Appendix 1

Environmental Risks

Sch33.5 Application

All environmental risks are addressed in Sch33.5, which mandates that prior to commencing construction of any "specified work" – primarily those impacting drainage, flood storage and defenses, water flow or quality, and water resource conservation – the designated contractor must present plans and method statements for the projects to the Environment Agency or local drainage authorities (such as lead local flood authorities or internal drainage boards) for their approval. Adverse effects are addressed through design mitigation strategies. When construction mitigation measures are necessary, they should be clearly defined, and a management process should be established to ensure subsequent implementation.

To be issued with a Sch33.5, a GWRA and WFD compliance report needs to be completed. The basis for a GWRA is the Conceptual Site Model (CSM) to establish key source-pathway-receptor linkages for each phase of the proposed construction works. For each asset, a summary and assessment of the environmental background is included along with the proposed construction activities and interactions between groundwater, geology, and nearby water features. All construction activity has the potential to interfere with both the groundwater and surface water regime during the construction phases and/or post-construction. By understanding the linkages and risk from construction a monitoring plan is proposed to capture any environmental impact from the construction process.

A WFD compliance report requires the determination of the risk of construction activity with both surface watercourses and groundwater. Prior to construction, relevant baseline data is required for the aquifer body/bodies and/or major watercourse(s), covering all relevant WFD quality elements as metrics for surface water and groundwater. As a minimum, adverse effects on the supporting quality elements of affected water bodies are to be avoided and enhancements, where practically possible, are to be achieved. In addition, supporting documents may be required also to account for flooding risk (FRA), contamination and remediation works (contamination assessment, LQA, RS and RIP) and impact of discharged waters to receiving waterbodies (H1RA).

Contamination linkages

For an environmental contamination risk, all three components of the contamination linkage – source, pathway, and receptor – must be present. A risk of contamination only exists when there is a source of contaminants that can be transported through a pathway to a receptor. Although each asset has unique challenges and is to be assessed on a case-by-case basis, risks can be determined by grouping together frequently occurring linkages common for construction activity as summarised in Table 1.

Table 1 – Categories of potential impacts to water environment (although variable, construction activity is placed in a typical order of decreasing risk)

Construction Activity	***Principal***	***Main mechanisms for potential contamination / environmental impact (or linkages) during temporary works***
Newly added discharge to watercourses (including via a slurry / water treatment)	Either the introduction or alteration of a discharge to a receiving waterbody (e.g. River Tame, River Blythe).	• Runoff water resulting in potential leaching of contaminants from stripped ground or spillages from site activities with subsequent discharge. • Runoff collecting soil from stripped ground resulting in erosion and increased turbidity levels with subsequent discharge. • Changes in the volume or quality of water in a receiving waterbody impacting normal ecosystem function.
Watercourse diversion	Alteration of a pathway of a watercourse.	• Scour and / or bank erosion impacting channel morphology (deviating from design) • Disturbance to natural sediment transport regime affecting the balance of watercourse channel with flow and sediment regime through the system affecting aquatic ecosystems. • Altered flow patterns affecting crossing structures.
Cutting	Excavation of material to create a level surface. Typically, extensive dewatering will be involved.	• Soil erosion and sedimentation in adjacent areas. • Contamination from excavated materials. • Altered drainage patterns impacting water quality. • Groundwater lowering in the adjacent area.
Retained cut	Structural support installed for a steeper overall slope gradient than naturally possible. This may be a partially retained cutting, which would include an element of naturally supported slope (usually above the retained element) or a fully retained cutting with vertical sides.	• Blockages to groundwater flow resulting in increases to levels upstream of structure (potentially causing groundwater flooding). • Contaminant leaching from exposed soils.
Underground structure (ventilation and intervention shafts, cross passages and adits)	passage with cross-passages connecting between two parallel tunnels.	• Groundwater ingress results in lowering of groundwater level. • During a construction phase, ingress is controlled with dewatering which may be potentially contaminated due to construction activity.
Major excavations	Excavations of ground to target depth. Dewatering may be required if excavations go below groundwater level and is typically achieved via sump pumping.	• Dewatering near potential contamination sources, such as old landfill sites, can draw contaminated water towards the works, spreading contamination within the aquifer. • Mobilisation of nearby contaminated groundwater. • Potential for slope instability and erosion.
Tunnel / portal	Two subsurface parallel tunnels connected by the portal (entry and exit point)	• Altered groundwater flow, due to local diversions due to presence of tunnel pathway and creation of fractures. • Generation of turbidity which has the potential to interfere with watercourses and treatment of bacteria. • Addition of various polymers during progression of TBM introducing a potential source of contamination to surrounding groundwater.
Piling	Driving or boring circular foundations into the ground to support structures by transferring loads to the soil.	• Continuous flight auger piling works will interact with the groundwater, but no groundwater will be abstracted. • Local groundwater flow changes during and after piling for piled foundations construction.

Construction Activity	***Principal***	***Main mechanisms for potential contamination / environmental impact (or linkages) during temporary works***
		• Pathway creation via penetrative works during and after piling for sheet pile walls construction.
Minor excavations (abutments / pile cap excavations / trenches / bridge piers)	Excavations of ground to target depth (including the use of sheet piles). Dewatering may be required if excavations go below groundwater level and is typically achieved via sump pumping.	• Altered groundwater flow effecting water quality. • Contaminant leaching from exposed soils. • Potential for slope instability and erosion.
Embankments	Constructed mounds for infrastructure support. As the addition of material is above ground level, no dewatering is required.	• Altered groundwater flow effecting water quality. • Contaminant leaching from exposed soils. • Potential for slope instability and erosion. • Soil stabilisation (including the addition of lime)
Liming (soil stabilisation)	Enhancement of the geotechnical properties of soil by introducing lime to improve strength and stability of soil	• Lime leaches into water
Managed aquifer recharge (MAR)	Controlled injection of water into aquifers for groundwater replenishment.	• Newly added source of water to an underlying aquifer body with potential contamination from cross concentration, subsurface contaminant mobilisation, chemical reactions.

Construction activity contaminants of concern

Materials and contaminants of concern are to be focused on for ensuring no environmental impact as shown in Table 2.

Table 2 – Contaminants of concern and associated construction activities (in decreasing order of most commonly occurring for a typical construction site)

Materials / contaminants of concern	**Commonly associated construction activities**	**Environmental hazards**
Silt	Excavations, run off from stockpiles and any areas of stripped / exposed soil during general construction activity	Silt is generated when rainfall causes soil particles to be mobilised by the runoff and washed into the water courses. Fine sediment causes damage to aquatic life in rivers and streams by smothering and blocking sunlight.
Oil / hydrocarbons	General construction activity (use of diesel, lubricating oil, fuel oil, petrol and hydraulic fluids)	Oil and hydrocarbon spills from construction plant / equipment can spread quickly and cover large areas if it gets into the water environment, polluting water and soils and causing significant environmental damage
Fresh concrete	Retained cuts, underground structure, tunnel / portal and piling, concrete wash-out, ready-mix lorries	Fresh (uncured) concrete and concrete wash out releases CrVI (and other metals) and generates high pH water. CrVI is a hazardous pollutant contained in the cement component of concrete and is highly mobile in the environment over a wide pH range.
Re-mobilisation of sub surface contaminants	Primarily any activity associated with dewatering	Pre-existing contamination can be mobilised by dewatering activities as pollution can be drawn towards the abstraction point

Bentonite	Piling, retained cuts	Bentonite can highly pollute water, smothering plants and animals and blocking sunlight.
Deposition of material and subsequent leaching	Tunnels (and associated arisings), embankments, cutting, excavation, retained cut	Excavated material can contain high concentrations of naturally occurring metals or pre-existing contamination. When contamination is exposed to varying environmental conditions, there is a potential for leaching into the environment.
Liming (soil stabilisation)	Soil stabilisation, cuttings, embankments, vehicle movement via haul roads	Lime is highly alkaline and corrosive and there are risks to the surrounding environment as lime dust settles on surfaces and is washed off into the drainage network, generating high pH water.
Polymer flocculant	Retained cut, piling, water treatment	Polymer flocculant is highly viscous in water and contains acrylamide, which is thought to be carcinogenic in drinking water

Other environmental risks

During the earthworks season, which typically spans from March to October, various earth movement activities including muck away, ground remodeling, stockpiling, and excavation are conducted. As temperatures rise during the summer months, these materials dry out, leading to the generation of significant amounts of dust. This dust can settle in drainage channels and eventually make its way into watercourses when it rains. Once in the water, these fine-grained particles form silt, contributing to an increase in Total Suspended Solids (TSS) and turbidity levels.

In addition, open boreholes should be clearly marked and kept covered to ensure against accidental ingress of construction related materials. At the end of the monitoring period and use, boreholes must be formally decommissioned by backfilling and capping to prevent contamination of groundwater from site activities such as concreting which could potentially escape to the surrounding groundwater.

Other general construction risks involve pollution from surface machinery; leaching from galvanised metals, spillages related to waste and material usage; uncontrolled water sources; uncontrolled silt, and; organic substances like sewage effluent, herbicides, and pesticides. It is crucial to implement control measures to mitigate these risks effectively. Section 16 of the CoCP [8] sets out general mitigation measures and practices to minimise impacts to groundwater.