APPENDIX I

Geotechnical Risk Register

GEOTECHNICAL RISK EVALUATION MATRIX

PROBABILITY (P)		
Very High	Very likely >75%	**5**
High	Probable 40-75%	**4**
Medium	Possible 10-40%	**3**
Low	Unlikely 2-10%	**2**
Very Low	Negligible <2%	**1**

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IMPACT (I)			
		TIME	**COST**
Very High	**5**	>50%	>20%
High	**4**	25-50%	10-20%
Medium	**3**	10-25%	5-10%
Low	**2**	2-10%	1-5%
Very Low	**1**	<2%	<1%

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RISK		**Impact**				
		5	**4**	**3**	**2**	**1**
Probability	**5**	**25**	**20**	**15**	**10**	**5**
	4	**20**	**16**	**12**	**8**	**4**
	3	**15**	**12**	**9**	**6**	**3**
	2	**10**	**8**	**6**	**4**	**2**
	1	**5**	**4**	**3**	**2**	**1**

Risk Ratings		
	1 to 4	Low Risk
	5 to 10	Medium Risk
	12 to 16	High Risk
	20+	Critical Risk

Sources: Probability and impact nomenclature and scorings are based on a number of sources including -
HD22/08 Managing Geotechnical Risk
Describing probability: The limitations of natural language (Hillson)
Probability frequencies and the % increase of costs are Mouchel derived values

The time and cost impact should be reviewed to be project specific. Percentages have been provided as indicative but these should be reviewed following consultation with the project manager depending on the criticalility of deadlines and cost and contractual arrangements. Ideally percentages should be changed into real terms giving days/weeks/months delay and the extra cost to suit the project size.

GEOTECHNICAL RISK ASSESSMENT

Risk Rating (R) = Probability (P) x Impact (I)

No	Hazard	Cause	Consequence	Before Control			Risk Management Measures	After Control			Comments or further recommended actions
				P	I	R		P	I	R	
1	Unidentified voids associated with shallow underground mine working and abandoned shafts.	Insufficient information on the ground conditions to identify areas of shallow mine workings and allow appropriate design measures to mitigate the risk.	Potential for failure due to insufficient bearing capacity or excessive settlement of the highway. Future instability as a result of rising groundwater causing degradation of underground pillars, floors and roofs as the water table returns to its original level following the cessation of mine de-watering.	5	4	20	Make all parties aware of the presence of mine shafts close to the site and the potential for deep and shallow workings within the study area. Review all the available information and assess using a suitable ground model.	2	4	8	Continued and ongoing monitoring of the highway. Implement a monitoring plan to include frequency, reaction to change etc.
2	Unforeseen deep surface mining backfill Presence of voids or loose materials	Insufficient information on the ground conditions to identify areas of deep backfilled brick pits and allow appropriate design measures to mitigate the risk	Presence of voids or loose/ soft materials leading to excessive settlement of the highway. Differential settlement of the highway causing undulations in the road surface. Void migration to surface and ground loss causing damage to the existing highway. Settlement/subsidence of surface or groundwater into fills causing excessive settlement of the backfill and highway.	4	4	16	Make all parties aware of the presence of surface mining and possibility of shallow workings within the study area. All the available information reviewed and assess using a suitable ground model. Adequate GI has been carried out to identify hazard. Engineering solutions designed that minimise the impact of the workings where infrastructure can't be moved.	2	4	8	Ongoing monitoring of the road surface for signs of settlement and subsidence. Implement a monitoring plan and methods of reacting to any future settlement or subsidence of the road surface.
3	Presence of soft and loose deep Made Ground.	Deep infill of historical clay brick pits with uncontrolled Made Ground comprising soft clays or loose granular material.	Excessive settlement of highway adjacent infrastructure utilities due to the soft, unconsolidated recent Made Ground Deposits. Potentially differential settlement across the highway road surface.	5	3	15	All the available desk study information reviewed and the potential settlement using a suitable ground model as been assessed. GI has been carried out. These deposits may require excavation and replacement of more suitable fill or ground improvement if unacceptable levels of settlement occur along the highway.	3	3	9	Implement a monitoring programme to visually observe any changes in the road surface, in particular new cracks or settlement. Use of surveying equipment at set points along the highway to monitor and record any changes.
4	Dissolution of the Chalk at depth - associated with the groundwater table.	Dissolution of the chalk causing soft ground or the potential for voids at the ground water table.	Soft ground conditions/potential for voids at depths of around 45 to 50m bgl. Possibility of the voids migrating to the surface.	3	1	3	All available information has been reviewed and assessed using a suitable ground model. Adequate GI has been carried out to identify the risk and the hazard of the void migrations.	2	1	2	If ground investigation indicates impact at the surface, include monitoring programme.

GEOTECHNICAL RISK ASSESSMENT

Risk Rating (R) = Probability (P) x Impact (I)

No	Hazard	Cause	Consequence	Before Control			Risk Management Measures	After Control			Comments or further recommended actions
				P	I	R		P	I	R	
5	Insufficient GI data (Groundwater)	Limited GI available at specific locations of scheme elements. In particular, limited groundwater information with regard to seasonal variations. Potential for perched groundwater.	Greater risk of encountering unanticipated ground conditions. May result the use of ground models of a reduced accuracy.	3	3	9	Limited GI has been carried out to identify the hazard. Monitor groundwater levels and design appropriate measures as necessary.	1	3	3	Additional GI to install monitoring piezometers to assess the GW levels on site.
6	Dissolution/ wash out of fines (near Surface)	Leaking water pipes/sewer pipes/surface water drainages/soakaways	Formation of isolated areas of soft ground/ voids near to the surface that in turn cause subsidence/ settlement of the highway road surface.	4	3	12	Make all parties aware of the risk of shallow features forming, contact utilities providers to make them aware of the risk and implications of leaks in the area of the highway. All the available information reviewed and assess using a suitable ground model. Adequate GI has been carried out to identify hazards.	3	2	6	Ongoing monitoring of the road surface for signs of settlement and subsidence. Implement a monitoring plan and methods of reacting to any future settlement or subsidence of the road surface.

Notes:

1. A 'Hazard' is a condition or physical situation with a potential for an undesirable event. This risk register is limited to the management of geotechnical and geoenvironmental hazards. Safety, environment or business hazards are not included.
2. A 'Risk' is an uncertain event or set of circumstances that should it occur would have an effect on achieving the projects objectives.
3. The risk management strategy adopted, as included in 'Managing Geotechnical Risk - Improving Productivity in UK Building and Construction' by Clayton C.R.I, published by DETR and ICE in 2001, is as follows:
   - avoid
   - if unavoidable, transfer
   - if non-transferable, mitigate
   - if unable to mitigate, accept and manage
4. Risk ratings columns are colour shaded according to degree of risk to illustrate those hazards considered to be of greatest risk