TRANSPORT FOR LONDON

RIVER CROSSINGS: SILVERTOWN TUNNEL

SUPPORTING TECHNICAL DOCUMENTATION

RIVER CROSSINGS GROUND INVESTIGATION DESK STUDY: STATEMENT OF INTENT

Mott MacDonald

May 2013

This report sets out the proposed studies and investigations for the formal Ground Investigation of the two project study areas at Silvertown and Gallions Reach respectively.

This report is part of a wider suite of documents which outline our approach to traffic, environmental, optioneering and engineering disciplines, amongst others. We would like to know if you have any comments on our approach to this work. To give us your views, please respond to our consultation at www.tfl.gov.uk/silvertown-tunnel

Please note that consultation on the Silvertown Tunnel is running from October – December 2014



TfL River Crossings - Ground Investigation Desk Study

Statement of Intent

May 2013

Transport for London

Mott MacDonald

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Transport for London

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Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	22 Feb 2013	R Harper	GR Taylor/ P Rutty	J Baber	Draft for comment
B	22 May 2013	R Harper	GR Taylor	P Rutty	Final for approval

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Content

1. Scheme

Transport for London (TfL) is currently developing a number of potential schemes collectively known as the River Crossings Programme which will provide new crossings of the River Thames in East London. The options currently being considered by TfL are as follows:

- A tunnelled crossing at Silvertown;
- A replacement for the Woolwich Ferry (at Woolwich/Gallions Reach); and
- A fixed link (either a bridge or immersed tube tunnel) at Gallions Reach.

It is anticipated that each of the above options will comprise Geotechnical Category 2 structures as defined in Section 3 of the Highways Agency document, HD22/08, 'Managing Geotechnical Risk'. A decision on which options to progress will be made during 2013. An envisaged programme for delivery into service of the first two projects is 2021 and 2018 respectively. The programme for the third scheme is still in development but its completion date would be after 2021 irrespective. An application has been made for the Silvertown Tunnel to be developed via a Development Consent Order (DCO) application. The replacement for the Woolwich Ferry would be taken forward via a Transport and Works Act (TWA) Order.

A significant amount of information is currently available for the project area; however, at present, no comprehensive complete study has been undertaken. Mott MacDonald have been commissioned by TfL to undertake a formal Ground Investigation Desk Study for the two project study areas at Silvertown and Gallions Reach respectively. The extents of the site areas are shown in the location plans contained in Appendix A.

2. Objectives

The objectives of the Ground Investigation Desk Study commission are as follows:

- Compile and review all existing factual information for the project study areas;
- Undertake site inspections (or walkover surveys) of the project study areas;
- Undertake Phase 1 Contamination Assessments for the project study areas;
- Document the findings of the desk study in a Preliminary Sources Study Report (PSSR), and
- Produce a Ground Investigation Report (as appropriate).

The work is to be carried out in accordance with the UK Highways Agency document HD 22/08, 'Managing Geotechnical Risk'.

Further work and reports would be produced in accordance with HD22/08 as the project progresses towards implementation.

3. Existing Information

3.1 Silvertown Study Area

In October 2010, Mott MacDonald prepared a comprehensive geotechnical desk study to assist with the design of the London Cable Car scheme across the River Thames between Royal Victoria Dock on the north side of the river and the Greenwich Peninsula on the south side. Although the desk study was primarily carried out for the cable car project, the scope of the desk study was expanded to cover the proposed tunnel crossing scheme being developed at the same location (Silvertown). Ground investigation for the cable car project was subsequently undertaken. Therefore, an extensive database of existing geotechnical information for the Silvertown study area is available.

3.2 Gallions Reach Study Area

The Gallions Reach study area includes the Thames Gateway Bridge (TGB) Project study area; much work has been undertaken for the TGB Project study area. This information is likely to be particularly useful for the desk studies at Gallions Reach. The extent and usefulness of this information has not yet been assessed.

4. Geotechnical Risk

The key geotechnical risks that are envisaged for the project study areas at Silvertown and Gallions Reach are detailed in the respective Preliminary Geotechnical Risk Registers contained in Appendix B. The Geotechnical Risk Registers will operate as live documents and will be reissued as part of the PSSR and at key stages throughout the development of the respective projects.

5. Proposed Studies and Investigations

The Ground Investigation Desk Study commission will include, but may not be limited to, the following activities:

- A comprehensive review of all the available factual information for the project study areas, including geological and historical maps;
- The commissioning of Envirocheck historical landuse assessments for both project study areas;
- The commissioning of Unexploded Ordnance (UXO) risk assessments for both project study areas;
- Site inspections (or walkover surveys) of the project study areas;
- Production of a PSSR, bringing together details of:
  - Site boundaries;
  - Site topography;
  - Geology, hydrogeology and geomorphology;
  - Ground and groundwater conditions;
  - Potential geotechnical problems and preliminary geotechnical parameters;
  - Previous and existing use of the site;
  - Services/utilities at the site;
  - Anticipated construction hazards; and
  - Proposed ground investigation.
- Preparation of Phase 1 Contamination Assessment reports for both project study areas.

Additionally, a Ground Investigation Report is to be produced (if considered necessary) in accordance with UK Highways Agency document HD 22/08, 'Managing Geotechnical Risk'.

Other reports prepared during the subsequent development of the project will also be produced in accordance with the UK Highways Agency document HD 22/08.

6. Specialist Consultation

6.1 UXO Risk Assessment

Although an Unexploded Ordnance (UXO) risk assessment was undertaken as part of the London Cable Car desk study, its extent is limited. Therefore, it is envisaged that UXO risk assessments will be required for both project study areas as part of the Ground Investigation Desk Study commission.

6.2 Contamination Assessment

Phase 1 Contamination Assessments are to be undertaken for the project study areas at Silvertown and Gallions Reach as part of the Ground Investigation Desk Study commission.

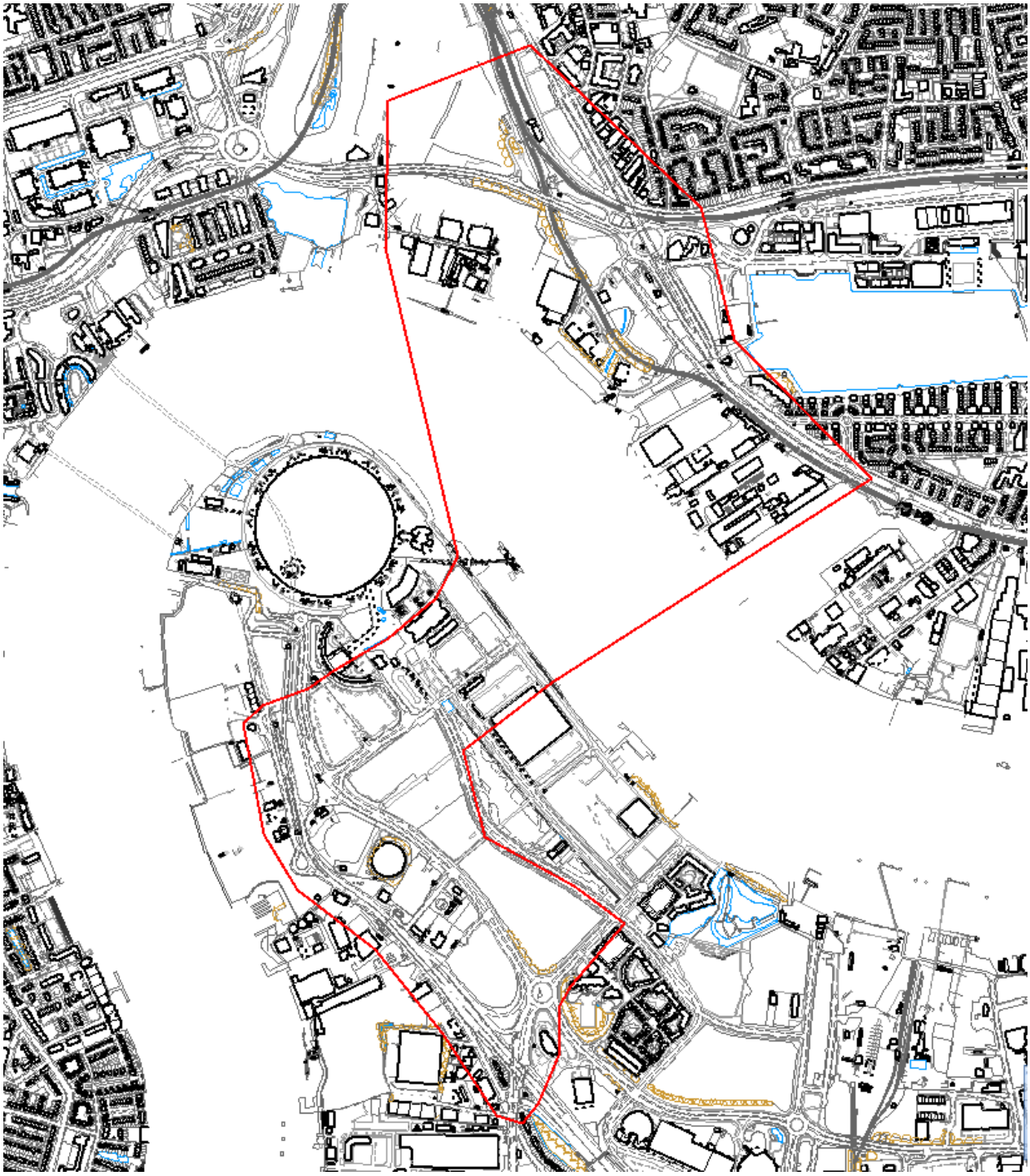
6.3 Specialist Geotechnical Processes

At present no specialist geotechnical processes are envisaged at either project study area given the proposed schemes.

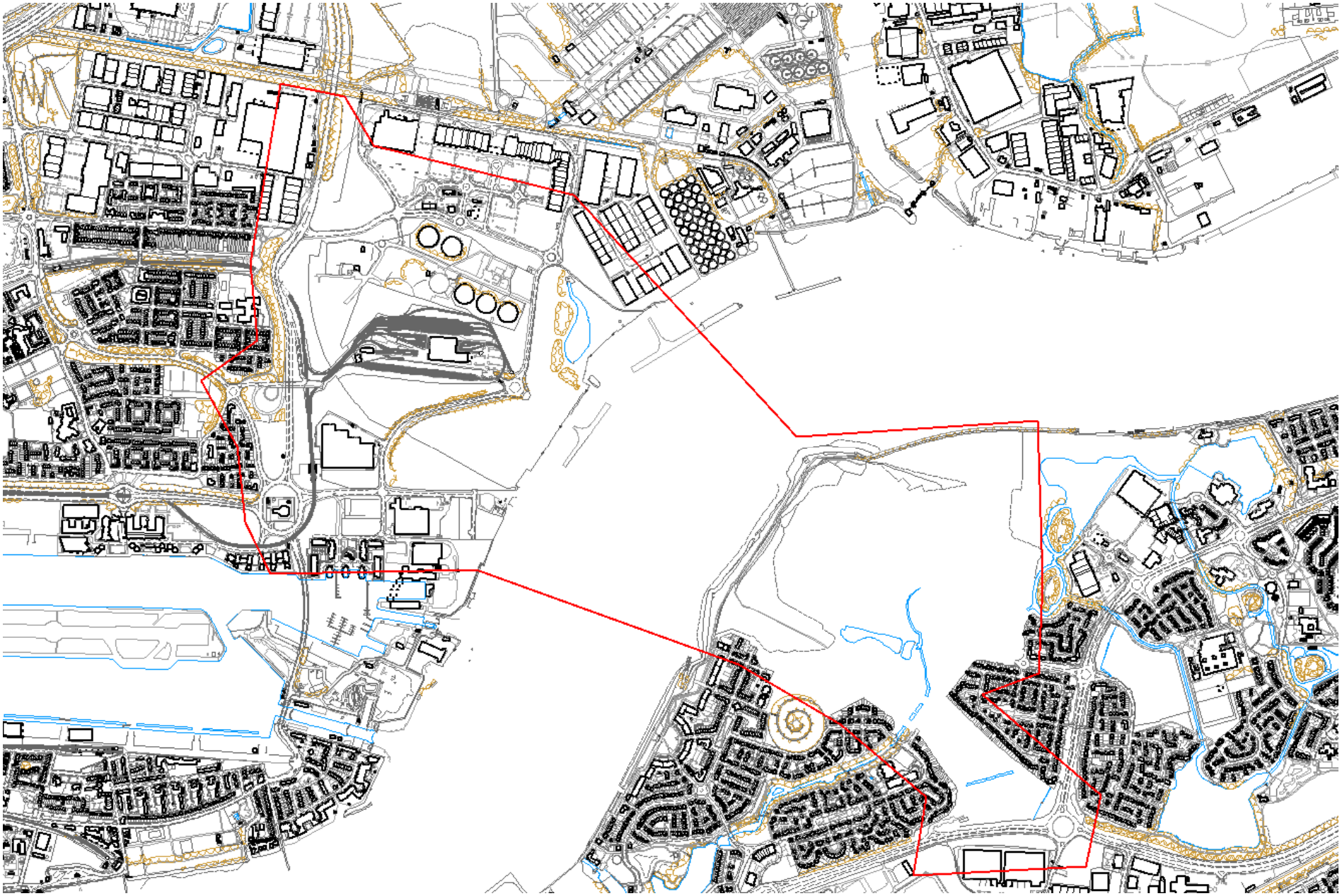
Appendices

Appendix A. Site Location Plans

Plan A - Final Silvertown GI area



Plan B - Gallions GI area



Appendix B. Preliminary Geotechnical Risk Registers

PRELIMINARY GEOTECHNICAL RISK REGISTER: SILVERTOWN

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

NOTE: RISK TYPES; HS = Health & Safety, T = Time, C = Cost, R = Reputation, E = Environment
Risk: I = Intolerable, S = Significant, T = Tolerable, N = Negligible

Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
GENERAL	Aggressive sulphate attack	Potential aggressive sulphate attack due to the oxidisable pyrite in the London Clay or chloride in the superficial soils could present aggressive conditions for the reinforced concrete used in the construction of the tunnel lining and tunnel portal substructures.	H	M	S	TCRE	Review the findings of chemical testing undertaken as part of the Cable Car ground investigation. Specify sulphate resistant concrete during the detailed design phase.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat north and south of the River Thames	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	M	S	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high/medium risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that both non-intrusive and intrusive survey methods be employed to clear the site of any potential UXO threat prior to any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat within the river bed	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	H	I	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that a magnetometer survey should be employed to clear the site of any potential UXO threat in advance of any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unforeseen ground conditions	Gaps in the geotechnical data for the study area increases the likelihood of encountering unforeseen ground conditions during construction.	VH	M	S	HSTCR	Undertake additional project-specific ground investigation in order to improve the accuracy of the ground model for the study area.	M	L	T	TBC	TBC	TBC
	Ground unsuitable for improvement	The use of ground improvement techniques will only be suitable for use in specific strata.	M	L	T	TCRE	Undertake additional project-specific ground investigation in order to improve the accuracy of the ground model for the study area.	L	L	N	TBC	TBC	TBC
	Ground obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruct piling/tunnelling works.	M	H	S	TCR	Undertake additional ground investigation to confirm the location and depth of suspected historical foundations.	L	H	T	TBC	TBC	TBC
	Excavation induced ground movement	Ground movements may result in causing unacceptable damage to overlying structures, adjacent subsurface structures and buried services within the vicinity of the proposed works.	M	M	T	HSTC	MM undertook a Stage 1 Potential Damage Assessment to identify any structure which may be at risk of damage due to the proposed works. These structures have been referred for Stage 2 assessments.	M	L	T	TBC	TBC	TBC
ENVIRONMENTAL	Presence of in situ asbestos	Asbestos in situ from historical works at the site may be a risk to site operatives during construction and may delay the construction programme.	H	M	S	HSTCE	Asbestos was encountered in the Made Ground during the Cable Car ground investigation within the infilled former dock entrance, but not elsewhere. Further ground investigation will improve understanding of the extent of the asbestos on site.	H	L	T	TBC	TBC	TBC
	Other contaminants	Contaminants resulting from the former land us (i.e. gas works) may be encountered within the superficial deposits. The risks posed by on site contaminants are described in greater details in the Contaminated Land Risk Assessment.	M	M	T	HSTCR	Mitigation measures for the various contaminants potentially found at the site are described in the Contaminated Land Risk Assessment.	M	L	T	TBC	TBC	TBC
	Spoil disposal	Excavated spoil arising from either ground investigation or construction, particularly within the Made Ground or superficial deposits, may be classified as contaminated waste.	M	M	T	HSTCRE	The likelihood of encountering contaminated ground at the site should be established by undertaking a project-specific ground investigation. Any contaminated spoil encountered during ground investigation/construction should be disposed of at licensed sites.	M	L	T	TBC	TBC	TBC
	Natural ground gas	Natural ground gas such as methane from clayey peat in the Alluvium will be a hazard during excavation works associated with the tunnel portals.	L	M	T	HSTCE	Make allowance in the ground investigation proposals to investigate this aspect further.	L	L	N	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: SILVERTOWN

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

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Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
CUT & COVER TUNNELS	Contamination of the Lower Aquifer	Piles extending into the Chalk may provide a pathway for contaminants resulting in contamination of the Lower Aquifer.	M	M	T	TCRE	Undertake additional ground investigation to investigate the presence of contamination in the superficial deposits. Make provisions during piling to avoid the migration of contaminants into the underlying Chalk i.e. the use of protective liners.	M	L	T	TBC	TBC	TBC
	Diaphragm wall obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruct diaphragm wall panel installation.	M	M	T	TCR	Consider the use of the secant piling if the ground investigation establishes a high likelihood of encountering ground obstructions.	L	L	N	TBC	TBC	TBC
	Uplift pressures on the undersides of the ground slabs	Uplift pressures due to significant pore water pressures in the granular units of the Lambeth Group may have an adverse effect on the proposed ground slabs at the tunnel portals.	M	M	T	TCR	May require a programme of dewatering to be instigated during construction and drainage to be installed to avoid the build up of excessive pore water pressures.	L	L	N	TBC	TBC	TBC
CORSS PASSAGES	Tunnel face instability	Water ingress into the tunnel from the sand units of the Lambeth Group or the overlying Harwich Formation (formerly known as the Blackheath Beds) may result in face instability requiring immediate works to support the tunnel face.	M	M	T	TCR	Use ground improvement techniques to minimise groundwater ingress.	M	L	T	TBC	TBC	TBC
HIGHWAY EARTHWORKS	Earthworks instability	Inadequately designed and constructed earthworks cuttings may incur slope failure either during construction or following completion of the proposed works.	H	L	T	HSTCR	Temporary and permanent earthworks should be designed in accordance with relevant design standards.	L	L	N	TBC	TBC	TBC
	Soft spots within the slope face	Soft spots in the slope face of highway cuttings may result in slope failure/instability.	M	M	T	HSTCR	Any soft material identified within the slope face should be excavated out and replaced with engineered fill.	L	L	N	TBC	TBC	TBC
	Soft spots within the embankments foundations	Soft spots in the embankment foundations may result in embankment instability or excessive settlement of the embankment.	M	M	T		Any soft material identified should be excavated out and replaced with engineered fill. The embankment foundation should be proof rolled to identify any soft sports.	L	L	N	TBC	TBC	TBC
BORED TUNNELLING	Difficult tunnelling conditions	Mixed face ground conditions or bands of hard cemented material in the Lambeth Group may have adverse effects on tunnelling progress.	M	H	S	TCR	Select appropriate tunnelling cutter head detail following further detailed ground investigation.	L	H	T	TBC	TBC	TBC
	Tunnel face instability	Water ingress into the tunnel from the sand units of the Lambeth Group or the overlying Harwich Formation (formerly known as the Blackheath Beds) may result in face instability requiring immediate works to support the tunnel face.	M	M	T	TCR	Design appropriate measure to increase face stability, e.g. grouting	M	L	T	TBC	TBC	TBC
	Tunnelling obstructions	Clay stones of hard cemented material may present difficult tunnelling conditions within the London Clay. Hard layers of material may also be encountered within the Harwich Formation and the Lambeth Group (i.e. mid-Lambeth hiatus)	M	M	T	TCR	Select appropriate tunnelling cutter head detail following further detailed ground investigation.	L	M	T	TBC	TBC	TBC
	Deep periglacial scour hollows	Periglacial scour hollows encountered during tunnelling could result in local face instability and may require immediate works to support the face.	M	M	T	TCR	Undertake additional ground investigation to define the variability in the interface between the periglacial deposits.	L	L	N	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: SILVERTOWN

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Next risk assessment (Date): TBC

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	Existing Cable Car foundations	Proximity of the proposed tunnel to the existing London Cable Car foundations may reduce the skin friction on the existing pile foundations.	H	L	T	HSTC	Since detailed as built records for the Cable Car construction should be available, the tunnel should be designed to minimise the interaction between the structures Nevertheless, an impact assessment on the London Cable Car structure should be undertaken.	L	L	N	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: GALLIONS REACH - Ferry Crossing Option

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

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Risk: I = Intolerable, S = Significant, T = Tolerable, N = Negligible

Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
GENERAL	Aggressive sulphate attack	Potential aggressive sulphate attack due to chloride in the superficial soils could present aggressive conditions for the reinforced concrete used in the construction the ferry terminal piers.	H	M	S	TCRE	Review the findings of chemical testing undertaken as part of the nearby ground investigations. Specify sulphate resistant concrete during the detailed design phase.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat north and south of the River Thames	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	M	S	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high/medium risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that both non-intrusive and intrusive survey methods be employed to clear the site of any potential UXO threat prior to any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Consolidation of soft Alluvium/Peat layers	The construction of the approach roads for the ferry terminals may result in excessive consolidation of the underlying Alluvium/Peat.	M	M	T	HSTCR	Undertake project-specific ground investigation to better understand the geotechnical properties of the Alluvium/Peat.	L	L	N	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat within the river bed	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	H	I	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that a magnetometer survey should be employed to clear the site of any potential UXO threat in advance of any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unforeseen ground conditions	Gaps in the geotechnical data for the study area increases the likelihood of encountering unforeseen ground conditions during construction.	VH	M	S	HSTCR	Obtain historical data for the extensive ground investigation undertaken as part of the East London River Crossing project. Undertake additional project-specific ground investigation in order to improve the accuracy of the ground model for the study area.	H	L	T	TBC	TBC	TBC
ENVIRONMENTAL	Presence of in situ asbestos	Asbestos in situ from historical works at the site may be a risk to site operatives during construction and may delay the construction programme.	H	M	S	HSTCE	Further ground investigation will improve understanding of the extent of the asbestos on site.	H	L	T	TBC	TBC	TBC
	Other contaminants	Contaminants resulting from the former land us (i.e. gas works) may be encountered within the superficial deposits. The risks posed by on site contaminants are described in greater details in the Contaminated Land Risk Assessment.	M	M	T	HSTCR	Mitigation measures for the various contaminants potentially found at the site are described in the Contaminated Land Risk Assessment.	M	L	T	TBC	TBC	TBC
	Spoil disposal	Excavated spoil arising from either ground investigation or construction, particularly within the Made Ground or superficial deposits, may be classified as contaminated waste.	M	M	T	HSTCRE	The likelihood of encountering contaminated ground at the site should be established by undertaking a project-specific ground investigation. Any contaminated spoil encountered during ground investigation/construction should be disposed of at licensed sites.	M	L	T	TBC	TBC	TBC
	Saline intrusion into aquifer	The ground water is generally separated from the brackish water of the Thames by a layer of alluvium/clay. When the river is put into hydraulic continuity with the groundwater there is a risk of saline intrusion into the aquifer.	H	H	S	TCRE	During construction, this might be tolerated but long term the river should be separated again. This can be achieved either through the use of selectively placed cohesive material or by use of ground membranes.	L	L	N	TBC	TBC	TBC
ERRY TERMINALS	Ground obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruction piling works.	M	H	S	TCR	Make allowance in the ground investigation proposals to investigate this aspect further.	L	H	T	TBC	TBC	TBC
	River wall and tie back anchors	The presence of the river wall and the associated tie back anchors may conflict with the construction of a jetty built as part of the Woolwich Ferry replacement.	M	M	T	TCR	Undertake a project-specific ground investigation to establish the location of tie back anchors within the project study area.	L	M	T	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: GALLIONS REACH - Ferry Crossing Option

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

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Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
FE	Historic jetties	The presence of former jetties may be an impediment to new foundation construction.	M	M	T	TCR	Undertake further investigation to establish the extent of existing jetties within the project study area.	L	M	T	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: GALLIONS REACH - Immersed Tube Option

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

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Risk: I = Intolerable, S = Significant, T = Tolerable, N = Negligible

Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
GENERAL	Aggressive sulphate attack	Potential aggressive sulphate attack due to chloride in the superficial soils could present aggressive conditions for the reinforced concrete used in the construction of the open ramps and tunnel portal substructures.	H	M	S	TCRE	Review the findings of chemical testing undertaken as part of the nearby ground investigations. Specify sulphate resistant concrete during the detailed design phase.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat north and south of the River Thames	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	M	S	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high/medium risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that both non-intrusive and intrusive survey methods be employed to clear the site of any potential UXO threat prior to any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat within the river bed	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	H	I	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that a magnetometer survey should be employed to clear the site of any potential UXO threat in advance of any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unforeseen ground conditions	Gaps in the geotechnical data for the study area increases the likelihood of encountering unforeseen ground conditions during construction.	VH	M	S	HSTCR	Obtain historical data for the extensive ground investigation undertaken as part of the East London River Crossing project. Undertake additional project-specific ground investigation in order to improve the accuracy of the ground model for the study area.	H	L	T	TBC	TBC	TBC
	Excavation induced ground movement	Ground movements may result unacceptable damage to overlying structures, adjacent subsurface structures and buried services within the vicinity of the proposed works.	M	M	T	HSTCRE	Undertake Stage 1 Potential Damage Assessment to establish the extent of the expected ground movements due to the proposed works and identify the affected structures.	M	L	T	TBC	TBC	TBC
ENVIRONMENTAL	Presence of in situ asbestos	Asbestos in situ from historical works at the site may be a risk to site operatives during construction and may delay the construction programme.	H	M	S	HSTCE	Further ground investigation will improve understanding of the extent of the asbestos on site.	H	L	T	TBC	TBC	TBC
	Temporary loss of mud flats	Dredging in the river bed resulting in the temporary loss of mud flats will require approvals from the Environment Agency and the potential need to provide compensation sites.	M	L	T	TCRE	Liaise with the Environment Agency to establish the potential need to provide compensation sites.	L	L	N	TBC	TBC	TBC
	Spoil disposal	Excavated spoil arising from either ground investigation or construction, particularly within the Made Ground or superficial deposits, may be classified as contaminated waste.	M	M	T	HSTCRE	The likelihood of encountering contaminated ground at the site should be established by undertaking a project-specific ground investigation. Any contaminated spoil encountered during ground investigation/construction should be disposed of at licensed sites.	M	L	T	TBC	TBC	TBC
	Other contaminants	Contaminants resulting from the former land us (i.e. gas works) may be encountered within the superficial deposits. The risks posed by on site contaminants are described in greater details in the Contaminated Land Risk Assessment.	M	M	T	HSTCR	Mitigation measures for the various contaminants potentially found at the site are described in the Contaminated Land Risk Assessment.	M	L	T	TBC	TBC	TBC
	Impact of dredging on water quality	Dredging associated with immersed tube tunnel may impact on the water quality.	M	M	T	TCRE	Agree limits with the Environment Agency and develop dredging methods accordingly . Undertake detailed environmental surveys to understand the impacts fully.	M	L	T	TBC	TBC	TBC
	Saline intrusion into aquifer	The ground water is generally separated from the brackish water of the Thames by a layer of alluvium/clay. When the river is put into hydraulic continuity with the groundwater there is a risk of saline intrusion into the aquifer.	H	H	S	TCRE	During construction, this might be tolerated but long term the river should be separated again. This can be achieved either through the use of selectively placed cohesive backfill material or by use of ground membranes within the tunnel backfill.	L	L	N	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: GALLIONS REACH - Immersed Tube Option

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

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Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
CUT & COVER	Natural ground gas	Natural ground gas such as methane from clayey peat in the Alluvium will be a hazard during excavation works associated with the tunnel portals.	L	M	T	HSTCE	Undertake ground investigation to further define the properties of the Alluvium. Gas monitoring wells were identified during the walkover survey to the east of Armada Way. Any data from these wells should be obtained from the relevant stakeholder.	L	L	N	TBC	TBC	TBC
	Diaphragm wall obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruct diaphragm wall panel installation.	M	M	T	TCR	Consider the use of the secant piling if the ground investigation establishes a high likelihood of encountering ground obstructions.	L	L	N	TBC	TBC	TBC
	High groundwater table	Uplift pressures due to significant pore water pressures may have an adverse effect on the proposed ground slabs at the tunnel portals and the proposed walls of the open ramps.	L	M	T	TCR	May require a programme of dewatering to be instigated during construction and drainage to be installed to avoid the build up of excessive pore water pressures.	L	L	N	TBC	TBC	TBC
IMMERSED TUBE TUNNEL	Historic jetties	The presence of former jetties may be an impediment to new foundation construction.	M	M	T	TCR	Undertake further investigation to establish the extent of existing jetties within the project study area.	L	M	T	TBC	TBC	TBC
	River wall and tie back anchors	The presence of the river wall and the associated tie back anchors may conflict with the construction of a jetty built as part of the Woolwich Ferry replacement.	M	M	T	TCR	Undertake a project-specific ground investigation to establish the location of tie back anchors within the project study area.	L	M	T	TBC	TBC	TBC
	Dredging in the Chalk	Potential to encounter hard bands and flint bands within the Chalk with limited river space to operate large machinery to break through the hard material.	M	M	T	TCR	Undertake ground investigation to further define the ground model. An allowance in the programme should be made to account for encountering bands of hard material.	M	L	T	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: GALLIONS REACH - Bridge Option

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

NOTE: RISK TYPES; HS = Health & Safety, T = Time, C = Cost, R = Reputation, E = Environment
Risk: I = Intolerable, S = Significant, T = Tolerable, N = Negligible

Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
GENERAL	Aggressive sulphate attack	Potential aggressive sulphate attack due to chloride in the superficial soils could present aggressive conditions for the reinforced concrete used in the construction of the bridge and viaduct piers.	H	M	S	TCRE	Review the findings of chemical testing undertaken as part of the nearby ground investigations. Specify sulphate resistant concrete during the detailed design phase.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat north and south of the River Thames	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	M	S	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high/medium risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that both non-intrusive and intrusive survey methods be employed to clear the site of any potential UXO threat prior to any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unexploded ordnance (UXO) threat within the river bed	Severe injury/death to site operatives and destruction of construction works/existing structures.	VH	H	I	HSTCRE	The detailed UXO risk assessment of the study area, carried out in accordance with CIRIA C681, assigned a high risk of encountering UXO on land within the study area. It is recommended in the UXO risk assessment that a magnetometer survey should be employed to clear the site of any potential UXO threat in advance of any intrusive ground works.	H	L	T	TBC	TBC	TBC
	Unforeseen ground conditions	Gaps in the geotechnical data for the study area increases the likelihood of encountering unforeseen ground conditions during construction.	VH	M	S	HSTCR	Obtain historical data for the extensive ground investigation undertaken as part of the East London River Crossing project. Undertake additional project-specific ground investigation in order to improve the accuracy of the ground model for the study area.	H	L	T	TBC	TBC	TBC
ENVIRONMENTAL	Presence of in situ asbestos	Asbestos in situ from historical works at the site may be a risk to site operatives during construction and may delay the construction programme.	H	M	S	HSTCE	Further ground investigation will improve understanding of the extent of the asbestos on site.	H	L	T	TBC	TBC	TBC
	Spoil disposal	Excavated spoil arising from either ground investigation or construction, particularly within the Made Ground or superficial deposits, may be classified as contaminated waste.	M	M	T	HSTCRE	The likelihood of encountering contaminated ground at the site should be established by undertaking a project-specific ground investigation. Any contaminated spoil encountered during ground investigation/construction should be disposed of at licensed sites.	M	L	T	TBC	TBC	TBC
	Other contaminants	Contaminants resulting from the former land us (i.e. gas works) may be encountered within the superficial deposits. The risks posed by on site contaminants are described in greater details in the Contaminated Land Risk Assessment.	M	M	T	HSTCR	Mitigation measures for the various contaminants potentially found at the site are described in the Contaminated Land Risk Assessment.	M	L	T	TBC	TBC	TBC
	Impact of dredging on water quality	Dredging associated with the construction of the bridge piers may impact on the water quality.	M	M	T	TCRE	Agree limits with the Environment Agency and develop dredging methods accordingly . Undertake detailed environmental surveys to understand the impacts fully.	M	L	T	TBC	TBC	TBC
	Natural ground gas	Natural ground gas such as methane from clayey peat in the Alluvium will be a hazard during excavation works associated with the approach viaducts.	L	M	T	HSTCE	Undertake ground investigation to further define the properties of the Alluvium. Gas monitoring wells were identified during the walkover survey to the east of Armada Way. Any data from these wells should be obtained from the relevant stakeholder.	L	L	N	TBC	TBC	TBC
CUT & COVER	Diaphragm wall obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruct diaphragm wall panel installation.	M	M	T	TCR	Consider the use of the secant piling if the ground investigation establishes a high likelihood of encountering ground obstructions.	L	L	N	TBC	TBC	TBC
	Excessive ground movement	Soft superficial deposits below the open ramps will be susceptible to excessive settlement/heave causing long term premature deterioration	H	VH	I	TCR	Design piles to extend to the Chalk to reduce settlement to acceptable levels. Design a suspended base slab for the tunnel approaches to mitigate the impact of ground heave.	VL	VL	N	TBC	TBC	TBC

PRELIMINARY GEOTECHNICAL RISK REGISTER: GALLIONS REACH - Bridge Option

Date: 17/05/2013 **Project Phase: Ground Investigation Report** **Project:** **TfL River Crossings**

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Risk Assessment carried out by: R Harper
Next risk assessment (Date): TBC

	Threat	Consequences	IMPACT	LIKELIHOOD	RISK	RISK TYPE	Potential Risk Control Measures / Actions	IMPACT	LIKELIHOOD	RESIDUAL RISK	OWNER	Action (by whom and when)	Current Risk Ranking
	High groundwater table	Uplift pressures due to significant pore water pressures may have an adverse effect on the proposed ground slabs at the tunnel portals and the proposed walls of the open ramps.	L	M	T	TCR	May require a programme of dewatering to be instigated during construction and drainage to be installed to avoid the build up of excessive pore water pressures.	L	L	N	TBC	TBC	TBC
APPROACH VIADUCT	Piling obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruct piling for the approach viaducts.	M	M	T	TCR	Undertake project-specific ground investigation to establish the likelihood of encountering ground obstructions.	L	L	N	TBC	TBC	TBC
	Contamination of the Lower Aquifer	Piles extending into the Chalk may provide a pathway for contaminants resulting in contamination of the Lower Aquifer.	M	M	T	TCRE	Undertake additional ground investigation to investigate the presence of contamination in the superficial deposits. Make provisions during piling to avoid the migration of contaminants into the underlying Chalk i.e. the use of protective liners.	M	L	T	TBC	TBC	TBC
BRIDGE	Ground obstructions	Natural ground obstructions such as granular and cemented beds and man made obstructions such as foundation remains could obstruction piling works.	M	H	S	TCR	Make allowance in the ground investigation proposals to investigate this aspect further and confirm the location and depth of suspected historical foundations.	L	H	T	TBC	TBC	TBC
	River wall and tie back anchors	The presence of the river wall and the associated tie back anchors may conflict with the construction of a jetty built as part of the Woolwich Ferry replacement.	M	M	T	TCR	Undertake a project-specific ground investigation to establish the location of tie back anchors within the project study area.	L	M	T	TBC	TBC	TBC
	Historic jetties	The presence of former jetties may be an impediment to new foundation construction.	M	M	T	TCR	Undertake further investigation to establish the extent of existing jetties within the project study area.	L	M	T	TBC	TBC	TBC

NEGATIVE CONSEQUENCE SCORE TABLE

Impact			Health and Safety	Time	Cost	Reputation	Environment
1	very low	negligible	negligible	negligible effect on programme	negligible	negligible	negligible
2	low	minor	minor injury	5% effect on programme	1% budget	minor effect on local company image/ business relationship mildly affected	minor environmental incident
3	medium	serious	major injury	12% effect on programme	10%budget	local media exposure/ business relationship affected	environmental incident requiring management input
4	high	threat to furture work and client relations	fatality	25% effect on programme	20% budget	nationwide media exposure / business relationship greatly affected	environmental incident leading to prosecution or protestor action
5	very high	threat to business survival and credibility	multiple fatalities	50% effect on programme	50% budget	permanent nationwide affect on company image/ significant impact on business relationship	major environmental incident with irreversible effects and threat to public health or protected natural resource

LIKELIHOOD SCORE TABLE

Likelihood			Probability
1	very low	negligible / improbable	<1%
2	low	unlikely / remote	>1%
3	medium	likely / possible	>10%
4	high	probable	>50%
5	very high	very likely / almost certain	>90%

			Likelihood				
			Very Low	Low	Medium	High	Very High
		Score	1	2	3	4	5
Negative Consequence	Very Low	1	n	n	n	n	t
	Low	2	n	n	t	t	s
	Medium	3	n	t	t	s	s
	High	4	n	t	s	s	i
	Very High	5	t	s	s	i	i

Risk Key

intolerable	RED	i	20 to 25
significant	AMBER	s	10 to 16
tolerable	YELLOW	t	5 to 9
negligible / trivial	GREEN	n	1 to 4