE or PP) is to be laid over the prepared and compacted surface, with suitable welded overlaps and 50mm thick fine sand blinding layer above;
- Granular drainage blanket layer – a coarse sized material (6F5) will be placed and gently tracked in to a thickness of 500mm;
- Drainage channels – perimeter swales will be formed within each lagoon basin as shown on the schematic drawing; and
- Leachate collection system, in the form of swales with perimeter collection pipework, leachate collection points with leachate pumps and collection/off-site disposal.

In addition to the stockpile construction and design, a typical haul road construction is to be constructed for access into, and between the basins. The will comprise an initial *Terram* layer placed on the in-situ material lagoon bund material at the location of access, as indicated on the schematic. Additionally, a geogrid layer should be placed due to the high frequency of plant movements in and out of the stockpile area. A layer of circa 300mm compacted granular fill (such as 6F5 granular fill) would be placed as the running surface, however, this will require a full temporary works design to determine the appropriate thickness of material to support the construction plant. A temporary

works design has not been undertaken here. The haul road connection to the inside of the Lagoon would be tied into the granular drainage blanket.

Information on the requirements and specification for the lagoon stockpile lining are shown on Drawing A720-E05-IW-CGL-EW-DR-0001, presented as Figure 1 to this report.

4.2 Regulatory correspondence

The proposed lagoon design and temporary stockpiling have been reviewed by the Canal and River Trust (CRT) and confirmation has been received that the proposals are accepted (see Appendix B).

The Environment Agency has confirmed they are comfortable with the general arrangements proposed though raised queries with regards to operational aspects of the stockpile management. Specifically, the Environment Agency requested confirmation with regards to provision of additional leachate pumping, in periods of unusually high rainfall and with regards to the protection of the proposed leachate collection points. FM Conway has confirmed that additional leachate storage capacity will be available on site for periods of heavy rainfall and corresponding leachate generation and that the collection points will be suitably fenced off with barriers to protect the collection points from vehicle / plant damage (see correspondence in Appendix B).

4.3 Health & safety precautions

Construction workers have the potential to come into direct contact with dusts, soils and groundwater during the excavation of bund and other materials. Based on the findings of the investigation the risk to construction workers is assessed as moderate to high. It should be noted that materials encountered within the lagoon bund include elevated TPH and total cyanides, together with loose asbestos fibres.

Appropriate health and safety measures should be incorporated during construction. Such precautions should include, but not be limited to:

- Personal hygiene, washing and changing procedures.
- Use of personal protective equipment, including disposable overalls, gloves etc.
- Measures to avoid surface water ponding and positive collection and disposal of on-site run-off.
- Regular cleaning of site roads, access roads and the public highway including dust suppressions methods (e.g. water spraying), if necessary.

- During excavation soils should be damped down to suppress dusts.

It is recommended that a watching brief is maintained by the Principal Contractor, particularly during ground works undertaken in areas where gross contamination, such as oily material or material of an unusual colour or odour, is encountered.

4.4 Post stockpile conditions

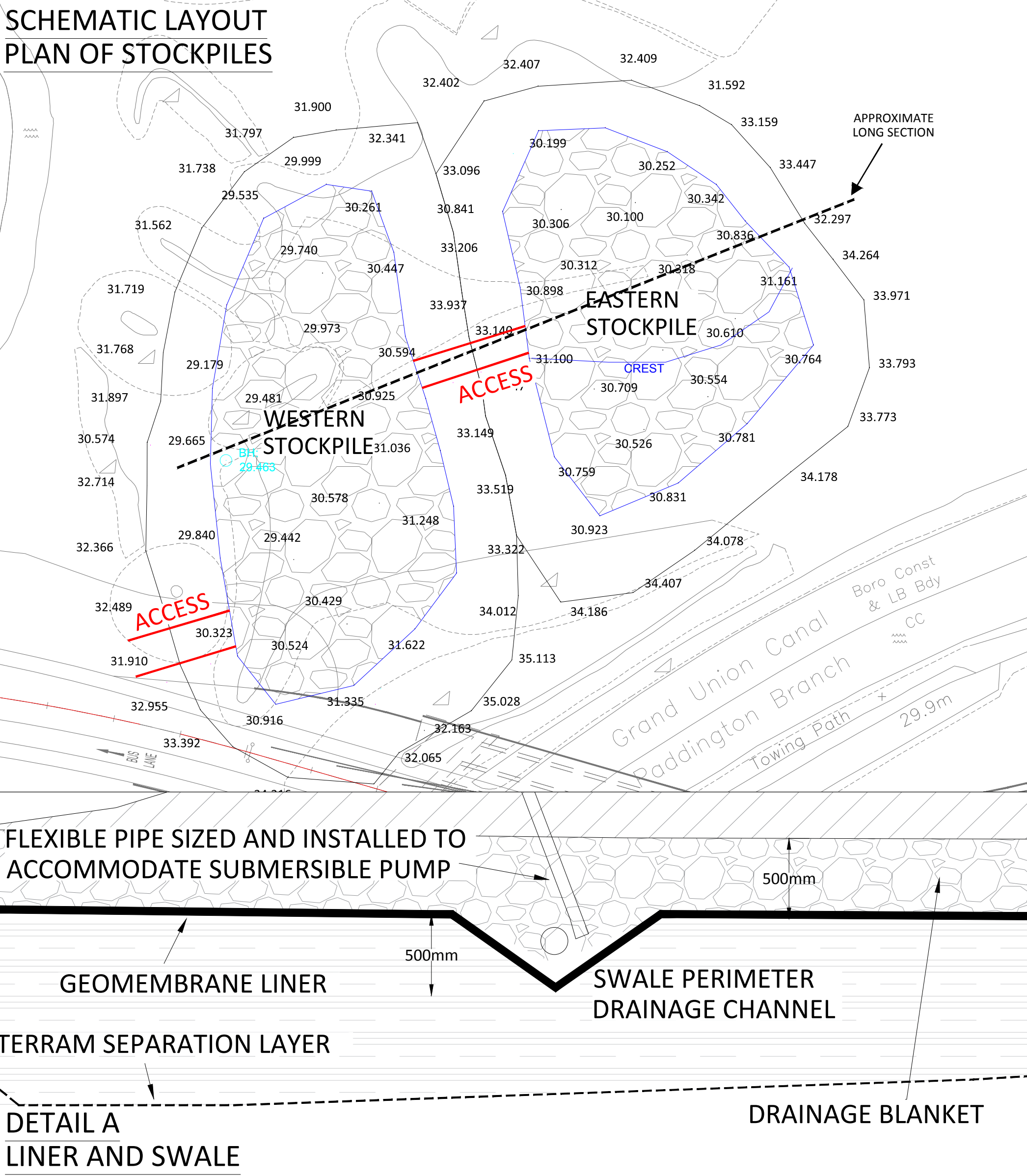
It is understood that, following stockpiling and re-use/disposal of stockpiled materials, the lagoon bund will be reconfigured in accordance with the ARUP Proposed Reconfiguration Works¹. This report does not address any aspects relating to these re-configuration works.

4.5 Acceptance of mitigation proposals

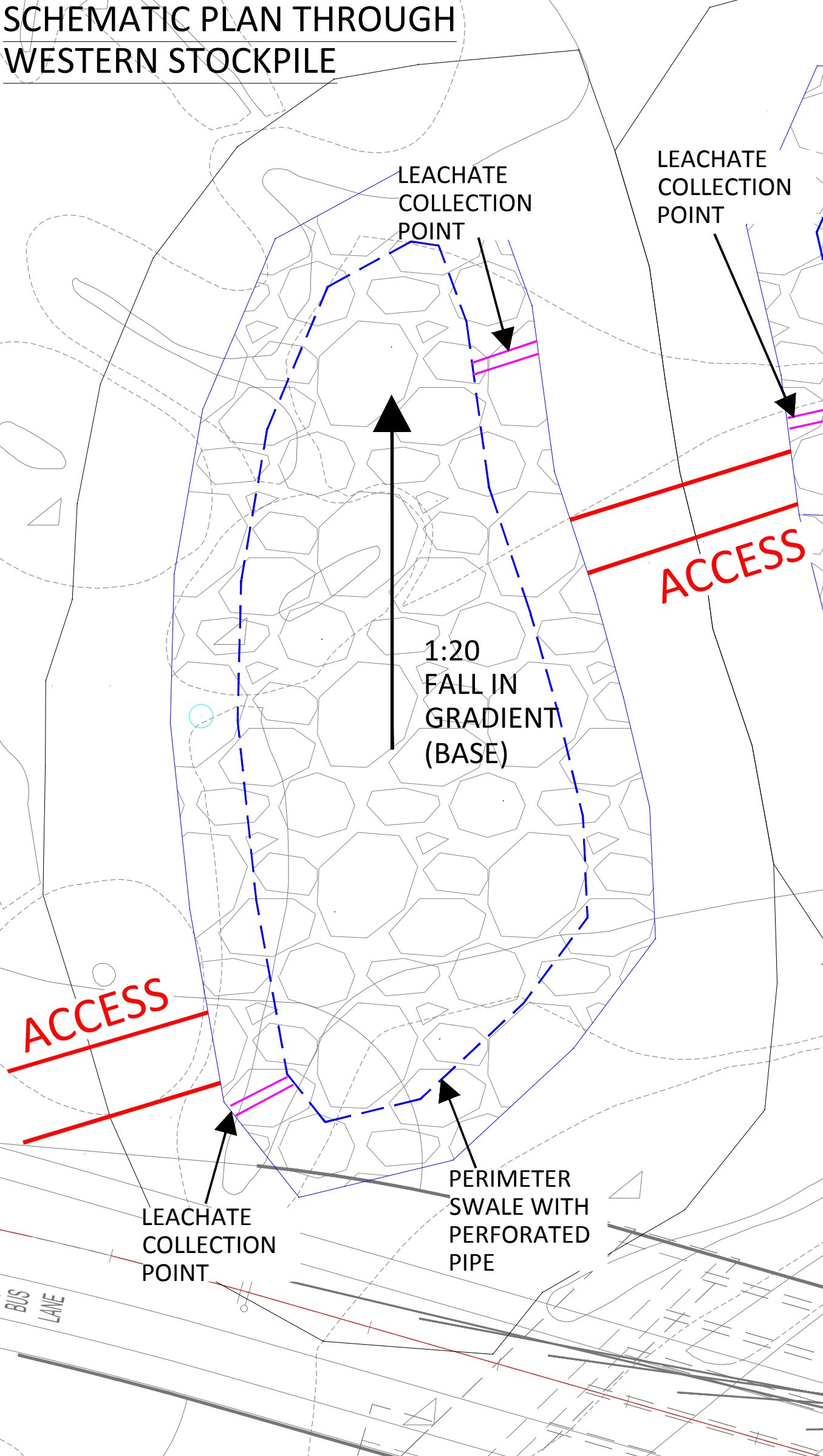
In addition to the responses and acceptance received from CRT and the Environment Agency it is recommended that this methodology is provided to the London Borough of Hillingdon (LBH) prior to adoption. Further packages of information will be produced for review by the Environment Agency and LBH, which will incorporate the necessary aspects of this report and be submitted under separate cover.

FIGURES

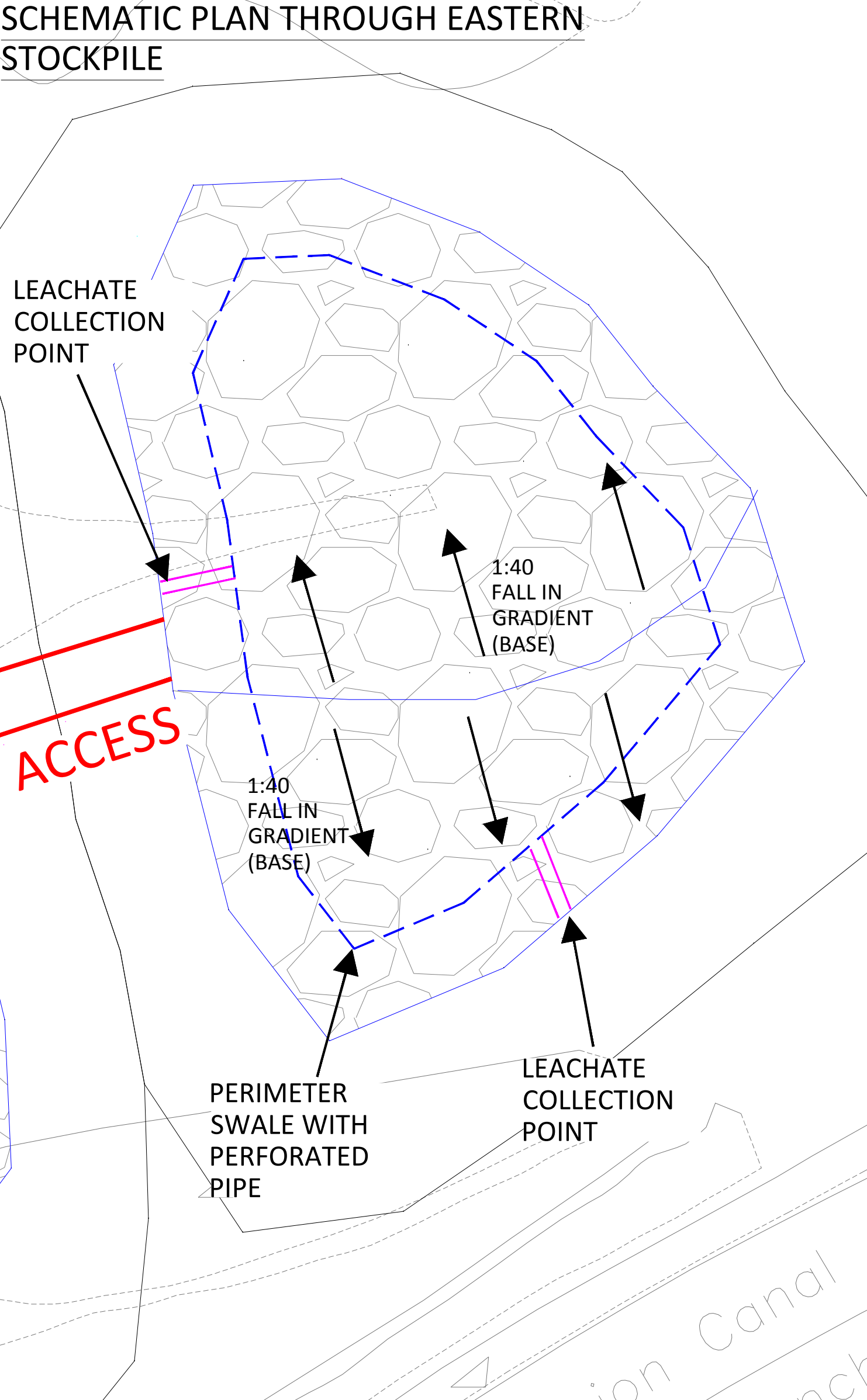
SCHEMATIC LAYOUT
PLAN OF STOCKPILES



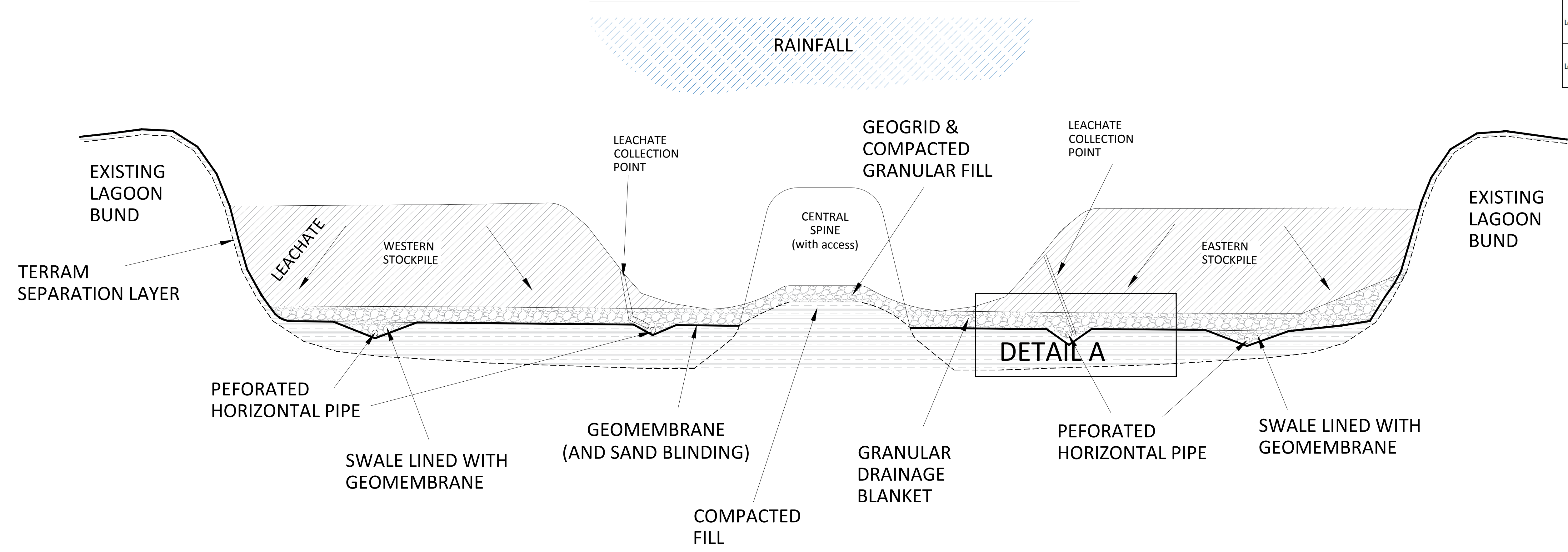
SCHEMATIC PLAN THROUGH
WESTERN STOCKPILE



SCHEMATIC PLAN THROUGH EASTERN
STOCKPILE



SCHEMATIC LONG SECTION THROUGH LAGOON STOCKPILES



Component	Requirements	Details/Specification
Configuration & Access	General	Two stockpiles are to be formed within the existing lagoon (western and eastern stockpiles), with access to the western stockpile from the south west and for the eastern stockpile to be formed through the central lagoon spine. Perimeter access to the eastern stockpile and access through the central spine will need to be maintained. The access points will be constructed with a terram separator laid on existing ground with overlying geogrid and approximately 300mm compacted granular fill (6F5 or similar).
Basal preparation	Separation layer	A geotextile (Terram GT series or similar) to be placed on existing lagoon floor with overlap of 300mm between rolls. Geotextile to be extended up sides of lagoon bund to a sufficient distance, and be suitably anchored, to prevent imported fill layer mixing with existing lagoon materials.
	Compacted Fill	Suitable site won or imported fill to be placed and compacted on existing lagoon floor, over separation layer, to create cross falls for the blanket drainage layer. The layer of fill to be of sufficient thickness to accommodate depth of drainage channels without disturbance of existing ground level.
Basal liner	Geomembrane	Impermeable geomembrane (HDPE, LLDPE or PP) placed and jointed / welded in accordance with manufacturer's standard requirements. Geomembrane to be provided by suitable manufacturer e.g. Geosynthetics, Monarflex with 50mm thick sand blinding above. Installation to be certified.
Drainage	Blanket drainage layer	500mm thick granular layer, comprised of suitable drainage material (SHW Series 500), to be placed above geomembrane and beneath stockpile, as per stockpile section drawing. Care to be taken to avoid puncturing underlying geomembrane.
Drainage	Drainage channels	Drainage channels (swales) should be 600mm wide and 500mm deep, and are to be dug around perimeter of stockpile area, as shown on the drainage channel section.
		The base of the drainage channels should be lined with the impermeable geomembrane, which should extend continuously beneath the entire drainage layer and be suitable anchored beyond the walls of the lagoon bund. The lined drains should then be filled with a suitable drainage material (SHW Series 500), as shown on the drainage channel section drawing.
Leachate collection	Sumps	Leachate generation estimated based on approximate 700m ² stockpile area, assuming a regionally average monthly rainfall of 93mm per month. Two leachate collection points are required to be constructed for both stockpiles, as shown on stockpile section. The perimeter drainage channel should be constructed as a swale, including a perforated horizontal pipe with collection points. The perforated pipe and collection pipes should be of sufficient size/diameter to allow for pumping. A narrow flexible submersible pump should be installed within the collection point pipe, extending above the maximum stockpiling level.
Leachate collection	Pumping	Leachate collection via pumping from leachate collection points, as per stockpile section. Pumping on a weekly frequency and following periods of rainfall.
Leachate collection	Collection and disposal	Leachate to be pumped to holding tanker, and disposed of off-site via a suitably licenced carrier on a weekly basis. Allowance to be made for pumping and disposal.

- General Notes**
- Plans and sections are schematic only
 - Stockpile dimensions to be determined by the Contractor based upon working area in existing lagoon bund.
 - Existing lagoon bund configuration will require two separate stockpiles with independent drainage systems, due to central bund.
 - Access into lagoon bund and between stockpile configurations is to maintain similar material separation as for the main stockpile.
 - Material stockpiles and surface drainage to be determined by the Contractor based upon their earthworks methodology.

1	26/05/17	FOR TENDER PURPOSES
0	19/05/17	FOR TENDER PURPOSES
Rev	Date	Comments
Card Geotechnics Ltd 4 Godalming Business Centre Woodstock Way Godalming Surrey GU7 1YW T: 01483 310600		
Project Southall Western Access		
Client FM Conway		
Drawing title Lagoon Stockpile Lining Schematic		
Scale(s)		Job No.
NTS		CGN/037321
Drawn	TD	18/05/17
Checked		
Approved		
A720-E05-1W-CGL-EW-DR-0001		Rev. 1
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APPENDIX A

CGN037321/ Southall Western Access:

Lagoon Contaminant Migration Appraisal

09 June, 2017

Mr Dominic Speller
Clark Smith Partnership Limited
Whitechapel Technology Centre
65 Whitechapel Road
London
E1 1DU

Our ref: CGN/037321

Please reply to: Kirsty Poore / Robin Slade

Dear Dominic,

Southall Western Access: Lagoon Contaminant Migration Appraisal

Following recent discussions please find below our assessment of potential risks to controlled waters caused by the planned stockpiling of material in the Lagoon Bund area of the Southall Western Access development site during the construction of the proposed new road embankment. The assessment has been undertaken to address the concern posed by the Environment Agency that the overburden surcharge created by the stockpiled material may compress the underlying material such that new contamination pathways are created, and thus potentially impacting nearby watercourses.

The Southall Western Access development covers an area of approximately 7.66 hectares and a site location plan of the overall development area is included in Figure 1. It is proposed to construct a new road alignment where embankment fill is to be won from areas of the site and stabilised within temporary stockpiles before being placed within the earthworks. This site won material is expected to be generated mostly from Area 1 ("River Crane incorporating Western Embankment and Flood Alleviation Zone"), some from Area 2 ("Central Embankment") and part of Area 3 ("Lagoon Bund"). Refer to Figure 1 for these area details.

The Lagoon Bund area relevant to this assessment is located within the eastern section of the site, located between the *Grand Union Canal* and *Yeading Brook*. The Lagoon Bund comprises a roughly circular bowl shaped area, divided by a central spine, of approximately 5,450m² and is understood to have been used as a depositary area for dredged materials from the *Grand Union Canal*. Ground level at the centre of the lagoon is approximately between 29.0m above Ordnance Datum (mOD) and 29.5mOD with the exterior or 'bunds' of the lagoon at a level of approximately 4m above this. It is proposed that some of the bund will be excavated where it overlaps with the proposed embankment alignment, and it is planned to use the remaining area of the Lagoon Bund to temporarily stockpile material and use as a lime stabilisation area.

The *Yeading Brook* is located approximately 15m to the northwest of the lagoon bund and is orientated northeast-southwest, with flow towards the southwest. The *Grand Union Canal* is located to the southeast of the lagoon bund and is orientated northeast-southwest, flowing towards the southwest.

Ground model

Two ground investigations have been undertaken within the lagoon bund area; the first by Ian Farmer Associates (IFA) in 2014¹ and the second by CGL in 2017^{2,3}. An exploratory hole location plan for the Lagoon Bund area is presented in Figure 2. The ground investigations indicated that the ground conditions generally comprise Made Ground overlying superficial deposits of Alluvium and River Terrace Deposits, over the London Clay Formation.

The CGL trial pit investigations in 2017 encountered granular Made Ground generally comprising slightly gravelly, clayey sand over cohesive Made Ground which generally comprised stiff, sandy, gravelly clay. Strong hydrocarbon odours were noted within the cohesive Made Ground. The IFA and CGL borehole investigations indicated that the Made Ground was underlain by Alluvium in the south of the lagoon bund area, cohesive River Terrace Deposits in the west and north, and granular River Terrace Deposits in the east adjacent to the *Grand Union Canal*. The Alluvium typically comprised soft to firm, slightly gravelly to gravelly, sandy clay whilst the cohesive River Terrace Deposits typically comprised firm, slightly sandy, gravelly clay. The granular River Terrace Deposits encountered in the east of the Lagoon Bund comprised sandy gravel. A moderate hydrocarbon odour was noted in the Alluvium in borehole CP06 in the south of the site. The superficial deposits were underlain by the London Clay Formation.

A cross section of the lagoon bund area is presented in Figure 3 which indicates that the granular River Terrace Deposits pinch out towards the northwest (away from the *Grand Union Canal*) and the alluvial deposits are found to directly overlie the London Clay Formation.

Groundwater was not encountered during the IFA and CGL ground investigations with the exception of a slight seepage in borehole CP04 at 25.88mOD towards the base of the Alluvium. Groundwater monitoring recorded in the IFA report¹ and CGL 2016 report⁴ indicated groundwater within the cohesive alluvial deposits in boreholes CP04 and CP06, and an overall groundwater flow direction to the west, towards *Yeading Brook*. Recent groundwater monitoring undertaken by CGL on 2 June 2017 recorded groundwater within the cohesive River Terrace Deposits (BH1A), Made Ground (BH2A) and granular River Terrace Deposits (BH3A). Samples of groundwater from the three boreholes has been scheduled for chemical analysis, the results of which are currently awaited. It is also noted that the results of the groundwater monitoring indicate the presence of sub-artesian water pressures within the Alluvium and River Terrace Deposits, confined by the overlying impermeable Made Ground and relatively impermeable Alluvium.

Impacts of proposed stockpiling

It is understood that the proposed stockpiles would cover a plan area of approximately 5,450m² and would be up to 4m in height based on the lagoon volume and dimensions quoted in Arup's lagoon reconfiguration report⁵. Based on these parameters, stockpiling of the site won material would result in a surcharge load of approximately 100kN/m² assuming a bulk density of 20kN/m² for the material and 20kN/m² from construction plant. This surcharge would result in an increase in pore pressures in the underlying cohesive strata and an order of settlement would also occur.

¹ Ian Farmer Associates Limited (2015) *Southall Gasworks Redevelopment – Hillingdon Sites. Factual Ground Investigation Report*. May 2015. Report reference 21247A.

² CGL (2017) *Western Access, Southall. Earthworks Material Acceptability and Waste Characterisation (Western Access Site)*.

³ CGL (2017) *Pump Lane*. Draft borehole logs. BH1A, BH2A, BH3A, BH3B, BH4B.

⁴ CGL (2016) *Southall, Pump Lane Western Access. Preliminary Geotechnical Design Report. Revision 1*. December 2016. CG/03732.

⁵ Arup (2017) *Southall Waterside Development. CRT Lagoon Proposed Reconfiguration Works*. February 2017.

As previously outlined, this additional surcharge loading has the potential to compress the underlying Made and natural ground, including contaminated material. Whilst compressing the contaminated material in itself does not present an issue, if the contamination is mobile within groundwater then the increase in pore pressures could result in such groundwater 'squeezing' out from beneath the stockpile to the sides. Therefore, if water is present within the shallow ground, the stockpiling of material within the Lagoon Bund theoretically has the potential to create new pathways for contamination to migrate into controlled waters (*Yeading Brook* and *Grand Union Canal*).

However, the following rationale is considered to show that the stockpiling of material within the Lagoon Bund does not result in an increased risk of contaminant migration to controlled waters. The mechanism is illustrated in Figure 4.

- The superficial deposits within the Lagoon Bund area are predominantly cohesive and therefore act as a relatively impermeable barrier to lateral and vertical contaminant migration.
- The granular River Terrace Deposits in which the shallow groundwater table is present are not continuous and are present beneath relatively impermeable Alluvium and Made Ground; therefore, it is unlikely that stockpiling would introduce new contaminants into the groundwater and the likelihood of migration of these contaminants to the downstream *Yeading Brook* is considered to be low.
- Groundwater has been encountered in the cohesive alluvial deposits during past monitoring and ground investigations within the Lagoon Bund. Hydrocarbon contamination was encountered within the Alluvium in borehole CP06 and the groundwater within the stratum has the potential to mobilise contaminants within the soil; however, this groundwater is likely to represent a perched water table which is not considered to be continuous or laterally pervasive, and therefore not in continuity with the *Yeading Brook*.
- Where groundwater is not present in the cohesive Made Ground and cohesive River Terrace Deposits, the contaminants are unable to be mobilised.

Conclusions

Interpretation of the ground and groundwater conditions at the Southall Western Access Lagoon Bund area indicates that, should new contamination pathways be created due to the loading of the existing ground, then the risk to downstream controlled waters from contaminants migrating within groundwater is considered to be low.

The relatively impermeable nature of the cohesive Made Ground, Alluvium and cohesive River Terrace Deposits restrict the migration of potential contaminants. In addition, the granular River Terrace Deposits, where migration of contaminants could readily occur, are not continuous beneath the site. Similarly, the groundwater encountered in the Alluvium is not considered to be laterally pervasive and it is considered unlikely that increased contaminant migration to downstream controlled waters receptors would occur.

We trust this meets your requirements, however, if further information is needed, please do not hesitate to contract us.

A summary of the above findings and interpretation will be incorporated within our proposed Southall Western Access remediation strategy addendum report, for onward submission to the regulators.

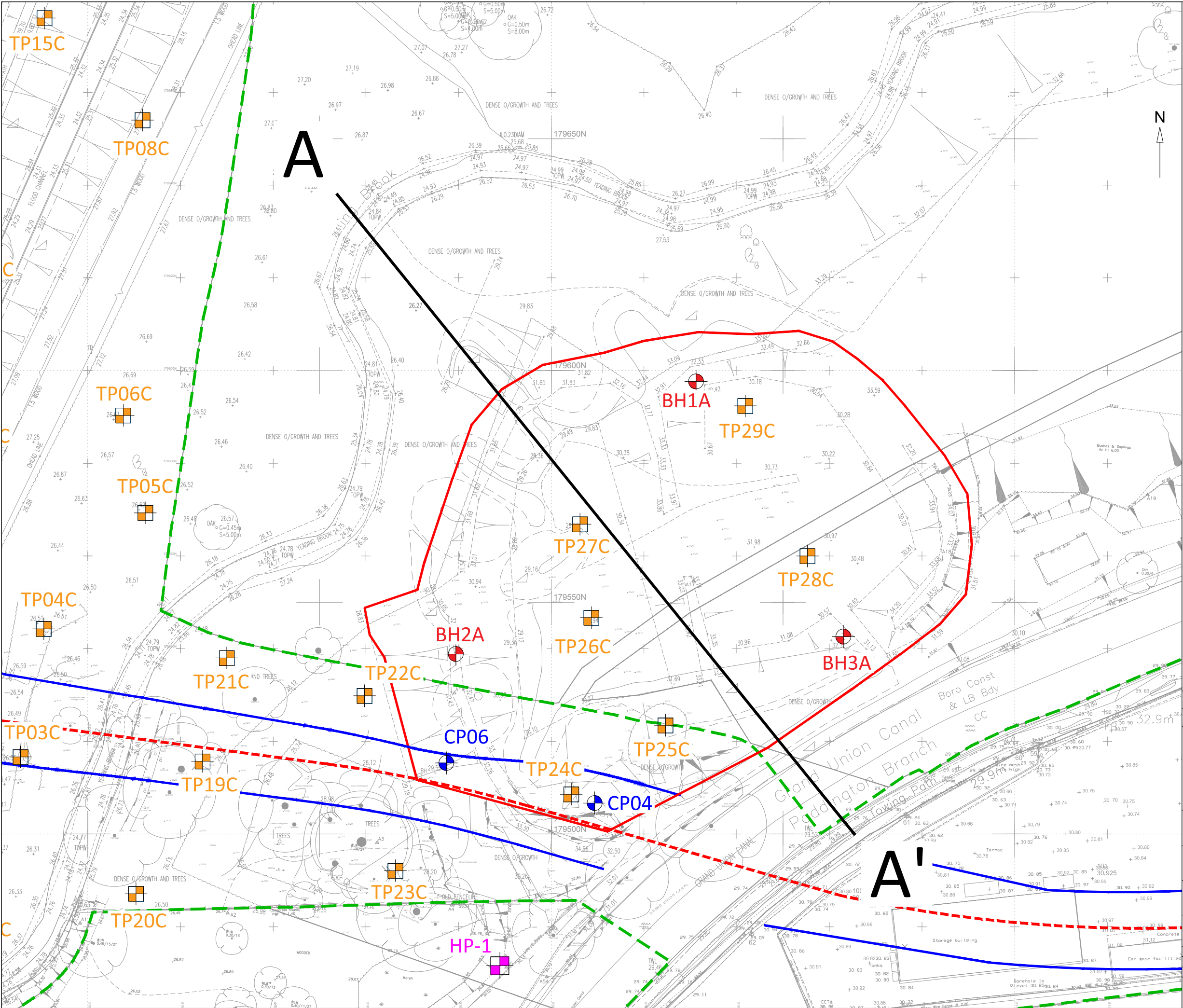
Yours sincerely

A handwritten signature in black ink, appearing to read "K Poore".

Kirsty Poore, Senior Engineer
Card Geotechnics Limited

Encl.	Figure 1	Site Location Plan
	Figure 2	Exploratory Hole Location Plan
	Figure 3	Cross Section of Lagoon Bund
	Figure 4	Schematic diagram of contaminant migration

FIGURES



KEY

- Borehole location (Ian Farmer 2014)
- Borehole location (CGL 2017)
- Western Access Site boundary
- Western Access Road Alignment
- Indicative embankment extents
- Extent of existing Lagoon Bund

Drawing produced from: A724-E05-PA-VEC-HW-DR-0001

0	25/05/17	
Rev	Date	Comments

Card Geotechnics Ltd
4 Godalming Business Centre
Woolsack Way
Godalming
Surrey
GU7 1XW
T: 01483 310600

Project

Southall Stockpiling in Lagoon Bund Area

Client

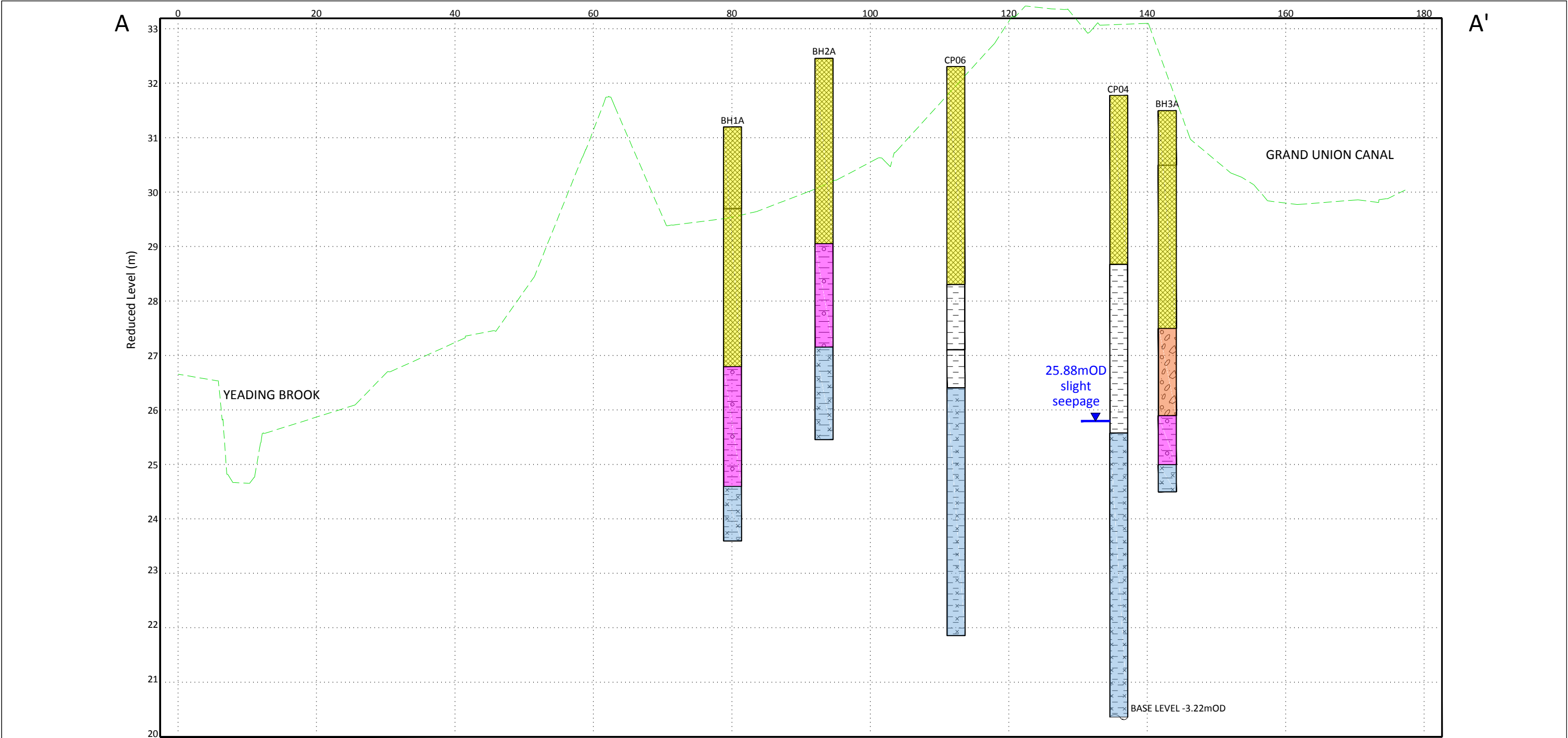
Clark Smith Partnership

Drawing title

Figure 2 - Exploratory Hole Location Plan

Scale(s) NTS		Job No. CGN/03732I	
Drawn	TSB	25/05/17	Dwg No. A720-E05-IW-CGL-GEO-DR-0001
Checked			Rev. 0
Approved			

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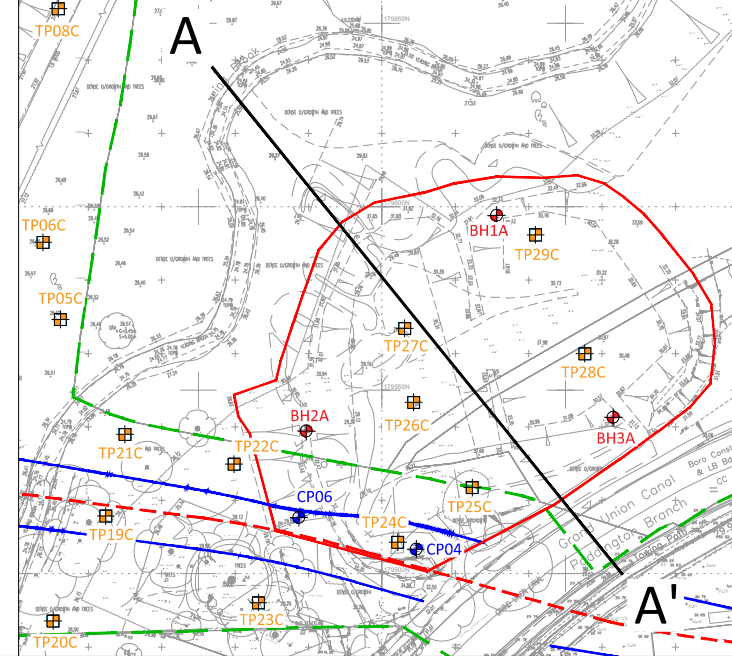
KEY - PLAN

- Borehole location (Ian Farmer 2014)
- Borehole location (CGL 2017)
- Western Access Site boundary
- Western Access Road Alignment
- Indicative embankment extents
- Extent of existing Lagoon Bund

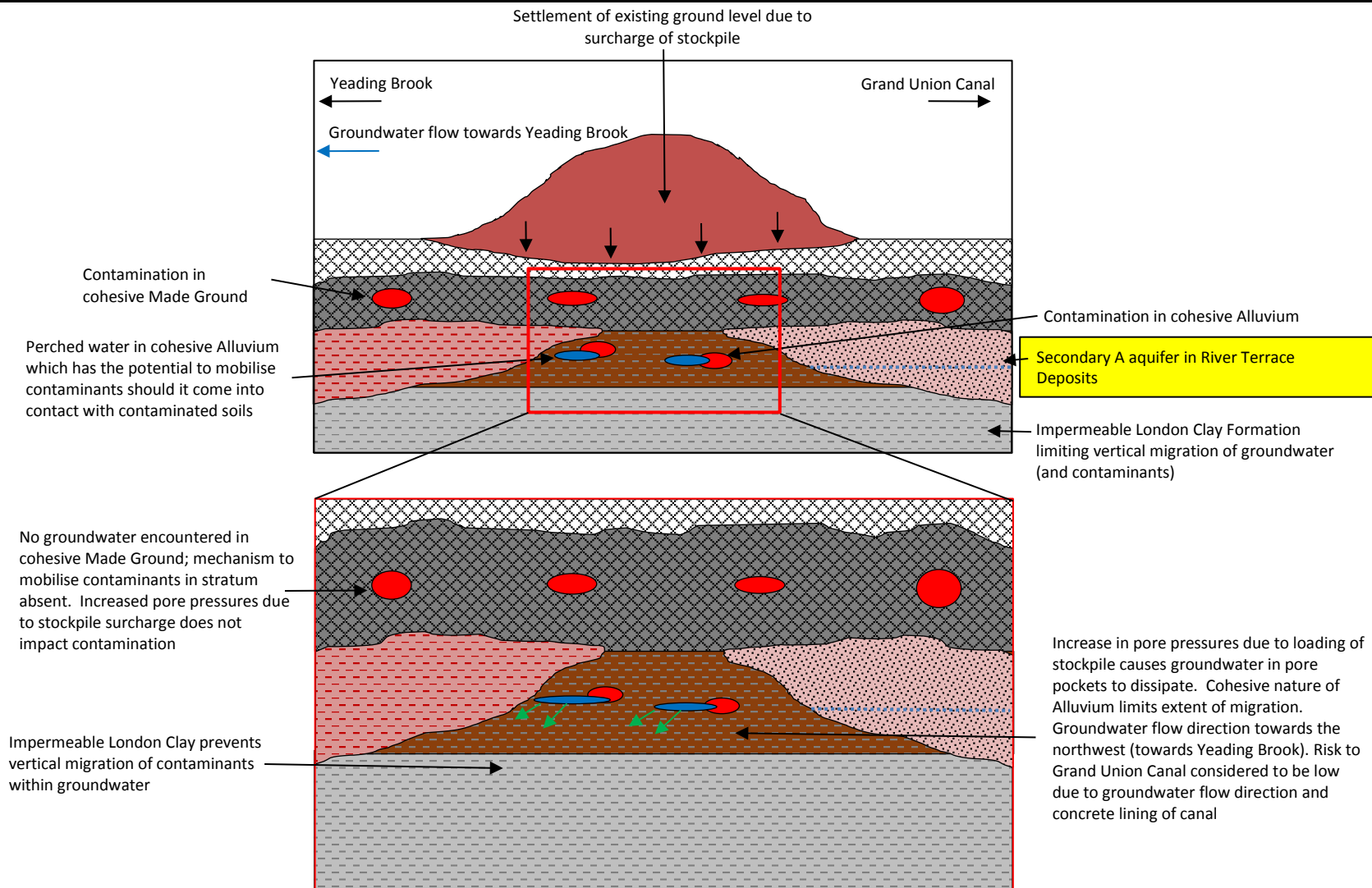
KEY - SECTION

- Existing ground level
- MADE GROUND (CLAY)
- ALLUVIUM
- RIVER TERRACE DEPOSITS (GRANULAR)
- RIVER TERRACE DEPOSITS (COHESIVE)
- LONDON CLAY FORMATION

Drawing produced from: A724-E05-PA-VEC-HW-DR-0001



0	25/05/17		
Rev	Date	Comments	
 Card Geotechnics Ltd 4 Godalming Business Centre Woolsack Way Godalming Surrey GU7 1XW T: 01483 310600			
Project		Southall Stockpiling in Lagoon Bund Area	
Client		Clark Smith Partnership	
Drawing title		Figure 3 - Section A-A'	
Scale(s) NTS		Job No. CGN/03732I	
Drawn	TSB	25/05/17	Dwg No. A720-E05-IW-CGL-GEO-DR-0001
Checked			Rev. 0
Approved			
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Client	Project	Job No
Clark Smith Partnership	Southall Stockpiling in Lagoon Bund Area	CGN/037321
	Title	Figure 4
	Schematic diagram of contaminant migration	

APPENDIX B

Regulatory Correspondence



Canal &
River Trust

19 June 2017

Rikki Lamb
Southall Waterside
169 Brent Road
Southall
UB2 5LE

Our Ref	N/A
Your Ref	N/A

Dear Mr Lamb

ACCEPTANCE OF TEMPORARY STOCKPILING OF MATERIAL

I can confirm that C&RT have reviewed and accepted the proposed temporary stockpiling of material on dredging lagoons at Minet Tip as per document,

Southall Western Access

Lagoon Temporary Stockpile

Appraisal – Revision 1

A720-E05-IW-CGL-EW-RP-0002 P2

Regards,

Toby Pearce
Works Engineer – West London

London Waterways

Canal & River Trust Harbour Master's Office 24 Canute House Durham Wharf Drive Brentford TW8 8HP
T 0303 040 4040 E enquiries.london@canalrivertrust.org.uk www.canalrivertrust.org.uk

Patron: H.R.H. The Prince of Wales. Canal & River Trust, a charitable company limited by guarantee registered in England and Wales with company number 7807276 and registered charity number 1146792, registered office address First Floor North, Station House, 500 Elder Gate, Milton Keynes MK9 1BB

Selina Adams

From: Robin Slade
Sent: 19 June 2017 17:29
To: 'Spence, Keith H'
Cc: Thomas, Jenny; Owen Flowers
Subject: FW: Southall western access re-use criteria

Afternoon Keith,

Please see the below confirmation email from Larry Kyan at FM Conway regarding the points raised on management of leachate from the temporary stockpile lagoon at the Southall western access site.

We will refer to these measures within our current Remediation Strategy Addendum which captures the stockpiling aspects of the scheme along with a number of other aspects recently discussed (including the scheme re-use criteria).

I should be able to provide an update on this addendum report and the re-use criteria tomorrow.

Best regards,
Robin

From: Larry.Kyan [mailto:Larry.Kyan@fmconway.co.uk]
Sent: 16 June 2017 07:34
To: Owen Flowers <OwenF@cgl-uk.com>; Dominic Speller <dominicspeller@csplondon.com>
Cc: Trevor Cole <trevor.cole@fmconway.co.uk>; Dean Sporn <Dean.Sporn@fmconway.co.uk>; Pablo Gallego <pablogallego@csplondon.com>; Bryn Jones <BrynJ@cgl-uk.com>; Robin Slade <RobinS@cgl-uk.com>
Subject: RE: Southall western access re-use criteria

Owen,

WE can confirm the following:-

- 1) The Leachate Collection points will be suitably fenced off (pedestrian barriers) so they are protected from damage by plant/vehicles.
- 2) In the event of unusually heavy rainfall the sumps will be pumped out more frequently as necessitated by the rain situation. There will be spare pumping capacity stored on site for such an eventuality.

Trust this answers the 2 No queries from EA

Larry Kyan - B Eng(Hons), MIHT, ICIQB, MSEW
Senior Contracts Manager
F M Conway Ltd
Conway House
Vestry Road
Sevenoaks
Kent
TN14 5EL

Direct Dial:01732600867
Switchboard:01732600700
M:07748632938
F:01732600990

From: Spence, Keith H [<mailto:Keith.Spence@environment-agency.gov.uk>]
Sent: 15 June 2017 10:58
To: Robin Slade <RobinS@cgl-uk.com>
Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>; Thomas, Jenny <jenny.thomas@environment-agency.gov.uk>
Subject: RE: Southall western access re-use criteria

Robin,

We have reviewed the revised schematic section of the proposed lagoon area stockpile and we are now comfortable with the general arrangement of the for the temporary stockpiling of excavated materials.

We have the following comments regarding the management of leachate within the stockpiles:

- We note that the sumps will be pumped weekly and following rainfall based on an assumed average monthly rainfall of 93mm per month. Can you please confirm that, in the event of an unusually heavy rainfall event, resource provision exists to ensure that leachate is pumped out and disposed of off-site in a timely manner.
- Can you confirm the leachate collection points will be protected to avoid them being damaged by plant operating in the stockpile area.

Regards,

Keith

From: Robin Slade [<mailto:RobinS@cgl-uk.com>]
Sent: 14 June 2017 10:19
To: Thomas, Jenny <jenny.thomas@environment-agency.gov.uk>; Spence, Keith H <Keith.Spence@environment-agency.gov.uk>
Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>
Subject: RE: Southall western access re-use criteria

Morning Jenny / Keith,

As just discussed Keith, I understand that FM Conway are hoping to commence enabling works on the lagoon area at the Southall western access next week, which will include commencing construction of the proposed basal liner and perimeter leachate collection system.

Would it be possible for you to feedback this week with your comments (particularly if you have any concerns) on the latest proposed stockpile liner schematic, as issued last Thursday (see below) so we can incorporate any required changes and inform the construction?

We have also issued St James with a revised lagoon stockpile options report which includes the proposed lagoon construction details and the schematic drawing alongside our paper regarding the potential creation of new contaminant migration pathways as a result of the lagoon stockpile surcharging. This will be captured in the wrap-up remediation strategy addendum which we are producing to pull together the various issues recently discussed but I see this has now been sent on to you via Aconex. Apologies that this has been sent on separately as our intention is to wrap this into one document for ease of your review.

Keith, thanks for the feedback earlier on the P20 modelling. I'll feedback shortly on the couple of points you raised and will advise as we obtain and assess the further site-specific data (e.g. permeability data) to feed into and revise the model.

Thanks,
Robin

Robin Slade, Associate Director



Tel: 01483 310600

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From: Robin Slade

Sent: 08 June 2017 17:23

To: 'Thomas, Jenny' <jenny.thomas@environment-agency.gov.uk>; 'Spence, Keith H' <Keith.Spence@environment-agency.gov.uk>

Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>

Subject: RE: Southall western access re-use criteria

Jenny / Keith,

Thanks for your time on the Southall western access telecom this morning.

As requested Jenny, the reference of our latest trial pit / soils report for the scheme is '*Western Access, Southall, Earthworks Material Acceptability and Waste Characterisation (Western Access Site)*', ref.

CGN037323E_EMAWC_Rev0, dated May 2017. This presents the most recent data and includes a drawing showing the trial pit locations completed over the recent three phases of investigation. If you can't track down a copy of this report, please let me know.

With regards to the proposed stockpile liner schematic, we have amended this so that the long-section shows both the western and eastern stockpiles with central spine – please see attached. As discussed, we are proposing two leachate collection points from the perimeter radial collection pipework for each stockpile area, notionally up- and down-gradient. The liner is to extend over the sides of the existing lagoon bund and will be protected by the 500mm drainage blanket.

FM Conway has asked if I can seek your buy-in to this attached updated proposed liner schematic from the perspective of capturing leachate generated from the stockpiling exercise. If you are able to feedback, I'd be grateful.

Keith, as discussed, we would welcome your comments on the re-use criteria on Monday / Tuesday next week so we can ideally update these for incorporation within our wrap up remediation scheme addendum report.

I'll look to provide an update on the additional borehole works next week.

Best regards,
Robin

From: Robin Slade
Sent: 08 June 2017 09:11
To: 'Thomas, Jenny' <jenny.thomas@environment-agency.gov.uk>
Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>; Spence, Keith H <Keith.Spence@environment-agency.gov.uk>
Subject: RE: Southall western access re-use criteria

Thanks Jenny.

I attach a current schematic for the lagoon stockpile lining which was briefly discussed at the last monthly meeting. If time allows this morning it would be good to talk this through also.

Best regards,
Robin

From: Thomas, Jenny [<mailto:jenny.thomas@environment-agency.gov.uk>]
Sent: 07 June 2017 17:21
To: Robin Slade <RobinS@cgl-uk.com>
Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>; Spence, Keith H <Keith.Spence@environment-agency.gov.uk>
Subject: RE: Southall western access re-use criteria

Hello Robin,

One or both of us will attend.

Regards,

Jenny

Jenny Thomas
Groundwater Quality Technical Specialist

✉ **Environment Agency, Kings Meadow House, Kings Meadow Road, READING, RG1 8DB**
☎ **Internal: 58723**
☎ **External: [+442030258723](tel:+442030258723)**

From: Robin Slade [<mailto:RobinS@cgl-uk.com>]
Sent: 07 June 2017 15:31
To: Thomas, Jenny <jenny.thomas@environment-agency.gov.uk>; Spence, Keith H <Keith.Spence@environment-agency.gov.uk>
Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>
Subject: RE: Southall western access re-use criteria

Hi Jenny / Keith,

I hope you both had a good break last week.

I just wanted to check you are still okay for our planned telecom tomorrow at 10:00?

My plan was for us to provide some background / context to the modelling completed to date, provide an update on the latest position from site and to obtain your feedback on our suggested CoC's and input parameters.

It would then be good to have a chat on one or two other ongoing tasks for the scheme including our latest proposals for containing the lagoon stockpiled materials.

My colleague Eoin, who has completed the P20 modelling to date, will join me on the call.

Best regards,
Robin

Robin Slade, Associate Director



Tel: 01483 310600

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From: Thomas, Jenny [<mailto:jenny.thomas@environment-agency.gov.uk>]

Sent: 30 May 2017 16:11

To: Robin Slade <RobinS@cgl-uk.com>

Cc: Spence, Keith H <Keith.Spence@environment-agency.gov.uk>

Subject: RE: Southall western access re-use criteria

Hello Robin,

To confirm, I have been able to download from the Dropbox and therefore anticipate Keith will be able to as well.

Regards,

Jenny

Jenny Thomas
Groundwater Quality Technical Specialist

✉ **Environment Agency, Kings Meadow House, Kings Meadow Road, READING, RG1 8DB**

☎ **Internal: 58723**

☎ **External: [+442030258723](tel:+442030258723)**

From: Robin Slade [<mailto:RobinS@cgl-uk.com>]

Sent: 26 May 2017 17:17

To: Thomas, Jenny <jenny.thomas@environment-agency.gov.uk>; Spence, Keith H <Keith.Spence@environment-agency.gov.uk>

Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>; Owen Flowers <OwenF@cgl-uk.com>

Subject: RE: Southall western access re-use criteria

Jenny, Keith,

Unfortunately I received a bounce back on my earlier message due to file size (~8MB). As such, I've set up a dropbox to the Southall western access P20 worksheets below..

https://www.dropbox.com/sh/lr823qawmpwxul9/AAAaSnBK6mR_-hI5L44cMyxNa?dl=0

If you struggle to access I'd be grateful if you could let me and my colleague Eoin know as soon as possible and we can look to send via another route.

Please refer to my email below for a couple of further details.

Best regards,
Robin

Robin Slade, Associate Director



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From: Robin Slade
Sent: 26 May 2017 16:50
To: 'Thomas, Jenny' <jenny.thomas@environment-agency.gov.uk>; 'Spence, Keith H' <Keith.Spence@environment-agency.gov.uk>
Cc: Eoin O'Sullivan <EoinO@cgl-uk.com>; Owen Flowers <OwenF@cgl-uk.com>
Subject: RE: Southall western access re-use criteria

Jenny, Keith,

Please find attached our Southall western access P20 worksheets, model input parameters and justification plus two prelim design drawings showing the embankment and sections (note these are subject to updates as they are from an earlier stage of the design). At present, we have modelled the following key contaminants, which have either been identified in leachate or are considered key gasworks related compounds; ammonia, benzene, benzo(a)pyrene, cadmium, chromium (VI), free cyanide, lead, naphthalene and phenol.

If you are able to review in advance of our telecom on Thursday 8th June this would help focus discussions. As per yesterday's meeting we will be obtaining additional soils, leachate and groundwater chemical data from site and have an opportunity to obtain permeability data from the proposed additional boreholes close to the brook, which will help refine the model.

I look forward to discussing in two weeks.

Best regards,
Robin

From: Robin Slade
Sent: 26 May 2017 14:53
To: 'Thomas, Jenny' <jenny.thomas@environment-agency.gov.uk>; 'Spence, Keith H' <Keith.Spence@environment-agency.gov.uk>; Eoin O'Sullivan <EoinO@cgl-uk.com>
Subject: RE: Southall western access re-use criteria

Apologies, the below should have said 'Thursday 8th June' rather than 'Tuesday'.

I put it down to Friday afternoon!

Thanks,
Robin

-----Original Appointment-----

From: Robin Slade

Sent: 26 May 2017 14:51

To: Thomas, Jenny; Spence, Keith H; Eoin O'Sullivan

Subject: Southall western access re-use criteria

When: 08 June 2017 10:00-11:00 (UTC+00:00) Dublin, Edinburgh, Lisbon, London.

Where: Telecom

Jenny, Keith,

Further to yesterday's meeting please could you set aside some time on Tuesday 8th June for a telecom to discuss our proposed re-use criteria, protective of controlled waters, for the Southall western access scheme.

I will forward on our P20 modelling sheets and parameter justification shortly so that you have a chance to review ahead of discussing. Given the project pressures it would be good if we could, as much as possible, agree the input parameters and modelled contaminants as part of this session.

My colleague Eoin, who has completed the modelling to date, will join us on the call.

I hope you have a good break next week.

Best regards,
Robin

Conference call details:

0844 762 0762

Pin: 73078#

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APPENDIX G

Permissible Criteria for Imported General Fill

Table 1. Maximum permissible concentrations for importing soils for general fill.

Determinant		Maximum permissible concentration ¹ (mg/kg) ²		Rationale
		6% SOM	1% SOM	
Arsenic		35	35	GAC ⁴
Beryllium		88	88	GAC ⁴
Cadmium		87	87	GAC ⁴
Chromium (III)		3,300	3,300	GAC ⁴
Chromium (VI)		6.3	6.3	GAC ⁴
Lead		310	310	C4SL ⁹
Mercury		250	250	GAC ⁴
Selenium		600	600	GAC ⁴
Copper		426 ³	426 ³	Site specific criteria protective of controlled waters ³
Nickel		402 ³	402 ³	Site specific criteria protective of controlled waters ³
Zinc		6730 ³	6730 ³	Site specific criteria protective of controlled waters ³
Vanadium		1100	1100	GAC ⁴
Benzo(a)pyrene		3.6	3.6	GAC ⁴
Benzo(a)anthracene		22	18	
Benzo(b)fluoranthene		23	23	
Benzo(k)fluoranthene		23	23	
Chrysene		230	220	
Dibenzo(a,h)anthracene		2.3	2.2	
Indeno(1,2,3-cd)pyrene		23	26	
Naphthalene		35	6.3	
TPH aliphatic ⁶	EC5-6	260	80	GAC ⁴
	EC>6-8	750	160	GAC ⁴
	EC>8-10	190	34	GAC ⁴
	EC>10-12	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
	EC>12-16	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
	EC>16-35	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
TPH aromatic ⁶	EC5-7	3.2	0.88	GAC ⁴
	EC>7-8	1,000 ⁷	870	GAC ⁴ / Hazardous waste threshold ⁷
	EC>8-10	310	55	GAC ⁴
	EC>10-12	1,000	290	GAC ⁴ / Hazardous waste threshold ⁷
	EC>12-16	1,000 ⁷	1,000 ⁷	GAC ⁴ / Hazardous waste threshold ⁷
	EC>16-21	1,000 ⁷	1,000 ⁷	GAC ⁴ / Hazardous waste threshold ⁷
	EC>21-35	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
Sum of TPH aliphatic & aromatic C5-C10		< 1,000	< 1,000	Hazardous waste thresholds ⁸ (C10+ MPC based on threshold for C25+)
Sum of TPH aliphatic & aromatic C10+		< 1,000	< 1,000	
Phenols		6,000	2,000	GAC ⁴
Cyanide		34	34	GAC ¹⁰
Asbestos		<0.001% amosite and chrysotile, no detected fibres of crocidolite		GAC ¹¹

Notes:

- These maximum permissible concentrations (MPCs) are for import of capping soils only. Refer to the main body of the report for details of the scheme re-use criteria for site-won soils.
- In mg/kg dry soil except pH and asbestos.
- Site specific assessment criteria protective of controlled waters derived using the Remedial Targets Methodology model.
- Generic Assessment Criteria generated 'in-house' based on CLEA model Version 1.06. Barium and total cyanide GACs are derived from previously endorsed human health risk assessment models and are conservative values with reference to Dutch Intervention Values.
- Nable, Banuelos and Paul. (1997). *Boron Toxicity*. Plant and Soil, **Vol. 193**, pp1 81-198.
- Speciated TPH values must not exceed GAC, or hazardous waste threshold, where indicated above. Assessment of TPH must be made against hazardous waste threshold to confirm imported soils do not classify as hazardous material.
- GAC derived MPC for TPH fraction limited to 1,000mg/kg based on 'waste thresholds'.
- Environment Agency. (2007). *A Guide to Hazardous Waste Regulations: How to find out if waste oil and waste that contain oil are hazardous*. HWR08.
- Published C4SL for lead (DEFRA, 2014).
- GAC for cyanide derived by Atkins based on acute exposure for a 0-6 year old child.
- CGL in house modelling based on CIRIA C733 – Asbestos in soil and Made Ground and Addison et al (1988).

APPENDIX H

Maximum Permissible Concentrations for Imported Capping Layer Soils

Table 1. Maximum permissible concentrations for imported capping layer soils.

Determinant		Maximum permissible concentration ¹ (mg/kg) ²		Rationale
		6% SOM	1% SOM	
Arsenic		35	35	GAC ⁴
Beryllium		88	88	GAC ⁴
Boron (water soluble)		5	5	Limit for phytotoxic effect ⁵
Cadmium		87	87	GAC ⁴
Chromium (III)		3,300	3,300	GAC ⁴
Chromium (VI)		6.3	6.3	GAC ⁴
Lead		310	310	C4SL ¹⁰
Mercury		250	250	GAC ⁴
Selenium		600	600	GAC ⁴
Copper		135 ³	135 ³	BS 3882:2015 Specification for Topsoil ³
Nickel		75 ³	75 ³	BS 3882:2015 Specification for Topsoil ³
Zinc		200 ³	200 ³	BS 3882:2015 Specification for Topsoil ³
Vanadium		1100	1100	GAC ⁴
Benzo(a)pyrene		3.6	3.6	GAC ⁴
Benzo(a)anthracene		22	18	GAC ⁴
Benzo(b)fluoranthene		23	23	
Benzo(k)fluoranthene		23	23	
Chrysene		230	220	
Dibenzo(a,h)anthracene		2.3	2.2	
Indeno(1,2,3-cd)pyrene		23	26	
Naphthalene		35	6.3	
TPH aliphatic ⁶	EC5-6	260	80	GAC ⁴
	EC>6-8	750	160	GAC ⁴
	EC>8-10	190	34	GAC ⁴
	EC>10-12	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
	EC>12-16	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
	EC>16-35	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
TPH aromatic ⁶	EC5-7	3.2	0.88	GAC ⁴
	EC>7-8	1,000 ⁷	870	GAC ⁴ / Hazardous waste threshold ⁷
	EC>8-10	310	55	GAC ⁴
	EC>10-12	1,000	290	GAC ⁴ / Hazardous waste threshold ⁷
	EC>12-16	1,000 ⁷	1,000 ⁷	GAC ⁴ / Hazardous waste threshold ⁷
	EC>16-21	1,000 ⁷	1,000 ⁷	GAC ⁴ / Hazardous waste threshold ⁷
	EC>21-35	1,000 ⁷	1,000 ⁷	Hazardous waste threshold ⁷
Sum of TPH aliphatic & aromatic C5-C10		< 1,000	< 1,000	Hazardous waste thresholds ⁸ (C10+ MPC based on threshold for C25+)
Sum of TPH aliphatic & aromatic C10+		< 1,000	< 1,000	
pH		5-10	5-10	BS 3882:2015 Specification for Topsoil ³
Phenols		6,000	2,000	GAC ⁴
Cyanide		34	34	GAC ¹¹
Asbestos		No fibres detected ⁹		

Notes:

- These maximum permissible concentrations (MPCs) are for import of capping soils only. Refer to the main body of the report for details of the scheme re-use criteria for site-won soils.
- In mg/kg dry soil except pH and asbestos.
- British Standard BS3882:2015 Specification for Topsoil and requirements for use. Table 1. Values taken for pH 6-7.
- Generic Assessment Criteria generated 'in-house' based on CLEA model Version 1.06. Barium and total cyanide GACs are derived from previously endorsed human health risk assessment models and are conservative values with reference to Dutch Intervention Values.
- Nable, Banuelos and Paul. (1997). *Boron Toxicity*. Plant and Soil, **Vol. 193**, pp1 81-198.
- Speciated TPH values must not exceed GAC, or hazardous waste threshold, where indicated above. Assessment of TPH must be made against hazardous waste threshold to confirm imported soils do not classify as hazardous material.
- GAC derived MPC for TPH fraction limited to 1,000mg/kg based on 'waste thresholds'.
- Environment Agency. (2007). *A Guide to Hazardous Waste Regulations: How to find out if waste oil and waste that contain oil are hazardous*. HWR08.
- Laboratory screen by microscopy may be required subject to source of material.
- Published C4SL for lead (DEFRA, 2014).
- GAC for cyanide derived by Atkins based on acute exposure for a 0-6 year old child.

APPENDIX I

Attenuation Storage Liner

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

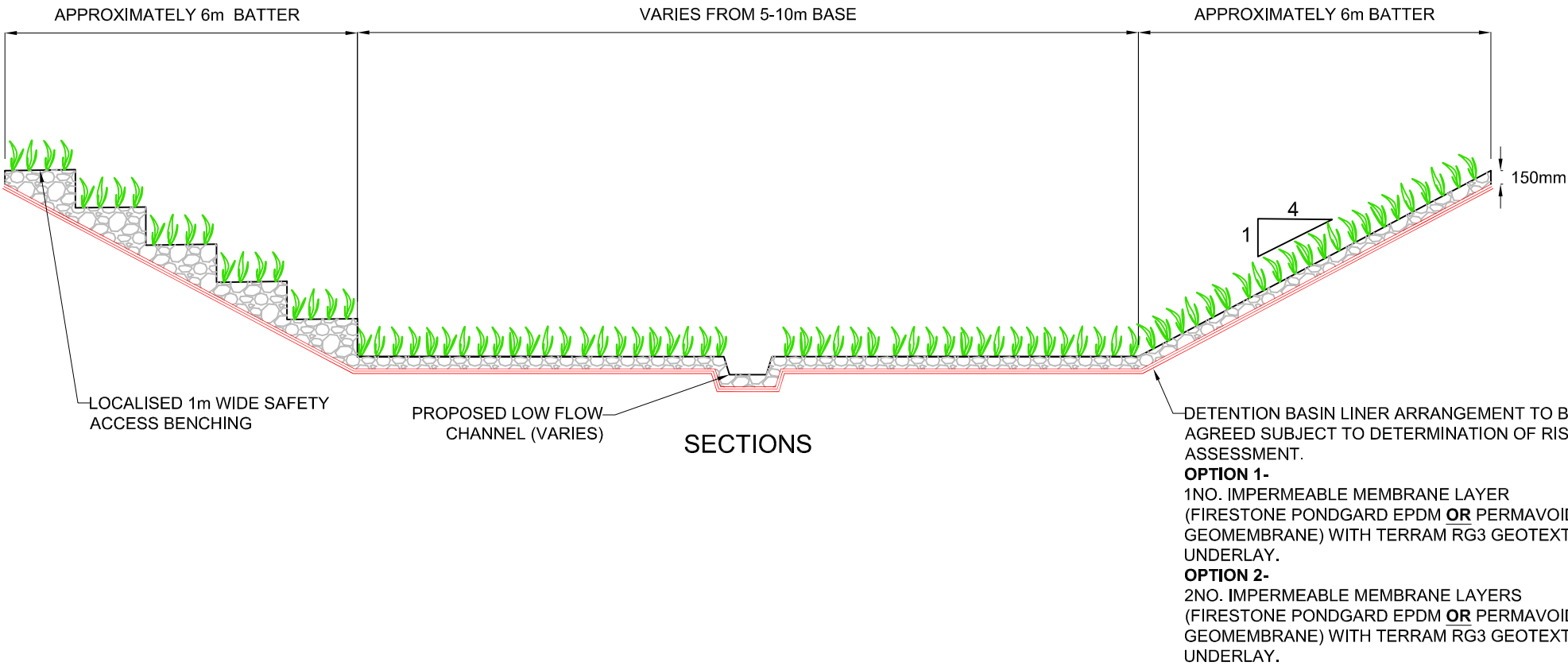
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MAINTENANCE/CLEANING
MULTIPLE BURIED SERVICES INCLUDING HIGH PRESSURE GAS MAINS - CONSULT SERVICES PLANS AND HOST UTILITY COMPANIES AND USE CABLE AVOIDANCE TOOLS BEFORE DIGGING. REMEDIATED BROWN FIELD SITE - DO NOT EXCAVATE BELOW THE MARKER LAYER WITHOUT A SITE SPECIFIC METHOD STATEMENT FOR THE LOCATION IN HAND. IF IN DOUBT - STOP WORK AND ASK

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MULTIPLE BURIED SERVICES INCLUDING HIGH PRESSURE GAS MAINS - CONSULT SERVICES PLANS AND HOST UTILITY COMPANIES AND USE CABLE AVOIDANCE TOOLS BEFORE DIGGING. REMEDIATED BROWN FIELD SITE - DO NOT EXCAVATE BELOW THE MARKER LAYER WITHOUT A SITE SPECIFIC METHOD STATEMENT FOR THE LOCATION IN HAND. IF IN DOUBT - STOP WORK AND ASK

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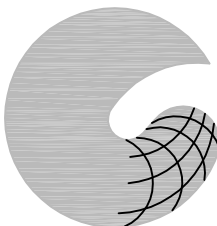
P1	20/04/17	FOR INFORMATION	SR	TI
REV	DATE	AMENDMENT DETAILS	BY	APPR.

PROJECT
WESTERN ACCESS
SOUTHALL

DRAWING TITLE
DETENTION BASIN
CROSS SECTION

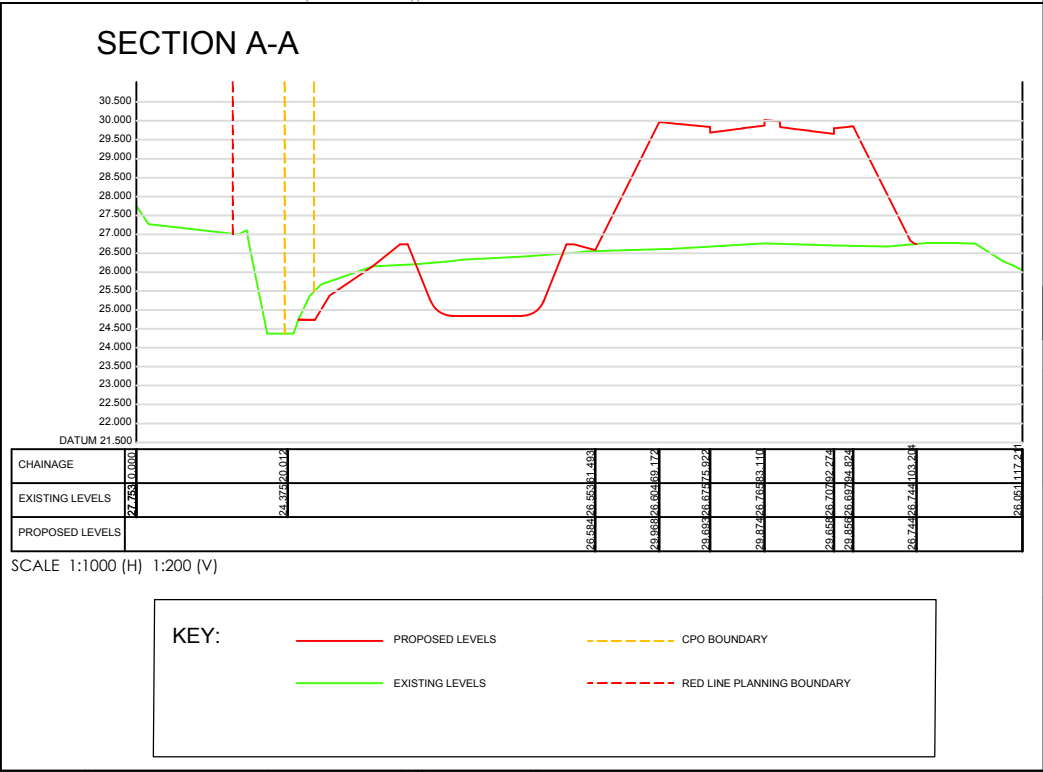
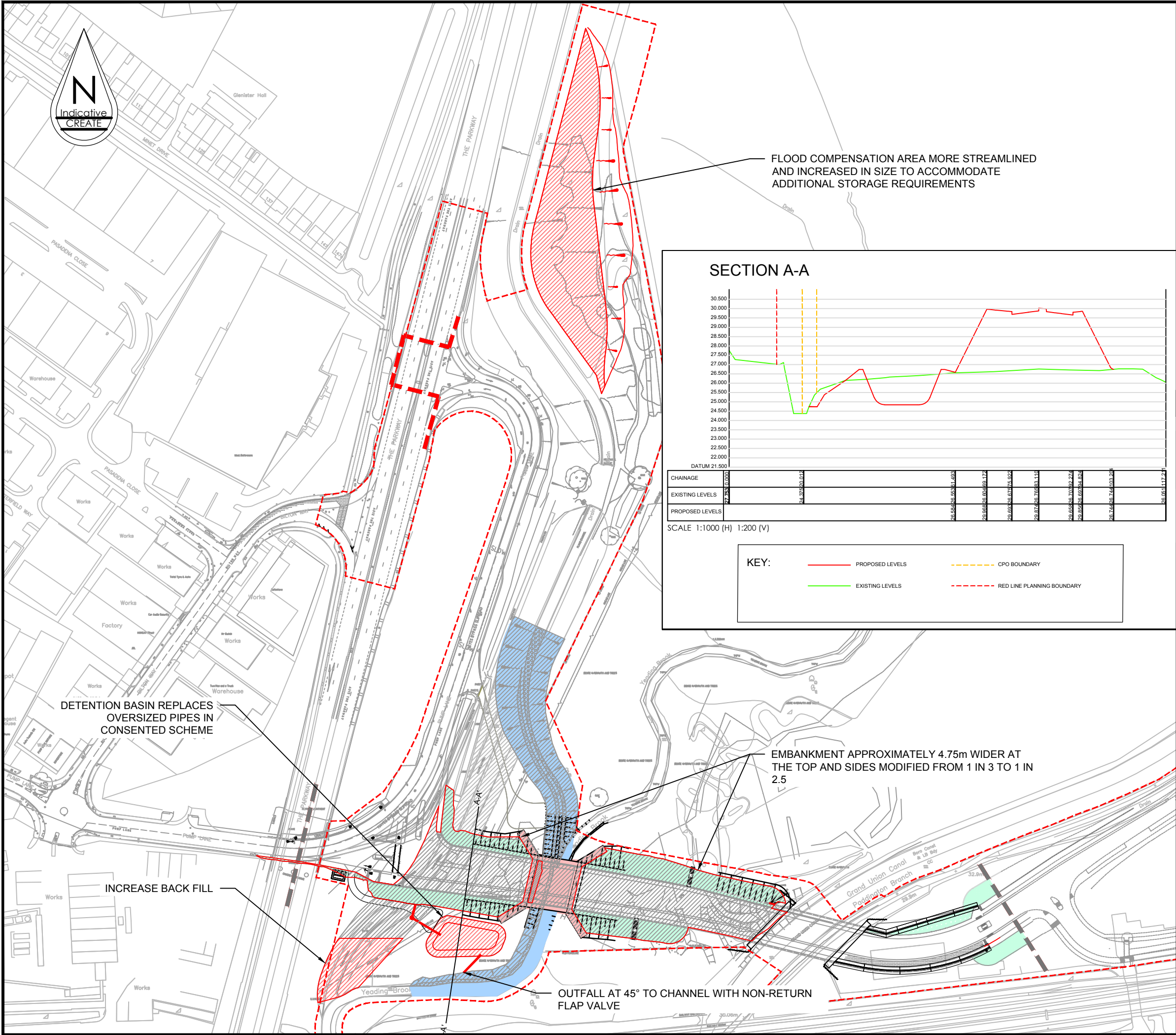
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DATE 05.07.17		DRAWING STATUS PRELIMINARY	
SCALE(S) NTS	DESIGNED MT	DRAWN PR	
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NOTE REVISIONS IDENTIFIED BELOW, INDICATE THE MORGAN TUCKER AMENDMENTS				
P2	19/05/17	AMENDMENTS TO DETENTION BASIN	SR	TI
P1	17/05/17	FOR REVIEW	SR	TI
REV	DATE	AMENDMENT DETAILS	BY	APPR.

PROJECT
WESTERN ACCESS
SOUTHALL

DRAWING TITLE
WEST ACCESS S73
FLOODPLAIN MODIFICATIONS FROM CONSENTED SCHEME

CLIENT
FM CONWAY

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	CHECKED BA	APPROVED TI
DRAWING No A720-E05-IW-CCE-EW-DR-SK-0301		
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APPENDIX J

Piling Risk Assessment

15th September, 2016

Your ref:

Our ref: CGN03732

Please reply to: Mark Peachey / Bryn Jones

Dear Dominic,

ASSESSMENT OF POTENTIAL CONTAMINATION FOR PILING – SOUTHALL PUMP LANE ACCESS

We have pleasure in providing an outline contamination assessment for the proposed use of Continuous Flight Auger (CFA) piles for the proposed Southall Pump Lane Access works.

Although the risks to worker health can be mitigated, there may be a risk to controlled waters from the piling required for the scheme. Continuous Flight Auger (CFA) piles to be installed for the bridge foundations and these shall be installed within the London Clay deposits.

Groundwater was encountered in all boreholes drilled within the vicinity of the proposed structure within the Made Ground and natural clay deposits at levels of between 29.00m AOD (eastern section) and 25.0m AOD (western section) with an inferred groundwater flow towards the Yeading Brook.

The use of CFA piles for the bridge foundations should minimise any risk of contamination of the underlying aquifer and also allow piles to be installed under sub-artesian to artesian pressures if present. The London Clay is classified as a Unproductive Aquifer by the EA (Arup GIR, 2015). The River Terrace deposits are designated a Principal Aquifer, however as discussed within the Arup Outline Geotechnical Design Report (2015), the productivity of the aquifer is poor and its capacity to supply water and/or river base flow is considered minimal. However, groundwater monitoring does suggest that a flow towards the brook, therefore creating a potential pathway.

Therefore, reference to the EA document 'Piling into contaminated sites' (Environment Agency, 2002) has been made to assess the potential impact from installing CFA piles into the underlying River Terrace aquifer. This document summarises the guidance provided in the 2001 EA document, 'Piling and penetrative Ground Improvement Methods on Land Affected by Contamination; Guidance on Pollution Prevention. NC/99/73' (2001).

The 2002 document identifies six potential pollution scenarios arising from piling techniques as follows:

- Scenario 1) Creation of preferential pathways through a low permeability layer, allowing migration and pollution of an aquifer;
- Scenario 2) Creation of preferential pathways through a low permeability layer, allowing migration of ground gases/vapours towards the surface;
- Scenario 3) Direct contact of construction workers with contaminated soil arisings brought to the surface;
- Scenario 4) Direct contact of the piles or foundations with contaminated soil or leachate leading to degradation of materials;
- Scenario 5) The driving of solid contaminants down into an aquifer during pile driving;
- Scenario 6) Contamination of groundwater by bentonite.

Piles are likely to increase the risk of contamination being transported into groundwater via the creation of new pathways. There is a risk that the aquifer will be impacted on via either piling through contaminated ground or creating a pathway for contamination by the installation of piles.

Source-Pathway-Receptor linkages associated with piling and ground improvement works must be considered in a site-specific context. The presence of environmental receptors that could be harmed by contaminants mobilised by ground works are defined by the hydrogeological properties of the underlying strata, the proximity to other receptors such as surface water bodies, the history, use and occupation of the site and its surroundings.

The site investigation presented within the Arup GIR (2015) and further discussions within the Arup OGDR (2015) has concluded that in the region of the proposed piles, no contamination has been identified. The following conclusions can be made in relation to CFA piling into the Chalk aquifer and the six potential pollution scenarios:

- Scenario 1 – No visual or olfactory evidence of contamination was identified in the superficial soils overlying the River Terrace aquifer or within the River Terrace deposits. The use of CFA piles will limit migration of any contaminants that may be encountered;
- Scenario 2 - There is no receptor for migration of ground gases and the soil to pile contact will reduce the likelihood of migration;
- Scenario 3 – It is assessed as very unlikely that contaminated materials will be encountered and brought to the surface during piling works. Workers will be protected by risk assessments being in place and PPE being utilised;

- Scenario 4 – No visual or olfactory evidence of contamination was recorded at this location;
- Scenario 5 – CFA piles will not introduce contaminants via pile driving.
- Scenario 6 - The use of bentonite will not be required; therefore, there should not be any risk to the underlying aquifer from bentonite contamination.

A significant amount of Made Ground has been identified within the central section of the site associate with the Minet Tip. Much of the Made Ground will be excavated during the earthworks and will either be treated in-situ for re-use or will be removed off site. No contamination was observed within the Made Ground at this section of the site.

Therefore, it is considered that the risk of encountering a source of contamination within soils that piling will be undertaken through is deemed **very low**.

Should the proposed piling technique be altered a further review of potential risks will be required.

CFA relies on the retention of soil on the auger flights to provide support to the surrounding soil until the auger is withdrawn and the concrete or grout intrudes at a rate that is consistent with that of the withdrawal of the auger to ensure that the soil within the bored wall sides is supported. Because of this, it is considered that there is a negligible risk of creating preferential pathways for contamination by the use of CFA piles.

It is recommended that during the works, should the Contractor come into contact with any material with visual or olfactory evidence of contamination at the structure, then piling activities should cease and advice sought prior to continuing.

It is concluded that information gathered to date would suggest the risk from the presence of contaminated material at the pile locations is very low. Thus, the risk to the principal aquifer from either piling through such material or creating a preferential pathway for contaminants is also very low.

If significant volumes of contaminated material are encountered over a wider area during enabling and/or construction works, a full risk assessment should be undertaken prior to continuing construction works and if necessary, impacted material removed. Any excavated soil arisings destined for disposal will require sampling and analysis to classify the soils in accordance with the Hazardous Waste Regulations and Landfill Regulations prior to disposal.

In any case, should any olfactory or visual evidence of contaminated material or groundwater be identified during the construction works, then it will need segregating and stockpiling separately on

site. Prior to disposal from site all material, contaminated or not, should be tested and classified in accordance with the Waste Acceptance Criteria (WAC).

A handwritten signature in black ink, appearing to read "M. Peachey".

Mark Peachey
Senior Engineer
Card Geotechnics Limited

A handwritten signature in black ink, appearing to read "B. Jones".

Bryn Jones
Associate Director – Geotechnics
Card Geotechnics Limited

APPENDIX K

Groundwater Monitoring Trigger Values

Table 1 – Proposed groundwater trigger levels for BH1A (lagoon stockpile area)

Contaminant	Baseline range (µg/l)	EQS value (µg/l)	Proposed trigger values (µg/l)
Ammoniacal Nitrogen	25,000 to 28,000	-	33,600 ¹
Benzene	<1.0	10	1.0 ²
Benzo(a)pyrene	<0.01	0.02	0.01
Cadmium	<0.02 to <0.08	0.25	0.08 ²
Chromium VI	<5.0	3.4	5.0 ²
Free Cyanide	<10	1	10 ²
Lead	1.0 to 4.1	1.2	4.9 ¹
Mercury	<0.05 to <0.5	0.07	0.5 ²
Naphthalene	0.17 to 0.24	2	0.29 ¹
Phenol	<1.0	7.7	1.0 ²
Sum of TPH-CWG Aliphatic and Aromatic (C5 to C35)	<10	-	10 ²
pH	7.1 to 7.3	-	6 to 9 ³

Table 2 – Proposed groundwater trigger levels for BH2A (lagoon stockpile area)

Contaminant	Baseline range (µg/l)	EQS value (µg/l)	Proposed trigger values (µg/l)
Ammoniacal Nitrogen	14,000 to 15,000	-	18,000 ¹
Benzene	<1.0	10	1.0 ²
Benzo(a)pyrene	<0.01	0.02	1.0 ²
Cadmium	0.32 to 6.0	0.25	7.2 ¹
Chromium VI	<5.0	3.4	5.0 ²
Free Cyanide	<10	1	10 ²
Lead	5.1 to 11	1.2	13.2 ¹
Mercury	<0.05 to <0.5	0.07	0.5 ²
Naphthalene	<0.01	2	0.01 ²
Phenol	<1.0	7.7	1.0 ²
Sum of TPH-CWG Aliphatic and Aromatic (C5 to C35)	<10	-	10 ²
pH	7.0 to 7.2	-	6 to 9 ³

¹ Proposed trigger level based on maximum baseline concentration plus 20%.² Proposed trigger level based on the laboratory limit of detection.³ Proposed trigger level based on EQS 2015 'high to good' water quality value.

Table 3 – Proposed groundwater trigger levels for BH3A (lagoon stockpile area)

Contaminant	Baseline range (µg/l)	EQS value (µg/l)	Proposed trigger values (µg/l)
Ammoniacal Nitrogen	1,000 to 6,900	-	8,280 ¹
Benzene	<1.0	10	1.0 ²
Benzo(a)pyrene	<0.01	0.02	0.01 ²
Cadmium	1.1 to 1.4	0.25	1.7 ¹
Chromium VI	<5.0	3.4	5.0 ²
Free Cyanide	<10	1	10 ²
Lead	1.9 to 3.7	1.2	4.4 ¹
Mercury	<0.05 to <0.5	0.07	0.5 ²
Naphthalene	<0.01	2	0.01 ²
Phenol	<1.0	7.7	1.0 ²
Sum of TPH-CWG Aliphatic and Aromatic (C5 to C35)	<10	-	10 ²
pH	7.0 to 7.2	-	6 to 9 ³

Table 4 – Proposed groundwater trigger levels for BH1B, BH2B and BH3B (down-gradient of lagoon stockpile)

Contaminant	Baseline range (µg/l)	EQS value (µg/l)	Proposed trigger values (µg/l)
Ammoniacal Nitrogen	76 to 300	-	360 ¹
Benzene	<1.0	10	1.0 ²
Benzo(a)pyrene	<0.01	0.02	0.01 ²
Cadmium	<0.08 to 0.19	0.25	0.23 ¹
Chromium VI	<5.0	3.4	5.0 ²
Free Cyanide	<10	1	10 ²
Lead	2.4 to 5.9	1.2	7.1 ¹
Mercury	<0.05 to <0.5	0.07	0.5 ²
Naphthalene	<0.01	2	0.01 ²
Phenol	<1.0	7.7	1.0 ²
Sum of TPH-CWG Aliphatic and Aromatic (C5 to C35)	<10	-	10 ²
pH	7.6 to 7.7	-	6 to 9 ³

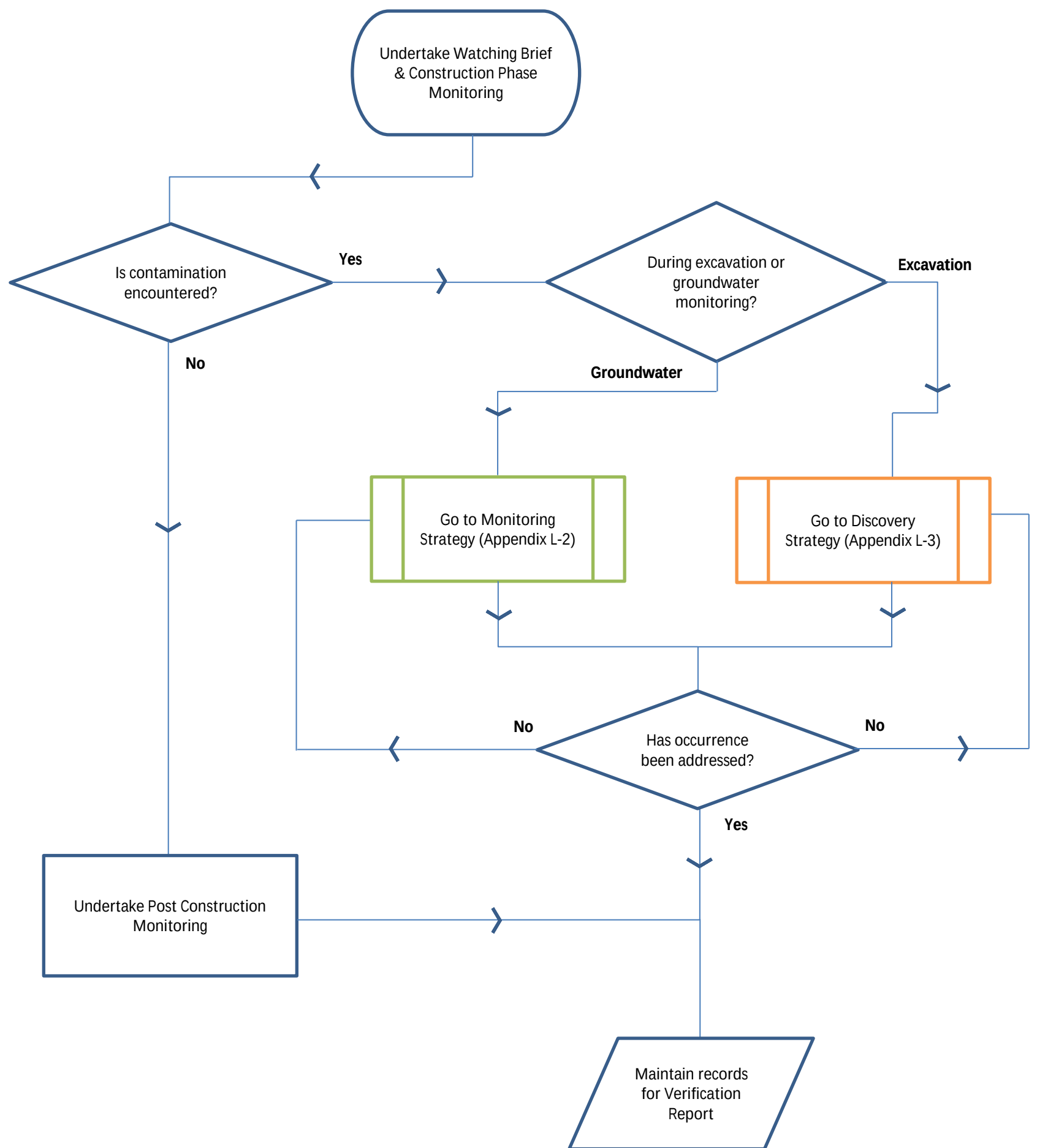
Note: Baseline range taken from sample results from BH2B & BH3B only. No baseline chemical data has been obtained for BH1B as was dry during the baseline monitoring rounds. Separate trigger levels may need to be established for these boreholes based on subsequent data.

Table 5 – Proposed groundwater trigger levels for BH4B (up-gradient of lagoon stockpile)

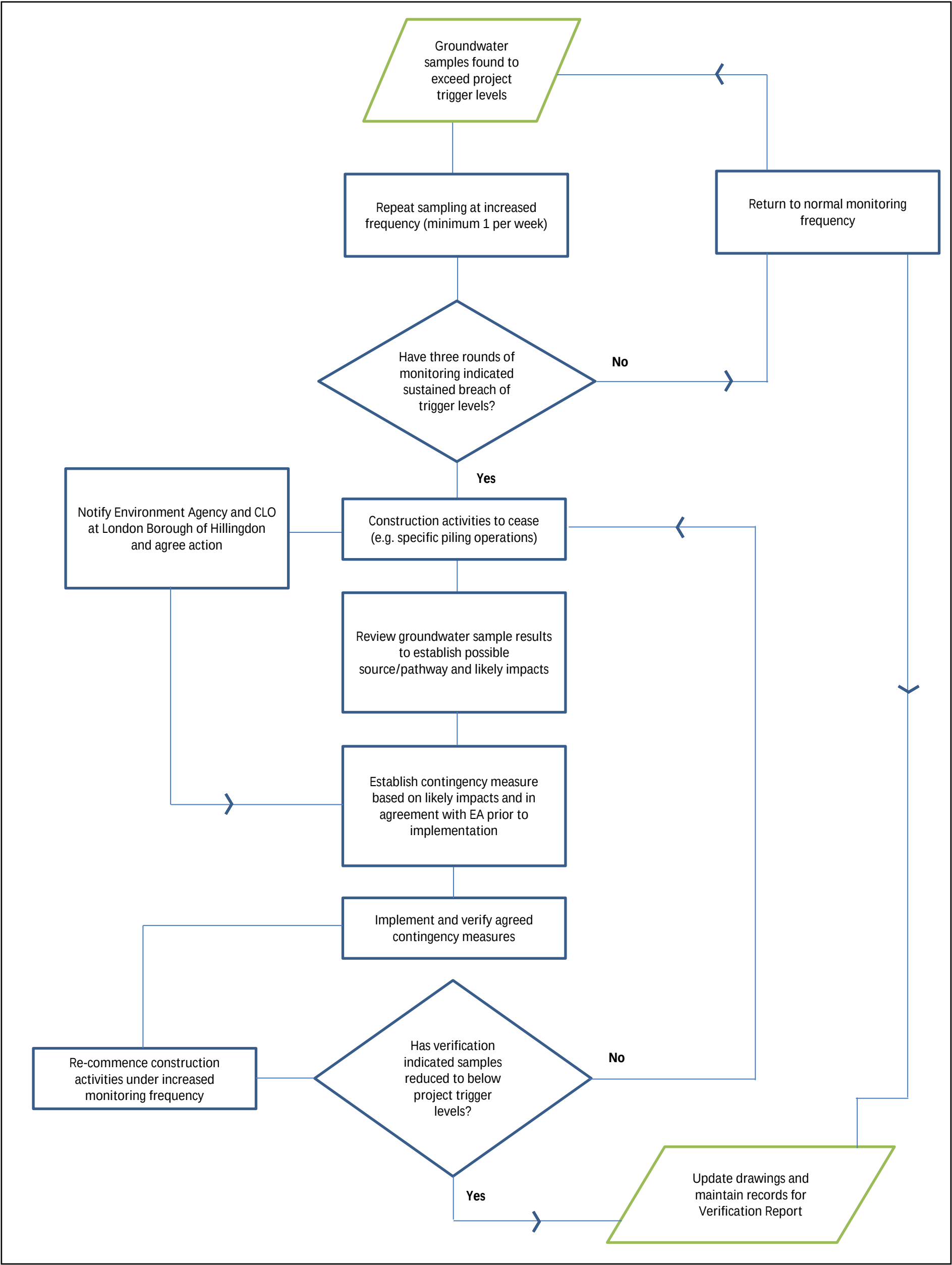
Contaminant	Baseline range (µg/l)	EQS value (µg/l)	Proposed trigger values (µg/l)
Ammoniacal Nitrogen	13,000 to 14,000	-	16,800 ¹
Benzene	<1.0	10	1.0 ²
Benzo(a)pyrene	<0.01	0.02	0.01 ²
Cadmium	0.03 to <0.08	0.25	0.08 ²
Chromium VI	<5.0	3.4	5.0 ²
Free Cyanide	<10	1	10 ²
Lead	0.3 to <1.0	1.2	1.0 ²
Mercury	<0.05 to <0.5	0.07	0.5 ²
Naphthalene	0.42 to 0.55	2	0.66 ¹
Phenol	<1.0	7.7	1.0 ²
Sum of TPH-CWG Aliphatic and Aromatic (C5 to C35)	<10 to 41	-	49 ¹
pH	7.3	-	6 to 9 ³

APPENDIX L

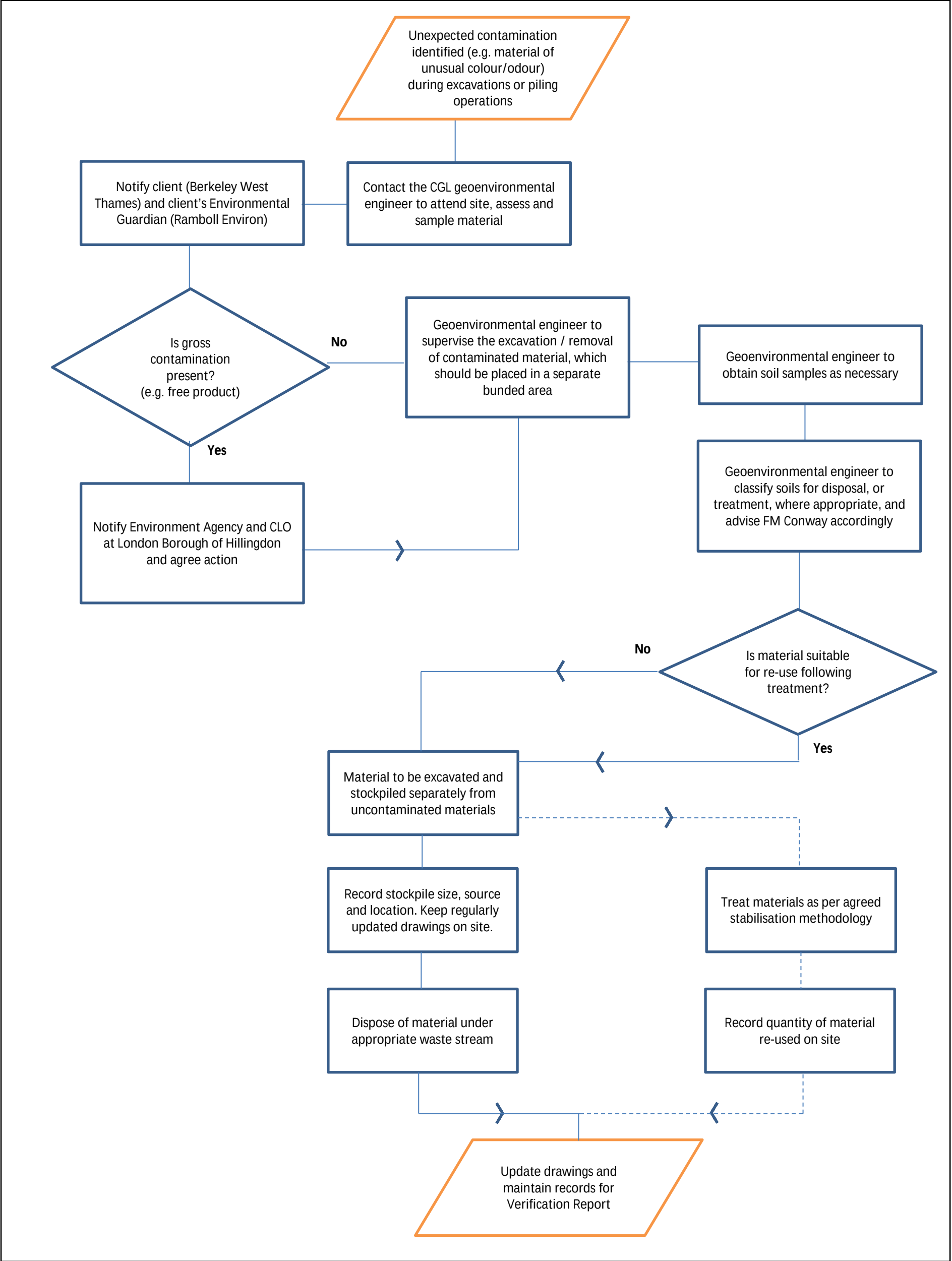
Geoenvironmental Process Charts



Client Clark Smith Partnership	Project Western Access - Remediation Scheme Addendum	Job No CGN/03732I
	Title Overview Geoenviromental Process Chart	Appendix L-1



Client Clark Smith Partnership	Project Western Access – Remediation Scheme Addendum	Job No CGN/03732I
	Title Groundwater Monitoring Process Chart	Appendix L-2



Client Clark Smith Partnership	Project Western Access – Remediation Scheme Addendum	Job No CGN/03732I
	Title Discovery Strategy Process Chart	Appendix L-3

APPENDIX M

Verification Plan

Reference	Principal requirements	Design or construction related	Site visit required by qualified geoenvironmental engineer	Supporting documentation
1.0 General principles	The proposed development will comprise three new earthwork embankments and two new bridge structures supported on piled foundations. The site verification requirements are as follows: - Removal and disposal of Made Ground material generated as part of enabling works excavations; - Excavation of natural soils to obtain formation levels for temporary and permanent works; - Separation and stockpiling of Made Ground and natural soils within the temporary lagoon stockpile area; - Verification sampling and testing including confirming acceptability of site won materials proposed for re-use to comply with site specific re-use criteria (Section 6 of the Remediation Scheme Addendum); - Monitoring of surface and groundwater throughout the construction phases; and - Watching brief for areas of unexpected / unidentified contamination. Amendments will be made to accord with differing conditions encountered during the progress of the works.	Design & construction	YES As detailed in Section 4.0 onwards.	Details of construction programme to be provided by FM Conway Limited (FMC).
2.0 Compliance with legislation	The construction and verification activities on the site should be undertaken in accordance with current health and safety and environmental legislation, in accordance with the contract.	Construction	-	-
3.0 Health and Safety requirements	This verification plan does not specifically cover health and safety requirements. This should be addressed in the Contractor's Health and Safety Plan.	Design & Construction	-	-

Reference	Principal requirements	Design or construction related	Site visit required by qualified geoenvironmental engineer	Supporting documentation
4.0 Waste disposal and materials management	All material bound for off-site disposal (either to a soil treatment facility or to landfill) will require characterisation in accordance with the Hazardous Waste Regulations 2005 and disposal in accordance with the requirements of the Landfill Regulations (2002, as amended) and the Environmental Protection (Duty of Care) Regulations, 1991. See Section 3.1 of Remediation Scheme Addendum for waste classification undertaken at investigation stage and associated appendices for details on waste classification requirements. Management of materials is to be undertaken in conjunction with the scheme Materials Management Plan (MMP) (Aconex ref: A720-E05-IW-BR-CGL-EW-TS-0002 P3).	Construction	YES - Obtain soils data and waste acceptance criteria (WAC) test data; - Screening of soils data against the established re-use criteria (see Section 6 of the RS Addendum); and - Waste classification of arisings requiring off-site disposal.	- Duty of care records for disposal of waste (including discharge consent if pumped groundwater discharged to sewer); - Laboratory test results; and - Material management protocols, as required (i.e. exemptions, permits etc).
5.0 Soft landscaping	Soft landscaping will be required in certain areas of the scheme including the embankment side slopes. Landscape requirements are to be confirmed though will include the use of topsoil and subsoil to act as a growing medium. Subsoil/topsoil will be soil imported from a known and reputable source or validated clean natural soils. Concentrations must be below the Maximum Permissible Concentrations detailed below in Appendix D. The pre-delivery chemical test results and source will be reviewed by a suitably qualified geoenvironmental engineer prior to the material being brought onto site.	Construction	YES - To validate construction of landscaping - To take samples for chemical analysis 1 test per 150 m³ (including a minimum of one test for each separate source material used).	- Source certificates and pre-delivery test data (to be provided by Contractor); - Site visit reports including photographs; - Chemical test results; - Comparison against topsoil import criteria (Appendix H, RS Addendum); and - Layout drawings showing location of areas of soft landscaping.
6.0 Gas protection	No enclosed spaces are proposed as part of the Western Access development requiring gas protection measures and, as such, this aspect if not required.	N/A	N/A	N/A

Reference	Principal requirements	Design or construction related	Site visit required by qualified geoenvironmental engineer	Supporting documentation
7.0 Construction monitoring	Groundwater Groundwater monitoring and sampling to be undertaken monthly during construction within established boreholes for the scheme with increased frequency (weekly) during key phases (e.g. piling operations). Resultant laboratory data to be compared to established trigger levels. Post- construction monitoring to be undertaken initially monthly dropping to bi-monthly for up to one year post construction. Surface water Surface water (Yeading Brook and Grand Union Canal) monitoring to include visual inspection and in situ physico-chemical parameter monitoring to be completed daily. Weekly monitoring and sampling during construction. Additional ammonia sampling to be undertaken from Yeading Brook concurrently with groundwater sampling. Post-construction surface water monitoring to be undertaken monthly up to three months after completion. Contingency measures to be reviewed in line with the RS Addendum.	Construction and post-construction	YES - Undertake water monitoring and obtain water samples; - Screen water data against the established groundwater trigger levels (see Section 9 of the RS Addendum); - Review baseline data for ammonia species in Yeading Brook and track trends in quality; - Pending review of data against trigger levels agree additional measures / contingency with the Environment Agency.	- Site visit reports including photographs; - Monitoring data sheets; - Chemical test results; and - Comparison against the established scheme trigger levels (see Section 9 of the RS Addendum).
8.0 Unexpected contamination	A watching brief, to include visual / olfactory inspection, is to be maintained during all enabling works, pile installation and earthworks construction. A qualified geoenvironmental engineer will undertake part-time supervision of site activities based upon the contractor's proposed programme. The contractor is to maintain a watching brief throughout the programme. Should unexpected contamination be encountered the process contained within Appendix L of the Remediation Scheme Addendum is to be followed. The watching brief is to include visual inspection for gross contamination, including free phase product or gasworks related wastes (e.g. spent oxide / 'blue billy' and foul lime) which are not to be re-used within the scheme.	Construction	YES Site supervision on part time basis, in accordance with Contractor's programme.	- Site visit reports including photographs; - Chemical test results; - Comparison against the established scheme re-use criteria (see Section 6 of the RS Addendum); and - Where required, revised risk assessment.