Welsh Government

M4 Corridor around Newport

Environmental Statement Supplement Volume 3: Appendix R11.2 Outline Remediation Strategy Report

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1 Introduction

1.1 Background

1.1.1 This outline remediation strategy has been prepared to underpin the mitigation and control measures for land contamination management associated with the development and operation of the proposed M4 corridor Around Newport (M4CaN, known as the 'Scheme').

1.1.2 Sites that may need to be built over or to be partially or wholly excavated along the route of the proposed new section of motorway have been identified.

1.1.3 An assessment of the associated risks to human health and the environment has identified relevant potential pollutant linkages for each of these sites and the potential need for remedial action. These were initially presented in the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES) and have been refined within the updated Appendix R11.1 following the availability of additional ground investigation data obtained during 2016.

1.1.4 This report presents the strategy for managing the identified contamination in accordance with relevant UK regulatory guidance, codes of practice and industry good practices (Section 1.3). This Outline Remediation Strategy proposes a sustainable approach so that *'the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a balanced decision-making process'* (SuRF-UK, 2013).

1.2 Scope

1.2.1 This Outline Remediation Strategy utilises the information from the individual risk assessments, together with details of the proposed approach to construction, to establish the most appropriate approach for managing the risks posed by potential land contamination.

1.2.2 This Outline Remediation Strategy considers land contamination as identified within the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES and Appendix R11.1 of the ES Supplement). The principal aim is to address those sites which lie wholly, or partly, in the path of the new section of motorway carriageway or adjacent to it. Those sites, or parts of sites, that lie adjacent to the route will only be considered in terms of remediation where the new section of motorway would detrimentally change the current level of risk posed to relevant pollutant linkages (RPLs).

1.2.3 The land contamination assessments have been based on the available site-specific information and, due to the nature of some risks identified, further investigation may be undertaken to support the remedial design. Therefore this document and the elements which comprise it are outline and will be refined as the Scheme design progresses and as further information is obtained to inform the risk-based decision making process.

1.2.4 This Outline Remediation Strategy Report includes the below elements.

- Setting of Remediation Objectives.
- A Remedial Options Appraisal.

- A Remediation Implementation Plan - including adoption of a Materials Management Plan.
- A Remediation Verification Plan with remediation criteria.

1.2.5 The Remediation Implementation Plan will also identify procedures to be followed to inform risk-based decision making when previously unidentified or unexpected contamination is encountered. This could take the form of a 'discovery strategy'.

1.2.6 The detailed remediation strategy will address potential land contamination relevant to the development and operation of the proposed new section of motorway.

1.3 Technical Basis for Strategy

1.3.1 Guidance on the management of land contamination is set out in the Model Procedures for the Management of Land Contamination - CLR 11 (Defra/Environment Agency, 2004). The Environment Agency has more recently developed concise guidance in three documents:

- GPLC1 – Guiding principles for land contamination (Environment Agency, 2010a);
- GPLC2 – FAQs, technical information, detailed advice and references(Environment Agency, 2010b); and
- GPLC3 – Reporting checklists (Environment Agency, 2010c).

1.3.2 The 'Guiding Principles' use the same terms and structure as the 'Model Procedures' of CLR11 which forms a detailed basis for further guidance published by the Welsh Local Government Agency, Development of Land Affected by Contamination: A Guide for Developers (WLGA and Environment Agency Wales, 2012). The three key stages in the Model Procedures are set out in Table 1.1.

Table 1.1: Stages of Contaminated Land Model Procedures

STAGE	Main action
Risk assessment	Defines whether the contamination is a problem, or will it become one
Options appraisal	Decides what to do and how to do it
Implementation of remediation	Manages the contamination and proves it has been dealt with

1.3.3 This document represents the result of the second stage of evaluating the possible remediation options to identify a preferred option or combination of options. GPLC3 sets out the expectations of Natural Resources Wales (NRW) for the information that is to be addressed in this Outline Remediation Strategy.

1.3.4 To arrive at the preferred option, specific guidance on different methods of remediation will be referred to from CL:AIRE (2011) the 'Definition of Waste: Development Industry Code of Practice'. In addition, the assessment of remediation with respect to sustainability will refer to the SuRF-UK Framework (2010).

1.3.5 The general principles of the remediation strategy have been discussed with land contamination technical representatives from Natural Resources Wales, Newport

City Council and Monmouthshire County Council. A Land Contamination Management Strategy (Appendix 11.3 of the March 2016 ES) has been developed and agreed that describes both the general approach to the characterisation of land contamination risks as well as the design, implementation and verification of remedial works.

1.4 Structure of Report

1.4.1 The remainder of this report includes the following sections.

Section 2: Overview of Environmental Risk Setting.

Section 3: Remediation Options Appraisal.

Section 4: Evaluation of Remediation Options.

Section 5: Preferred Approach & Outline Remediation Strategy.

Section 6: Outline Remediation Implementation Plan.

Section 7: Outline Remediation Verification Plan.

2 Overview of Environmental Risk Setting

2.1 Site Location

2.1.1 The existing M4 motorway connects London and South Wales, crossing the River Severn and using the Brynglas Tunnels to the north of Newport. The Scheme would include a new, approximately 23 km, three-lane motorway to the south of Newport between Junctions 29 (Castleton) and 23A (Magor).

2.1.2 From Junction 29 at Castleton, the new section of motorway would pass to the south and east of Newport and Duffryn, crossing the north eastern part of the Wentlooge Levels and the South Wales to London Mainline railway. The alignment would cross the River Usk to the south of Newport, crossing Newport Docks as an elevated section before continuing in an easterly direction towards Magor. To the east of the River Usk, the route passes to the south of the main Tata Llanwern steelworks, passing through the northern parts of the Caldicot Levels. The route would cross the South Wales to London Mainline on the approach to Magor, re-joining the existing M4 at Junction 23A.

2.1.3 The location of the existing M4 and the proposed new section of motorway are shown on Figure R2.4 (General Arrangement Drawings).

2.2 Environmental Sensitivity

2.2.1 An outline of the environmental sensitivity is presented below, based on information presented within the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES and Appendix R11.1 of the ES Supplement). Reference should be made to this document for full details regarding the environmental setting.

Geology

2.2.2 The regional geological sequence that characterises the geology encountered along the new section of motorway is summarised in Table 2.1.

Table 2.1: Geological Sequence

Geological Period	Unit	Description
Quaternary	Fluvial Alluvium	Occurs along the course of all major rivers and streams and lithology is variable.
	Tidal Flat Deposits	Occurs at the ground surface throughout Gwent Levels. Predominantly a soft silty clay, often laminated with thin silty partings. A sand and gravel unit is present beneath the estuarine alluvium within the Gwent Levels, and appears most prevalent and laterally extensive to the west of the River Usk.
	River Terrace Deposits	Localised presence of gravels or gravelly sands.
	Head Deposits	Isolated exposures of typically silty, sandy clay with rare gravels.
	Glacial Till	Between the Rhymney and Ebbw Valleys. Variable from a stiff, gravelly, silty clay to unconsolidated and unsorted gravels.
Triassic	Mercia Mudstone Group (MMG)	Outcrops at the surface towards the east and underlies much of the Gwent Levels. Typically comprises red and less commonly green and grey dolomitic mudstones and siltstones.
	Marginal Facies of MMG	Predicted to outcrop towards the east of the Scheme. Typically consists of conglomerate and/or breccia with clasts derived from local rocks most notably Carboniferous limestones.
Carboniferous	Avon Group Blackrock Limestone subgroups (Carboniferous Limestone Series)	Carboniferous Limestone Series is expected to outcrop between Magor and Caldicot. Typically thin to thick-bedded, dark grey to black, fine- to coarse-grained limestone with subordinate thin beds of shaley argillaceous limestone and mudstone.
Devonian	Tintern Sandstone	Tintern Sandstone is confined to a narrow area in the east. Typically a moderately weak to moderately strong, poorly cemented greyish to reddish fine to coarse sandstone with occasional silty mudstone bands.
	St Maughan's Group	Expected to underlie the Scheme in the west. Silty mudstones predominate although coarse beds are frequent.

2.2.3 The geology along the route of the proposed section of motorway can therefore be broadly divided into three zones.

- Devonian hills in the west.
- Alluvial low lying areas in the centre (Gwent Levels) that are typically underlain by Triassic bedrock.
- Carboniferous hills in the east.

Hydrology and Hydrogeology

2.2.4 The new section of motorway crosses the Gwent Levels, an area of flat, low-lying land bordering the Severn Estuary. The Gwent Levels include the Wentlooge Levels, between Castleton and the River Usk, and the Caldicot Levels, between the River Usk and Magor.

2.2.5 The new section of motorway also crosses low undulating hills around Castleton and Magor. There are a number of small streams in the hills around Castleton and Magor. The main watercourses in these areas are Nant-y-Moor Brook near Coedkernew and St Brides Brook at Magor. A number of small brooks and drains flow from issues and ponds along these hills.

2.2.6 Land across the Gwent Levels has been reclaimed from the sea by the erection of coastal sea defences and the construction of a complex network of drainage channels. Ground elevation varies across the Levels from approximately 7.0 m above ordnance datum (AOD) at the coastal sea defences to around 6.0 m AOD on the lower lying 'Levels'.

2.2.7 The Levels drainage system takes the form of a three tier network of channels comprising straightened rivers, streams or reens, and field ditches. The reen system exhibits a particularly complex flow pattern. The drainage system conveys water into the Severn Estuary via a number of sluices through the sea defence wall. Water levels within the reen system are principally managed by Natural Resources Wales (since the Caldicot and Wentlooge Levels Internal Drainage Board functions, staff and assets were transferred to them in April 2015) on the basis of seasonal penning levels. Typically, water levels are raised from winter penning to summer penning throughout March and then lowered to winter levels during October.

2.2.8 The proposed new section of motorway would pass through industrial areas situated to the south of Newport where it would cross three principal water bodies. These are the River Usk, the River Ebbw and the Newport (Alexandra) Docks, with the latter being hydraulically connected to the River Usk.

2.2.9 The Devonian and Triassic bedrock is typically considered to be Secondary A aquifer. The Carboniferous bedrock constitutes a Principal Aquifer unit. A variety of unconsolidated superficial deposits, with variable aquifer designation, cap the bedrock along the route in higher areas in the east and west. Within the central area, estuarine alluvial deposits are classified as a non-aquifer, but localised river terrace deposits and sand and gravels that commonly underlie the estuarine alluvium are also considered to be Secondary aquifer.

2.3 Previous Investigation and Assessment

2.3.1 The proposed route has been subject to a series of investigations, which have identified sites with potential land contamination. The assessments of the route in relation to the presence of potential land contamination are presented in the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES and Appendix R11.1 of the ES Supplement).

2.4 Sites Affected by Land Contamination

2.4.1 The studies undertaken to date indicate that the proposed new section of motorway would be affected by a relatively small number of discrete/local areas of land potentially affected by contamination with the exception of the following areas.

- Newport Docks, including numerous historical and present industrial operations.
- Docks Way Landfill.
- Solutia Chemical Works.
- Llanwern Steel Works.

2.4.2 A brief description of these major sites is provided below and full details are provided in Annex D of the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES and Appendix R11.1 of the ES Supplement).

Newport Docks (CL-13)

2.4.3 The site was developed into dockland in the mid-1800s. It contains a variety of industrial/commercial uses, including timber yards, saw mill, coal sidings, spoil heaps, engine works, railway sidings, sanitary hospital, pumping station, refuse tip, slag heap and scrap yard. It also includes the infilled historical River Ebbw channel located in the southern part of the docks area and industrial estates on the east side of the River Usk.

Docks Way Landfill

2.4.4 This is an active municipal landfill impinging the new section of motorway alignment. The landfill site is divided into Area 1 (an unlined dilute and disperse landfill, which is now fully restored together with an area of known uncontrolled waste disposal) and Area 2 (an active engineered containment landfill).

2.4.5 Waste accepted into Area 1 included inert, household, commercial and industrial waste as well as bonded asbestos containing material and special waste. Waste accepted into Area 2 comprises principally domestic and commercial waste.

2.4.6 Previous ground investigations have identified that waste materials have been deposited beyond the Area 1 licenced boundary and may be present along the proposed Docks Way link road.

2.4.7 The route of the new section of motorway crosses the southern tip of the permitted (licenced) Area 2 landfill. In this area, the motorway is to be constructed on a piled earth embankment as it approaches the River Ebbw which it would then cross via a viaduct and piers. In this case the proposed new section

of motorway has been designed such that although the route passes through the licenced area, construction would not intrude into the landfill itself and its associated engineered liner and capping containment measures.

Solutia Chemical Works

2.4.8 The site comprises an active chemical plant with a number of waste disposal areas including an engineered cell containing buried chemical (mainly polychlorinated biphenyls (PCBs)) waste known as the PCB cell and a historical inert and industrial waste landfill. Elevated concentrations of PCBs and other contaminants have also been identified in shallow soils elsewhere at the site.

2.4.9 The route spans the PCB cell on an elevated section. The new section of motorway would cross the remainder of the Solutia Site on a viaduct (piled peirs) and earth piled embankment.

Llanwern Steelworks

2.4.10 The Llanwern Steelworks were built in the early 1960s. Slag heaps and settlement lagoons associated with the steelworks have been constructed to the south of the steelworks. This area comprises reedbeds, sludge lagoons and plant. It is understood that a number of sludge lagoons were filled with washing from the Basic Oxygen Steel-making processes and blast furnaces.

2.4.11 Waste within the lagoons has been identified as containing elevated levels of metals, hydrocarbons, cyanides, polychlorinated biphenyls and has a high pH. The area of reedbeds located to the west of the lagoons site has been used for treatment of industrial water containing elevated levels of metals, hydrocarbons and cyanides.

2.4.12 The lagoons are operated by Tata Steel whom holds three environmental permits for the management of wastes in this area.

2.4.13 The route partially transects both the reedbeds and containment lagoons on earth embankments.

Other Sites Affected by Land Contamination

2.4.14 In addition to the four areas discussed in the previous section, other areas of known and potential land affected by contamination have been identified. The sites are shown on Figure 1a to d and further details are provided for each area affected by the new section of motorway in Annex D in the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES and Appendix R11.1 of the ES Supplement).

2.5 Summary of Relevant Pollutant Linkages (RPLs)

2.5.1 For the purposes of CLR11 a relevant pollutant linkage is one that has been identified through risk assessment as presenting a potentially unacceptable risk to human health and/or the environment.

2.5.2 The findings of the risk assessments relating to potential land contamination for each area of known or potential land contamination site are summarised in Table 2.2. Within the table the risk level associated with the RPLs following Tier 1 and Tier 2 screening risk assessment is provided, which is taken from the Land

Contamination Assessment Report. The risks shown in **bold** within Table 2.2 indicate those that are considered to require control measures or remedial action in order to manage the potential contaminant linkages.

Table 2.2: Risk Assessment Summary

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
Risk during construction requiring mitigation																										
Ingestion / dermal contact / inhalation of contaminated dusts and soils by C.workers	n/a	V L	L	n/a	L	V L	L	V L	V L	**M**	**M to L**	**M to L**	**H**	L	L **(M)**	**M**	**M**	**M**	L	V L	**M**	L	**M to L**	V L	**M**	L
Inhalation of asbestos fibres by construction workers	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**H**	n/a	n/a	**H**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ingestion / dermal contact / inhalation of contaminated dusts and soils by off site public	n/a	V L	V L	n/a	V L	L	n/a	n/a	V L	n/a	V L	V L	**H**	V L	V L **(M to L)**	V L	V L	L	V L	V L	L	L	**M to L**	V L	L	L

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
Inhalation of ground gas / vapours by C. workers from MG material	n/a	V L	L	n/a	n/a	V L	V L	V L	n/a	**H**	**M**	**M to L**	**M**	L	L **(H)**	**H**	L	L	V L	L	**M**	L	**M to L**	V L	**M**	n/a
Inhalation of ground gas / vapours by off site public from MG material	n/a	n/a	V L	n/a	n/a	V L	n/a	n/a	n/a	n/a	V L	V L	L	n/a	V L **(H)**	**M**	V L	L	V L	V L	L	L	**M to L**	V L	L	n/a
Contaminated surface runoff to surface water	n/a	n/a	n/a	n/a	V L	L	V L	L	L	**M**	L	L	**M**	n/a	**M (M)**	**H**	**H**	**M**	n/a	n/a	n/a	n/a	**M to L**	n/a	n/a	V L
Contaminants leaching from MG into surface water	n/a	n/a	n/a	n/a	V L and L	L	V L	L	n/a	n/a	n/a	n/a	L	L	n/a	n/a	**M**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**M to L**
Perched water or aquifer groundwater entering surface water	n/a	n/a	n/a	n/a	n/a	L	V L	L	V L	**M**	V L	V L	L	V L	**M (M)**	**H**	**M**	**M to L**	n/a	n/a	n/a	n/a	**M to L**	n/a	n/a	n/a

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
Contaminants leaching from MG into deep aquifer	n/a	L	V L	n/a	n/a	**M to L**	n/a	n/a	V L	**M**	L	L	**M**	L	**M (M to L)**	L	**M**	**M to L**	V L	L	**M to L**	**M to L**	**M to L**	V L	**M**	L
Contaminants leaching from MG via band drains or piling	n/a	n/a	n/a	n/a	n/a	**M to L**	V L	L	V L	**M**	L	**M**	**M**	n/a	**M (M to L)**	n/a	**M**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for C. workers from peat horizons	n/a	n/a	n/a	n/a	n/a	**H**	n/a	**M**	n/a	**M to L**	**M to L**	**M**	**M**	**M to L**	**M**	**M**	**M**	**M**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for off site public from peat horizons	n/a	n/a	n/a	n/a	n/a	**M to L**	n/a	n/a	n/a	n/a	**M to L**	**M to L**	**M to L**	n/a	**M to L**	**M to L**	**M to L**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Band drain / pile pathway causing GW to contaminate	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L	n/a	n/a	V L	V L	n/a	n/a	**M**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
surface water																										
Contaminated Perched GW ingestion / dermal/ inhalation of HC vapours by C.workers	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dewatering pathway causing GW to contaminate surface water	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**M**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Risk during operation requiring mitigation																										
Ingestion / dermal contact / inhalation of contaminated dusts and	L	V L	n/a	n/a	V L	V L	V L	V L	V L	L	V L	V L	**M**	n/a	V L	V L	V L	V L	n/a	V L	V L	V L	L	V L	n/a	V L

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
soils by MW																										
Inhalation of asbestos fibres by MW	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ingestion / dermal contact / inhalation of contaminated dust and soils by motorway users	V L	V L	n/a	n/a	V L	V L	V L	V L	V L	V L	V L	V L	L	n/a	V L	V L	V L	V L	n/a	V L	n/a	V L	L	V L	n/a	V L
Ingestion / dermal contact / inhalation of contaminated dusts and soils by off site general public	V L	V L	n/a	n/a	V L	n/a	n/a	n/a	V L	V L	V L	V L	L	n/a	V L	V L	V L	V L	n/a	V L	n/a	V L	n/a	V L	n/a	V L
Inhalation of ground gas / vapours by MW by MG	L	V L	n/a	n/a	n/a	V L	V L	V L	n/a	L	V L	V L	L	n/a	V L	V L	V L	V L	n/a	V L	V L	**M to L**	L	n/a	L	n/a

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
material																										
Inhalation of ground gas / vapours by off site workers / public / motorway users by MG material	V L	V L	n/a	n/a	n/a	V L	V L	V L	n/a	V L	V L	V L	V L	n/a	V L	V L	**M to L (M)**	V L	n/a	V L	V L	L	L	V L	L	n/a
Contaminated run-off to surface water	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L	n/a	n/a	n/a	n/a	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Contaminants leaching from MG into surface water	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	V L	L	n/a	n/a	n/a	n/a	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Contaminants leaching from MG into deep aquifer	V L	L	n/a	n/a	n/a	n/a	n/a	L	V L	V L	L	L	**M to L**	L	**M to L**	L	**M**	**M to L**	V L	L	**M**	**M to L**	**M to L**	V L	**M**	**M to L**
Contaminants leaching from MG via band drains or	n/a	n/a	n/a	n/a	n/a	L	V L	n/a	V L	V L	V L	L	**M to L**	L	**M to L**	n/a	**M**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
piling																										
Perched water or aquifer groundwater entering surface water	n/a	n/a	n/a	n/a	n/a	L	V L	L	**M**	**M**	V L	n/a	L	L	**M to L**	L	**M**	n/a	n/a	n/a	n/a	n/a	**M to L**	n/a	n/a	L
Band drain pathway causing GW to contaminate surface water	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**M**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for M. workers from peat horizons	n/a	n/a	n/a	n/a	n/a	**M**	n/a	**M**	n/a	**M to L**	**M to L**	**M to L**	V L	n/a	**M to L**	**M to L**	**M to L**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Inhalation of soil gas / explosion for motorway users from peat horizons	n/a	n/a	n/a	n/a	n/a	**M to L**	n/a	**M to L**	n/a	**M to L**	**M to L**	**M to L**	V L	n/a	**M to L**	**M to L**	**M to L**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Potential contamination source area	Sites Potentially Affected by Contamination (CL)																								
	1	2	3	4	5	6	8	9	10	13	14	15	17	18	22	26 Lagoons	26 Reedbeds	27	29	30	32	33	35	38	39	41
Inhalation of soil gas / explosion for off site public from peat horizons	n/a	n/a	n/a	n/a	n/a	**M to L**	n/a	n/a	n/a	n/a	**M to L**	**M to L**	V L	n/a	**M to L**	**M to L**	**M to L**	**M to L**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Key
C. worker: Construction worker CW: Controlled water MG: Made ground MW: Maintenance worker H: High M: Moderate L: Low VL: Very Low

3 Remediation Options Appraisal

3.1 Introduction

3.1.1 The remediation options appraisal has been undertaken in accordance with the Model Procedures for the Management of Land Contamination - CLR11 (Environment Agency and Defra, 2004). The options appraisal comprises three stages as summarised in Table 3.1 with the key activities as indicated by the Environment Agency in their Guiding Principles document (Environment Agency, 2010a).

3.1.2 The process of options appraisal is similar to other well-established environmental procedures, in which the practicable and suitable solutions are identified through balanced evaluation of a range of management and technical factors and cost. The level of effort expended to resolve the issue, and to record the selection process, should be proportional to the scale of the challenge, the range of options available and the extent to which established good practice can be used to assist in the decision-making process. The following principles are taken into account:

- sustainable development;
- use of the waste hierarchy;
- the precautionary principle; and
- the proximity principle.

Table 3.1: Options Appraisal Stages

Stage	Activities
1. Identify feasible remediation options	(Review and refine CSM) Identify management and technical objectives Define remediation objectives and criteria Identify a short list of feasible options
2. Detailed evaluation of options	Evaluate and analyse options and in combination Decide which of the options is/are most appropriate
3. Develop remediation strategy	Consider zoning and timing of remediation Decide on verification Review costs/benefits Develop practical strategy for remediation

3.1.3 This Outline Remediation Strategy document is proposed to meet the stage 1 activities set out above, with stage 2 and 3 inputs being undertaken as the detailed scheme design is undertaken.

3.2 Remediation Objectives

3.2.1 Fundamental to the options appraisal is the setting of objectives for the Remediation Strategy to achieve. These objectives are split into two sets: firstly, management objectives for the overall route and secondly, RPL-specific risk-based objectives.

Overall Land Contamination Management Objectives

3.2.2 The overall objectives for the management of potential land contamination and remediation for the new section of motorway are as follows.

- Not worsen the existing level of risk posed by relevant pollutant linkages to human health and/or the environment.
- Mitigate potential risks by relevant pollutant linkages based upon the proposed future use of the site.
- Employ early risk-based decision making to ensure remediation is proportionate to the level of risk.
- Manage remediation sustainably according to the waste hierarchy so:
  - minimising the amount of material being excavated and disposed as waste;
  - reusing excavated materials on-site wherever it is beneficial;
  - including *in situ* and *ex situ* on site treatment; and
  - minimising the amount of and use of new materials.
- Use the precautionary principle.
- Minimise risk to remediation (construction) workers during remediation.
- Minimise risks to construction workers and general public from contaminated materials during remediation works and general construction activities.
- Avoid the spread of contamination directly related to the works.
- Take account of stakeholder needs, including regulatory compliance.
- Maintain good records and manage quality and knowledge appropriately.
- Maximise the benefits of the works.
- Minimise long term liabilities.

RPL-Specific Objectives

3.2.3 Specific remediation objectives for RPLs will be set in the Remediation Implementation Plan. Where RPLs present unacceptable site-specific or unique risks the detailed proposals will set objectives to manage contaminant migration from source areas via pathways or receptor exposure.

3.2.4 The factors that will be considered when setting the remediation objectives are presented in Table 3.2.

Table 3.2: Remedial Option Selection Criteria

Factor	Criteria
Effectiveness	Performance with respect to reducing the respective pollutants to levels that are acceptable or breaking pathways. Therefore options that are not suitable for the particular physical and chemical characteristics of the site are not considered any further.
Timescale	Remediation techniques that require a significant period of time to successfully meet the remedial objectives are not considered suitable for this site given the proposed development timetable.
Cost	Only remedial options that fulfil the remedial objectives within an acceptable cost bracket have been considered any further. The appraisal of cost is based on small treatment volumes that are anticipated to be presented, and therefore remedial approaches with significant set up/mobilisation cost are not considered suitable for the site.
Durability	All remedial options must be long lasting and minimise the potential for residual impacts to become apparent as the requirement for further remedial works post-development of the site is unacceptable.
Commercial Availability	There are many remediation technologies that have been used within the UK, however only a limited number of these are commercially available in the UK.
Track Record	Only remedial options with a proven track record in the UK have been selected. Options with no or poor UK track records may impact on other factors in this table such as effectiveness, timescale and cost.
Sustainability	Some remedial options have not been selected because of the likely environmental impacts. Examples include energy and material requirements.
Compatibility	Where the risk assessment identifies a number of pollutant linkages that may require different remediation techniques to successfully meet the remedial objectives, all remedial options must be compatible with each other as well as the proposed development scheme.
Permissions	Some remedial options will require forms of waste management licences & potentially other forms of licensing such as discharge consents etc. The form of licence may influence the selection of the remediation technique because of the likely timescales required for applications and the cost of application.
Site Constraints	The site conditions may limit the likely effectiveness of a given remedial technique due to issues such as access, available space and ground conditions.

3.3 Remediation Criteria

3.3.1 Site-specific remediation criteria will be developed for the Remediation Implementation Plan. These criteria provide a measure against which compliance with the remediation objectives can be measured. These may include the following measures.

- Clean-up standards (e.g. materials re-use criteria, or water EQSs).
- Site-specific assessment criteria developed from detailed quantitative risk assessment (e.g. materials containing contaminant levels below a threshold value will have no detrimental impact if they remain *in situ*).

- Engineering-based criteria such as thickness of cover soils, construction details, limitations on use.

3.3.2 Criteria will be developed for materials that can remain *in situ* untreated and for excavated materials looking to be reused. These criteria and a justification for the derived criteria will be prepared and agreed with NCC, MCC and NRW.

3.4 Feasible Options

Zonation

3.4.1 Land contamination management would be divided into two zones across the length of new section of motorway–a west and an east zone separated by the River Usk. This need is driven by the schedule for the construction of the River Usk Crossing which, until it is built, would limit the flow of construction traffic along the entire length of the new section of motorway.

3.4.2 The proximity principle would support this West and East division so that materials can be managed in reasonable proximity to their point of generation. This principle works to minimise the environmental impact and logistics of material transport.

Risk-based Material Management

3.4.3 The proposed new section of motorway would require major excavation and infilling activities to establish the required route alignment. The risks posed by potential land contamination would need to be managed to ensure the minimum of impact for these earthworks.

3.4.4 The risks relate to materials that are both proposed to be left *in situ* (sitting beneath embankment sections) and those that would be excavated (sitting in sections of cutting).

3.4.5 The decision-making process to manage this is outlined in the flow charts for potentially contaminated materials management (Annex A).

Excavated Materials

3.4.6 Where material is to be excavated it should be undertaken in accordance with good construction practices. This would minimise short term impacts on human health and the environment. Prior characterisation would establish whether the material is 'acceptable' for direct reuse or will require treatment to enable its reuse. In some cases, additional sampling and testing may be required if no suitable previous ground investigation data is available.

3.4.7 The suitable for reuse criteria would be agreed with NCC, MCC and NRW, to allow materials to be reused throughout the length of each zone (West or East), to minimise the risk of cross-contamination and reworking. A justification would be included in the final Remediation Strategy for the derivation of the suitable for reuse criteria.

3.4.8 As the remediation is to be undertaken as part of a highways scheme, materials that do not meet the reuse use criteria would be classified as 'unacceptable' as defined by the Specification for Highways Works (SHW) (Table 3.3).

Table 3.3: Classification of 'Unacceptable' Soils by SHW

Classification	Description
Unacceptable material class U1B	Contaminated materials that comply with Clause 601.2; including controlled wastes (defined in EPA 1990 Part IIA) whose level of contamination is above that given in either Appendix 6/14 or in Appendix 6/15 of the Earthworks Specification, but excluding all hazardous wastes (as defined in Hazardous Waste (England & Wales) Regulations 2005 and Radioactive Wastes (as defined in the Radioactive Substances act 1993).
Unacceptable material class U2	Hazardous wastes (as defined in Hazardous Waste (England & Wales) Regulations 2005 and Radioactive Wastes (as defined in the Radioactive Substances act 1993).

3.4.9 Where 'unacceptable' materials in class U1B or U2 are identified these would be risk assessed against suitable for reuse criteria and, if necessary subjected to treatment by *ex situ* physical, chemical or biological methods to render the material 'acceptable' again for reuse. Offsite disposal would be a solution of last resort.

3.4.10 The feasible options for *ex situ* treatment of soils are identified in Table 3.4.

Table 3.4: Feasible *Ex Situ* Materials Options Classified by Process (CL:AIRE, 2010)

Remediation technologies applied to excavated soil or treatment at surface of contaminated water or gaseous emissions			
Biological	**Physical**	**Chemical**	**Thermal**
Biological treatment	Soil washing and separation processes		Thermal treatment
	Stabilisation/solidification		
	Venting		
		Chemical oxidation and reduction	
	Vitrification		
Water and gas/vapour treatment			
Civil engineering-based methods : barriers of caps, liners and walls to break pathways			

3.4.11 The selection of the appropriate treatment process(es) relies on characterisation of the materials. This assessment has been undertaken within the Land Contamination Assessment Report and will be supplemented as required during detailed design.

In Situ Materials

3.4.12 Where a contaminated material is identified to remain *in situ* then it would be managed according to good practice. *In situ* materials would be incorporated into the design in one of two ways:

- built over; or
- remain within or adjacent to the footprint.

3.4.13 Risk-assessment would inform the decision as to whether *in situ* contaminated materials are 'acceptable' to remain without the need for remediation.

3.4.14 *In situ* materials that require further management would be subject to treatment by physical, chemical or biological methods. In addition, engineering solutions can be used to provide barriers to break relevant pollutant pathways. The feasible options are identified in Table 3.5.

Table 3.5: Feasible *In situ* Materials Treatment Options Classified by Process (CL:AIRE, 2010)

Remediation technologies taking place in the subsurface			
Biological	**Physical**	**Chemical**	**Thermal**
Permeable reactive barriers			Thermal treatment
Flushing, pump and treat			
Enhanced bioremediation		Chemical oxidation and reduction	
Phytoremediation	Electro-remediation		
Monitored natural attenuation	Stabilisation/solidification		
Sparging			
Venting			
	Vitrification		
Civil engineering-based methods : barriers of caps, liners and walls to break pathways and good practice pile construction with caps and seals			

3.4.15 The selection of the appropriate treatment process(es) relies on characterisation of the materials. This assessment has been undertaken within the Land Contamination Assessment Report and will be supplemented as required during detailed design.

Surface and Groundwater

3.4.16 Remediation of surface and groundwater is not anticipated to be required. Water encountered during construction would be managed in accordance with good practice in order to avoid environmental impact. All construction related water would be managed and assessed in order to avoid any contaminated water being discharged either to ground or surface water and this will be managed through the adoption of a Surface Water and Groundwater Management Plan.

3.4.17 Potential impact to both surface and groundwater for the permanent works would be managed by appropriate assessment and remediation of potential land contamination.

Justification for Combining Feasible Remediation Options

Ex situ Materials

3.4.18 Some of the potential areas of land contamination contain relatively small volumes of material that are to be wholly or partially excavated for construction due to the design of the new section of motorway rather than for remediation purposes (e.g. excavation for cut). The materials excavated would be managed according to the Materials Management Plan that defines requirements for demonstrating appropriate management and reuse. This would address requirements relating to both Made Ground being assessed for beneficial use

and potential wastes (i.e. silt materials excavated at Llanwern) being assessed to demonstrate full recovery as part of the intended reuse.

In situ Materials

3.4.19 Materials that are to remain *in situ* would be assessed on a site by site basis along the length of the new section of motorway. This would be based upon the risks identified per area of land potentially affected by contamination as set out in the Land Contamination Assessment Report (Appendix 11.1 of the March 2016 ES and Appendix R11.1 of the ES Supplement). Detailed risk assessment could establish the validity of materials remaining in place or options considered for excavation, treatment and reuse.

4 Evaluation of Remediation Options

4.1 Options Appraisal

4.1.1 Table 4.1 and 4.2 provide an assessment of the available treatment methodologies identifying the likely strengths and weaknesses.

Table 4.1: Excavate and *Ex Situ* Remedial Options Appraisal

Source Treatment		
Source	**Treatment Options**	**Suitability**
Elevated soil contaminants	*Ex situ* soil washing and separation processes	Effectiveness: Reduce contaminants to acceptable level. Timescales: Very quick. Cost: Cost effective for large volumes anticipated at the site where avoiding disposal. Durability: Permanent. Commercial Availability: Widely available, standard minerals processing equipment. Track record: Proven track record. Environmental Impact: Produces greenhouse gases as part of process. May create dust nuisance. Additives may be used to assist separation. Separation will produce a contaminated residue requiring further management. Water treatment may be required. Compatibility: Addresses wide range of organic and inorganic contaminants. If fine content of material is >40% then effectiveness drops. Depletion of fine fractions may change engineering properties of soil. Permissions: Mobile treatment plant will be required Site Constraints: Set up on-site or off-site. Potentially plant mobile across site.
Elevated soil contaminants	*Ex situ* biological treatment (biopiles, bioventing etc).	Effectiveness: Reduce contaminants to acceptable level. Effectiveness may be limited by other contaminants and/or ground conditions (clay rich materials). Timescales: Medium to long timescales (months). Heavy end nature of Total Petroleum Hydrocarbons (TPH) is likely to lead to extended periods of treatment. Can be more effective in warmer months. Cost: Cost effective for large volumes. Durability: Permanent. Commercial Availability: Widely available. Track record: Proven track record. Environmental Impact: Produces greenhouse gases as part of process. May create ongoing odour and dust nuisance. Control of drainage required. Potential large areas for treatment required. Compatibility: Will not treat heavy metal contamination and will have limited effectiveness on Polycyclic Aromatic Hydrocarbons (PAHs). Permissions: Mobile Treatment Licence may be required for certain techniques. Site Constraints: Limited hardstanding to undertake works where *ex situ* treatment is proposed.

Source Treatment		
Source	**Treatment Options**	**Suitability**
Elevated soil contaminants	*Ex situ* thermal treatment	Effectiveness: Potential for high contaminant removal. Timescales: Two stage process (low temperature thermal desorption followed by secondary treatment or in a single stage of incineration. Cost: Expensive for large volumes of material. Durability: Permanent. Commercial Availability: Available. Track record: Proven track record. Environmental Impact: Large energy requirement. Produces greenhouse gases and air emissions requiring abatement. Compatibility: Addresses wide range of organic contaminants and some inorganic contaminants. Pre-treatment stage of screening may be required. After treatment soils are cooled and re-moistened to control dust. Loss of organic matter content restricts post treatment use. Permissions: Treatment equipment will require permitting. Site Constraints: More likely that soil is treated off-site with associated transport costs.
Elevated soil contaminants	Stabilisation and solidification	Effectiveness: A physical/chemical method involving a reaction between a binder and soil to reduce contaminant mobility not removal. Reagent delivery and effective mixing can be difficult to achieve. Timescales: Quick. Cost: Cost effective for large volumes where reuse is anticipated at the site. Durability: Established via testing and requires long term monitoring. Commercial Availability: Available. Track record: Proven track record. Environmental Impact: Impact of additive needs to be assessed, e.g. high alkaline stabilizer may affect water quality Compatibility: Will result in increased volume. Addresses wide range of inorganic contaminants and some organic contaminants. Permissions: Treated material for reuse subject to regulatory approval and mobile plant licence required. Site Constraints: Set up on-site or off-site. Possible constraints for stockpiling of treated soils prior to use.

Source Treatment		
Source	**Treatment Options**	**Suitability**
Elevated soil contaminants	Vitrification	Effectiveness: Produces high temperatures to destroy organic contaminants or immobilise inorganic contaminants within glass-like material. Timescales: Quick. Cost: Expensive. Not cost effective for large volumes anticipated at the site. Durability: Permanent. Commercial Availability: Available. Track record: Proven track record. Environmental Impact: Energy intensive. Gaseous emissions require abatement. Compatibility: Soil structure destroyed and therefore difficult to reuse. Addresses wide range of inorganic contaminants and some organic contaminants. Material with a high water content problematic. Permissions: Treatment process likely to require permitting. Site Constraints: Set up on-site or off-site. Potentially plant mobile across site.
Elevated soil contaminants	Chemical oxidation and reduction	Effectiveness: Involves addition of chemicals to excavated soil to oxidise or reduce the contaminants thereby degrading them, reducing their toxicity, changing their solubility or changing their susceptibility to other forms of treatment. Timescales: Very quick. Cost: Not cost effective for large volumes anticipated at the site. Durability: Difficult to predict long term behaviour. May require long term monitoring. Commercial Availability: Available Track record: Proven track record. Environmental Impact: May require large volumes of reagent. Compatibility: Can treat a wide range of contaminants. May affect soil properties and subsequent reuse. Potential for post treatment mobilisation of reagent or secondary products. Possibly toxic intermediate reaction products. Permissions: May be required. Site Constraints: Set up on-site or off-site.
Elevated soil contaminants	Venting	Effectiveness: Air moved through stockpiles to remove contaminants. Timescales: Medium scale (months). Cost: Cost effective for large volumes anticipated at the site. Durability: Permanent. Commercial Availability: Available. Track record: Proven track record. Environmental Impact: Transfers contaminant to airborne emissions which require management. Compatibility: Suited to more volatile contaminants. Permissions: May be required. Site Constraints: Set up on-site or off-site.

Source Treatment		
Source	**Treatment Options**	**Suitability**
Ex situ remediation techniques produce contaminated water and gaseous streams which require secondary treatment.	Water and gas/vapour treatment	Effectiveness: Potential for high contaminant removal. Timescales: Should not delay primary treatment process. Cost: Additional to primary treatment process. Durability: Permanent. Commercial Availability: Including air stripping, carbon adsorption, filtration, ion exchange, reverse osmosis, chemical treatment are widely available. Track record: Proven track record. Environmental Impact: Depending on technique, may require energy input, may produce secondary wastes. Compatibility: Addresses secondary contaminant emissions. Permissions: May be required. Site Constraints: Set up on-site or off-site.
Pathway Treatment		
Pathway	**Treatment Options**	**Suitability**
Humans/controlled water/ ecosystem – Ingestion/dermal contact/exposure to reused elevated soil contaminants and vapours	Covering with topsoil/subsoil (cover system)	Effectiveness: Removes potential contamination pathway to receptors. Timescales: Very quick. Cost: Cost effective for volumes anticipated at the site if low permeability on-site materials are available. Durability: Long term option, but may require maintenance. Commercial Availability: Widely available. Track record: Proven track record. Environmental Impact: Controlled waters risk assessment required to assess risk to environment. No impact to human health once sufficient cover is in place. Materials designated as waste are not addressed enabling permit surrender. Compatibility: Addresses all contaminant sources at site so no compatibility issues. Permissions: Depending on volume and contaminant concentrations could be classified as 'waste' and require permit. Site Constraints: No major issues.
Humans/controlled water/ ecosystem – Ingestion/dermal contact/exposure to reused elevated soil contaminants and vapours	Capping with hardstanding of roadway	Effectiveness: Removes potential contamination pathway to receptors. Timescales: Very quick. Cost: Cost effective for volumes anticipated at the site if low permeability on-site materials are available. Durability: Long term option, but may require maintenance. Commercial Availability: Widely available. Track record: Proven track record. Environmental Impact: Controlled waters risk assessment required to assess risk to environment. No impact to human health once sufficient cover is in place. Materials designated as waste are not addressed enabling permit surrender. Compatibility: Addresses all contaminant sources at site so no compatibility issues. Permissions: Depending on volume and contaminant concentrations could be classified as 'waste' and require permit. Site Constraints: No major issues.

Table 4.2: *In situ* Remedial Options Appraisal

Source Treatment		
Source	**Treatment Options**	**Suitability**
Elevated soil and groundwater contaminants	Monitored Natural Attenuation (MNA)	Effectiveness: Reduce contaminants to acceptable level by confirming that natural processes are reducing contaminant concentrations within a specified timescale. Timescales: Slow (years) Cost: Requires extensive site investigation and assessment. Cost effective, but monitoring should be regularly reviewed to manage this long term liability. Contingency required if a change in conditions occurs, or contaminants do not behave as predicted. Durability: Permanent. Commercial Availability: Widely available Track record: Proven track record. Environmental Impact: Very little impact, other than continued resources for monitoring. Compatibility: Addresses wide range of organic and inorganic contaminants. Materials designated as waste are not addressed enabling permit surrender. Permissions: None required, but regulatory oversight maintained. Site Constraints: Land ownership for monitoring points if sentinel locations off-site.
Elevated soil and groundwater contaminants	Enhanced bioremediation	Effectiveness: Reduce contaminants to acceptable level. Effectiveness may be limited by other contaminants and or ground conditions (clay rich materials). Timescales: Medium timescales (months to years). Cost: Lower monitoring costs in comparison with MNA due to accelerated remediation. Durability: Permanent. Commercial Availability: Widely available. Track record: Proven track record. Environmental Impact: Minimal site disturbance. Additives introduced to groundwater. Materials designated as waste are not addressed enabling permit surrender. Compatibility: Will not treat heavy metal contamination and will have limited effectiveness on Polycyclic Aromatic Hydrocarbons (PAHs). Permissions: Permit will be required if groundwater pumping and treatment included. Site Constraints: Land ownership for monitoring points if sentinel locations off-site.
Elevated soil contaminants	Thermal treatment	Effectiveness: Potential for high organic contaminant removal. Ground heated to enhance the mobility of contaminants. Timescales: medium (Months to years) Cost: Expensive for large volumes of material. Four different methods – injection of steam or hot air; electrical resistance heating; electromagnetic heating; thermal conductive heating. Different methods have differing ranges of applicability with consequences for treatment efficiencies and costs. Durability: Permanent.

Source Treatment		
		Commercial Availability: Available. Track record: Proven track record. Environmental Impact: Large energy requirement. All heating methods require a recovery operation such as venting or pumping followed by treatment. Produces greenhouse gases and air emissions requiring abatement. Minimal site disturbance. Potential to damage soil structure, fauna and flora and impacts on groundwater quality from enhanced mobility of contaminants. Compatibility: Limited to enhancement of VOC/SVOC recovery. Applicable to a wide range of soil types. Buried structures and utilities may cause operating problems. Permissions: Treatment equipment will require permitting for secondary venting and pumping. Site Constraints: Likely to be applicable in a limited set of conditions.

5 Proposed Approach & Outline Remediation Strategy

5.1 Requirement for preparatory works

5.1.1 The preferred approach to remediation is underpinned by risk-based assessments and the setting of materials acceptability criteria. The acceptability criteria for reuse will be set out in the remediation implementation plan and will also form part of the Specification for Highways Works (SHW) (Earthworks). This will include materials acceptability criteria for physical properties (SHW Table 6/1 Appendix 6/1 criteria (Department for Transport, 2009)), for the water environment (SHW Appendix 6/14 criteria), and for human health (SHW Appendix 6/15 criteria). The final Remediation Strategy Report will include suitable to reuse criteria that will be used in SHW Appendix 6/14 and 6/15.

5.2 Summary of Remediation for the New Section of Motorway

5.2.1 Based upon the remedial options appraisal set out in Table 4.1, the overall remediation strategy that has been selected can be summarised as follows

- Avoidance – where feasible land potentially affected by contamination will be avoided. Examples of this include avoidance of the PCB cell at Solutia and the engineered cell of Docks Way landfill.
- A risk-based approach, underpinned by detailed site characterisation and quantitative assessment will be utilised. This will be used to assess the acceptability of material for the scheme for either reuse or retention *in situ*. Compliance end-points will be agreed with regulators where necessary.
- The classification of *ex situ* contaminated material will be integrated within the Earthworks specification as set out in Annex A.
- *Ex situ* material that is initially classified as unacceptable will be treated to meet the acceptability criteria agreed with NCC, MCC and NRW and verified for reuse within the Scheme, either directly or beneath cover.
- *Ex situ* material that is initially classified as waste will be processed and / or treated to demonstrate that once incorporated into the permeant works it has been fully recovered. The main example for this is the Llanwern lagoon silts that as a result of treatment and appropriate engineering placement will substitute for imported engineering fill.
- Materials that are to remain *in situ* with concentrations of contaminants that do not comply with the acceptability criteria could be treated by *in situ* methods to establish acceptability.
- Monitored Natural Attenuation is the preferred *in situ* approach, particularly for low and medium risk locations, or where risks may change due to the construction. It is the most sustainable approach with minimal intervention. This would be underpinned by post construction verification monitoring.
- Completed remediation works will be subject to a programme of verification, and be available for regulatory scrutiny.

- End of waste / recovery will be subject to a programme of verification, and be available for regulatory scrutiny.
- Management arrangements will be agreed to meet residual compliance obligations.

5.2.2 A Plan of an Outline Remediation Strategy is provided in Figure 3.

5.2.3 Detailed remediation requirements for the Tata Lagoons site (CL-26), Solutia site (CL-17) and Docks Way Link Road would be prepared in conjunction with detailed design. These site specific measures will form annexes of the detailed remediation strategy. The final Remediation Strategy Report will address all of the risks in bold shown in Table 2.2.

5.3 Timescales

5.3.1 The Remediation Strategy would be implemented as part of the construction schedule. Materials to be excavated would be managed and remediated as the Scheme is progressed.

5.3.2 The process for management of potential land contamination and resultant controls for remediation will be addressed within the earthworks strategy and Materials Management Plan, which will form part of the Construction Environmental Management Plan (CEMP).

5.3.3 A post construction verification programme would be implemented in order to demonstrate successful delivery of the works.

5.4 Environmental Permit Requirements

5.4.1 The preferred remediation would be subject to regulatory oversight and requirements for mobile plant licences, particularly for the anticipated soils treatment at Tata Lagoons (CL-26).

5.4.2 Remediation is proposed within areas that are presently permitted, including Llanwern Steelworks, Solutia, Docks Way Landfill and A1 Skips as shown in Figure 2a to d. There would be a requirement for permit variation and partial surrender. These sites particularly would be assessed to ensure that materials potentially identified as waste are appropriately characterised and managed to ensure that where they remain within the permanent works they have been fully recovered.

5.4.3 In establishing recovery it is anticipated guidance will be taken from the following key guidance.

- Environment Agency, Regulatory Guidance Note, RGN09: Surrender, Version 3, May 2013.
- Environment Agency, Regulatory Guidance Note, RGN13: Defining Waste Recovery: Permanent Deposit of Waste on Land, Version 1, March 2010.
- CL:AIRE, Definition of Waste. Development Industry Code of Practice, Version 2, March 2011.
- Environment Agency, Aggregate from waste steel slag: quality protocol, May 2016.

5.5 Overview of Specific Areas Requiring Remediation

Overview of Tata Lagoon and Reedbed Remediation Strategy

5.5.1 To be provided in the final Remediation Strategy Report.

5.5.2 The general approach to remediation and contamination management would include the following.

- Band drains will not be installed through significantly contaminated materials.
- Excavation and reinstatement of the lagoons and associated drainage to the north of the alignment. The coarse slag will be reused to form lagoon bunds and the silt will be placed within the reconstructed lagoon.
- Surplus coarse slag and silt will be reused within the motorway embankment as general embankment fill subject to meeting the reuse criteria (to be agreed with NCC, MCC and NRW). Lagoon materials may require treatment prior to reuse and demonstration of full recovery to achieve end of waste.
- Controls to mitigate risks from ground gas within lagoon materials.

Overview of Solutia Remediation Strategy

5.5.3 To be provided in the final Remediation Strategy Report. The general approach to remediation and contamination management would include the following.

- The PCB cell would not be disturbed.
- Clean materials (e.g. construction materials) would be placed over contaminated soils (including asbestos fibres) to protect construction workers and prevent cross contamination.
- Gas protection/venting measures would be installed to mitigate risk of gases migrating into nearby buildings as a result of the construction.

Overview of Docks Way Landfill Remediation Strategy

5.5.4 To be provided in the final Remediation Strategy Report. The general approach to remediation and contamination management would include the following.

- The engineered landfill will be avoided.
- Gas protection/venting measures will be installed to mitigate risk of gases migrating into nearby buildings as a result of the construction.
- Design would be developed to minimise the requirements for excavation.
- Design would be developed to minimise the effects of surcharging the ground.

Overview of Reuse of Materials and Motorway Embankment Design

5.5.5 During construction of the new section of motorway, contaminated materials will be potentially generated either as a result of remediation excavations (e.g. Tata Lagoons) or as a result of general construction activity (e.g. foundation arisings and general cutting excavations). The motorway embankment has been designed to enable contaminated materials to be placed within its core as a general embankment fill material subject to compliance with the suitable for reuse criteria (to be agreed with NCC, MCC and NRW). Existing ground investigation

samples and analysis data will be used to determine whether materials are suitable for reuse and where not available additional sampling and analysis will be undertaken to aid in establishing suitability. Where materials designated as waste are being considered for reuse information will be provided to demonstrate full recovery so end of waste designation can be agreed. Figures 4a to d show the embankment design during construction and under operation.

6 Outline Remediation Implementation Plan

6.1 Introduction

6.1.1 This section presents an Outline Remedial Implementation Plan (ORIP) for the selected remediation approaches. The ORIP covers the following aspects.

1. General procedures during excavations.
2. Excavation of materials from the route including contaminated soils – Generic Site.
    - Treatment of *in situ* materials to remain.
    - Procedures for encountering previously unidentified contamination.
    - General waste handling requirements.
    - Groundwater assurance monitoring programme.
    - Ground gas protective measures during construction.

6.1.2 It is considered that the implementation of the above remediation procedures would enable the remedial objectives set out in Section 3 to be achieved.

6.1.3 The remediation works would be undertaken as part of the overall construction programme. All requirements of the Principal Contractor should be followed in addition to the specifics of this implementation plan.

6.1.4 An Outline Materials Management Plan (MMP) has been prepared. The Outline MMP has been prepared using guidance from the Definition of Waste (CL:AIRE, 2011) and includes a framework for the management of materials to be excavated and placed during the works. The Outline MMP would be updated prior to construction commencing. The adoption of the MMP would assist with implementation of the remediation to Regulator requirements and support the production of the Remediation Verification Report.

6.2 Routine Documentation

6.2.1 To provide appropriate 'lines of evidence' to demonstrate to the Regulators that the appropriate remediation works have been undertaken, this section sets out the routine documentation that would be required.

6.2.2 All materials subject to excavation, treatment for reuse and ultimate disposal must be tracked throughout and evidence generated to provide an auditable trail. In the case of wastes for disposal this is achieved via compliance with the Duty of Care requirements, e.g. description of the European Waste Catalogue code, completed Transfer or Consignment Notes and acceptance at appropriately authorised facility(ies) with waste acceptance procedures set out in the Environmental Permit or Waste Exemption.

6.2.3 In the case of wastes considered for reuse this is achieved by providing documentation to demonstrate that once used the waste has been fully recovered. Guidance provided in RGN13 (Environment Agency, 2010d) will be utilised.

6.2.4 All tracking documentation shall be carefully documented by the Contractor. The routine documentation of the works to be carried out by the Contractor shall include, but shall not be limited to the following.

- Annotated plans of the site(s) identifying different excavation areas (referenced to site investigation data, as appropriate), stockpile locations, treatment areas and placement locations.
- Inspection procedures:
  - visual and olfactory;
  - field tests (as appropriate); and
  - laboratory confirmation (as appropriate).Registered waste carrier and non-waste haulier.
- Registered waste carrier and non-waste haulier.
- Tracking form/control sheets (including a running tally).
- Movement through any authorised treatment facility.
- Treatment results.
- Delivery tickets for non-waste materials:
  - drivers' name and vehicle registration;
  - quantity (running tally for each site/sub area); and
  - destination (receiving site/ or sub area).
- Acceptance procedures for non-waste materials:
  - visual and olfactory;
  - field tests (as appropriate);
  - laboratory confirmation (as appropriate);
  - signed delivery tickets (including instructions where to off load, as appropriate); and
  - record of where placed.
- Details of any material changes to the remedial works due to findings on the site.
- Declarations signed by a Qualified Person (as defined in The Definition of Waste Development Industry Code of Practice).
- Asbestos air monitoring results, if required.
- As built drawings, construction drawings; and any locations where previously unidentified contaminated soils are encountered.
- Sampling and testing results of imported clean cover soils and comparison to acceptability criteria.

6.3 General Procedures During Excavations

6.3.1 The Contractor shall take account of the following health and safety measures detailed in the following section to minimise potential risks to construction workers and the general public, together with nuisance issues, during the

construction/remedial works. Safe Systems of Work (SSoW) shall be designed and implemented by the Contractor, and furthermore the following measures would be taken into account.

- The remedial works will be monitored by the Environmental Clerk of Works, with support from specialists where required.
- Where stockpiling of material is necessary, stockpiles will be designated via markers to show whether they are clean/ acceptable for reuse or dirty/ unacceptable for reuse.
- Materials placed on stockpiles must be stored such that cross-contamination from dust dispersal, run-off from rainfall and contamination of underlying clean soils is prevented.
- A register of material stockpiles will be maintained with details including material origin, records of analysis and final destination.
- Where unsuitable materials are disposed of off-site to a licensed waste management facility, a schedule of information is needed, which will include waste transfer ticket number, vehicle registration, landfill and weight recorded by the weighbridge at the facility.
- A specific safe system of work shall be produced to cover material stabilisation/treatment works including requirements for verification sampling and testing to demonstrate the required characteristics have been met.
- Strict control measures to protect construction workers and adjacent land users from contaminated soil and water and also ground gas during construction.
- Following completion of the works a copy of the disposal records shall be included as part of the Verification Report.

6.4 Excavation of Materials from the New Section of Motorway including Contaminated Soils

6.4.1 A SSoW will be designed and adopted by the Contractor and shall include the production of all risk assessments and method statements. Measures to be implemented during earthworks shall include the following.

- Use of designated respiratory protective equipment (RPE)/personal protective (PPE) for site personnel.
- Requirement for stockpiling, temporary covering of stockpiles, and skips for residual materials.
- Segregation of yet unidentified significantly contaminated soils where necessary.
- Establishment of a decontamination unit and clean/dirty area protocols.
- Air monitoring for dispersion of asbestos.

6.5 Treatment of *In Situ* Materials to Remain

6.5.1 Site-specific remediation (acceptability) criteria will be developed following conclusions of the on going ground investigation using detailed quantitative risk

assessment (e.g. materials containing contaminant levels below a threshold value will have no detrimental impact if they remain *in situ*).

6.5.2 Where risk assessment identifies that further intervention is required then a site-specific source and/or pathway remediation implementation plan will be developed and implemented.

6.6 Procedures for Encountering Unidentified/ Unexpected Contamination

6.6.1 As a minimum, the following will need to be established by the Contractor prior to construction works commencing.

- Development of a procedure that will be followed if previously unidentified asbestos and chemical contamination are identified during earthworks.
- Development of a Safe System of Work to demonstrate that adequate control measures are put in place to manage potential soil contamination encountered, and ensuring ground workers have completed a health and safety risk assessment.

6.6.2 The following will need to be adhered to in relation to encountering previously unidentified chemical contamination and asbestos during construction works.

- Ensure personnel involved in the earthworks are briefed on the likely nature and type of soils that could indicate the presence of contamination (e.g. asbestos, discolouration, oils, odours, ash and clinker materials).
- If such material is encountered, the Environmental Clerk of Works should be immediately contacted to inspect the material.
- If material is identified within the earthworks areas as potentially contaminated, the extent should be delineated and samples collected for field and/or laboratory analysis as deemed appropriate by the Environmental Clerk of Works and supporting specialists, where required.
- All chemical analysis results of the materials remaining *in situ* will be screened against acceptability criteria (to be agreed with NCC, MCC and NRW). Should contamination be identified, delineation and comparison with the relevant acceptability criteria shall be used in conjunction with the Scheme layout plan. (Note that new acceptability criteria may need to be derived if not already generated for specific chemical determinants).
- Concentrations above the applicable acceptability criteria will require either further detailed risk assessment or remediation as advised by the Environmental Clerk of Works and supporting specialists, where required. Any further risk assessment or remedial action shall be agreed with the Environmental Clerk of Works and supporting specialists, where required. Based on available information, it is anticipated that should remediation be the most applicable course of action, source removal of localised “hot spots” is likely to be most appropriate, supported by verification testing. The remediation verification of any contamination sources identified during the earthworks will include the following.

- Delineation of the extent of contamination and verification by inspection and laboratory analysis of soils appropriate to the type of contamination being removed.
- Residual materials not suitable for reuse on site are to be disposed of off-site to a suitably licensed waste management facility.
- Where previously unidentified contamination is identified, delineation testing will be undertaken and where concentrations exceed the site specific target levels (SSTLs) the soils will be remediated or disposed of off-site to a suitably licensed waste management facility.
- Contaminated materials that are not to be left *in situ* will be reused within the Scheme as general embankment fill subject to meeting suitable for reuse criteria (to be agreed with NCC, MCC and NRW).
- Where contaminated materials are sent off-site to a suitably licensed landfill, appropriate chain of custody and consignment notes will be provided.

6.7 General Waste Handling Arrangements

6.7.1 With regard to the general soil waste handling requirements the Contractor shall adhere to the following general requirements while handling waste soils.

- Waste shall be stored and disposed of in accordance with the MMP.
- All waste shall be segregated in labelled, appropriate containers/areas.
- Measures shall be implemented to mitigate the potential atmospheric fibre release of asbestos during remediation to protect human health impacts and limit spread of contamination.
- Inert, non-hazardous and hazardous wastes shall be segregated and not mixed.
- Waste containers shall be located in a secure, controllable location.
- All Contractors staff/personnel working within the site will be briefed on the waste management requirements and waste minimisation measures. Records will be kept of attendance.
- Waste audits shall be completed periodically by the Contractor.
- If the Contractor requires any material to be disposed of to a waste disposal facility, the Contractor shall inform the Environmental Coordinator in good time to enable an audit of the identified potential disposal facility.
- No waste will be brought onto the Scheme site from off-site.
- The Contractor shall be responsible for determining whether wastes are hazardous (U2).

6.8 Groundwater and Surface Water Assurance Monitoring Programme

6.8.1 A number of existing monitoring wells on site and surface water sampling points shall be sampled prior to commencement of development work and at regular intervals during construction/site development works. The wells to be sampled

will allow monitoring of the shallow groundwater bodies and the deeper aquifers. Contaminants are to be monitored to assess any changes in the groundwater conditions or quality and appropriate remediation measures implemented as necessary. Surface water samples shall be sampled to establish baseline conditions prior to construction and to verify no contamination has taken place during construction.

6.8.2 *In situ* field testing for water quality indicators will also be required during purging and prior to sampling. The testing shall include dissolved oxygen, electrical conductivity, redox potential, temperature and pH.

6.8.3 Monitoring data shall be reviewed following each monitoring round and compared to baseline conditions (established during the pre-construction monitoring rounds) to determine if any concentrations of determinants have significantly changed. Should concentrations appear anomalous to baseline data, additional analysis and/or detailed risk assessment shall be undertaken to determine if the concentrations represent evidence of pollution or a potential risk to controlled waters. Should risks be identified a risk assessment will need to be undertaken or remediation strategy designed and implemented.

6.8.4 Details of the assurance monitoring required will be provided in the final Remediation Strategy.

6.9 Ground Gas Protection Measures

6.9.1 A detailed ground gas and vapour risk assessment will be undertaken and the need for gas protection and controls to be incorporated into the Scheme will be identified prior to construction and this section will be updated accordingly in the final Remediation Strategy. Consideration would also be given to mitigating ground gas risks that could be encountered during construction.

7 Outline Remediation Verification Plan

7.1 Remediation Verification Report

7.1.1 A final Remediation Verification Report shall be prepared by the Contractor. It will detail any remedial works carried out and present all excavation records, plans, sample records and verification results and a summary of the information identified in this section. The Verification Report will also present the 'lines of evidence' to verify that the reuse of materials and remediation has been achieved in accordance with the specification, procedures included within the CL:AIRE MMP submission and end of waste requirements. These 'lines of evidence' include the below.

- Site photographs of remedial works including *ex situ* and *in situ* treatment processes, placement of capping materials and membranes and piling protection measures.
- Records relating to the stabilisation work identifying areas of excavation, validation of removal and locations for reuse. Rewords of all required process analysis to obtain regulator sign off. Site supervision logs compiled by the Contractor.
- Records compiled by the Contractor confirming the required thickness of materials used for capping, including both site-won reused materials and any imported material. The records of checks that these materials to meet site use criteria and confirmation that a geotextile marker layer has been incorporated at the base of the capping materials above the contained horizons.
- Sample analysis results including results of chemical analysis as required in the specification for all materials.
- 'As built' drawings detailing the location and extent of excavations and placement of capping materials.
- Asbestos Containing Materials (ACMs) in soils, where identified, will be sampled to demonstrate soils remaining in the ground meet acceptance criteria.
- Any additional contamination encountered where not previously identified, and delineation testing identified concentrations exceeded the relevant SSTLs or the site reuse criteria provided in (to be agreed with NCC, MCC and NRW) (after due consideration given to the benefit of additional risk assessment), and the eventual fate of the soils whether they are remediated and reused or disposed of off-site.
- Groundwater/surface water assurance monitoring.
- Records of volumes of materials ultimately designated as wastes and removed from site with records of the disposal facility name and copies of waste transfer notes.

7.1.2 The format and contents of the Verification Report shall be compiled using guidance provided in the Environment Agency's Verification of Remediation of Land Contamination (Environment Agency, 2006).

7.1.3 The Verification Report shall demonstrate the following requirements were met during the works.

- Cover system construction details.
- Clean soils were placed to a minimum suitable thickness.
- Asbestos contaminated materials were suitably capped/contained, or disposed of site to an authorised waste management facility.
- Any significantly contaminated materials or suspected asbestos containing materials were remediated, capped/contained or sentenced for disposal off site to an authorised licensed waste management facility.
- Agreed end of waste criteria have been met.
- The groundwater assurance monitoring has recorded groundwater quality within the shallow and deeper aquifers and has demonstrated little or no impact on the current site conditions.

7.2 Off Site Disposal of Waste

Site Waste Management

7.2.1 During the works the Contractor shall, wherever possible, seek to minimise waste being generated and recover or reuse materials, which include reuse of all site derived soils including asbestos contaminated soils. However, it is anticipated that small volumes of unsuitable materials may require off-site disposal. The Contractor shall provide detailed information of volumes of waste generated and volumes of materials recovered.

Waste Transfer Notes

7.2.2 Under the Waste (England & Wales) Regulations 2011 all those responsible for producing or handling wastes have legal requirements placed upon them for the safe keeping, transport and subsequent recovery or disposal. Consequently, at the basic minimum, the Contractor shall ensure that all waste leaving site must have a Waste Transfer Note and a copy of every Waste Transfer Note for each load leaving site must be provided.

7.2.3 The Waste Transfer Note shall be compliant with Section 35 of Waste (England & Wales) Regulations 2011.

7.2.4 All Waste Transfer Notes shall be kept for a minimum of three years.

7.2.5 Any hazardous waste generated during the construction phase, will require the Contractor to register with the Environment Agency that they intend to produce hazardous waste and comply with the Hazardous Waste Regulations. The Contractor shall register and provide a ‘premises code’.

7.2.6 The Contractor shall be responsible for record keeping of all hazardous waste materials removed from site. This record keeping shall include the below.

- Maintaining records and registers of all hazardous waste removed from site. A consignment note must be completed to accompany hazardous waste that is removed from the site.
- The Contractor shall obtain hazardous waste consignment numbers from the Environment Agency for each and every consignment of hazardous waste removed from site.

- The Contractor shall provide returns from consignees of hazardous waste and provide completed waste consignment returns back to the Environment Agency for each consignment number given to the Contractor.

7.2.7 The Contractor shall ensure the below details of all hazardous waste consignments are recorded.

- Quantity – Quantity of waste in kilograms.
- Nature – A full description of the waste and its EWC code and components.
- Origin – Name and address of the premises at which the waste was produced.
- Destination- The name and address of the Consignee.
- Frequency of Collection – Where applicable.
- Mode of Transport – Mode of transport used to transport waste off site to the treatment facility.
- Treatment Method – Method of disposal or recovery.
- Identification of Carrier – Name and registration number of carrier used to transport waste off site to the treatment facility.

7.2.8 In addition to the above the Contractor shall ensure that he follows the guidance provided in 'A Guide to the Hazardous Waste Regulations – Records, Registers and Returns'[1].

7.3 Waste Disposal Testing, Inspection and Verification Requirements

7.3.1 The Contractor shall be responsible for any additional testing required of wastes to facilitate disposal to a licensed waste management facility. This shall include Waste Acceptance Criteria testing of soils and other materials being disposed to either landfills as required under the Landfill (England and Wales) Regulations 2002.

7.3.2 Any such testing necessary shall be identified by the Contractor who shall provide copies of any analysis results required.

7.4 Permits and Licenses

7.4.1 All details of licenses and permits that are obtained for the purposes of implementation of the remediation shall be documented as well as the details of their surrender.

7.4.2 All aspects and requirements of the permitting strategy approach should be addressed and adopted.

[1] The Hazardous Waste (England and Wales) Regulations 2005, Statutory Instrument 2005 No. 894

8 References

CL:AIRE (2010) Contaminated Land Remediation SP1001

CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice

DEFRA & Environment Agency (2004) Model Procedure for the Management of Land Contamination, Contaminated Land Report 11 (CLR 11), Environment Agency, Bristol.

Department of Transport (DfT) (2009) Manual of Contract Documents for Highway Works Vol 1 Specification for Highway Works (SHW), Series 600 Earthworks, November 2009.

Environment Agency (2010a) GPLC 1 – Guiding Principles for land contamination

Environment Agency (2010b) GPLC 2 – FAQs, technical information, detailed advice and references

Environment Agency (2010c) GPLC 3 – Reporting Checklists 2015

Environment Agency (2010d) Regulatory Guidance Note, RGN13: Defining Waste Recovery: Permanent Deposit of Waste on Land, Version 1, March 2010.

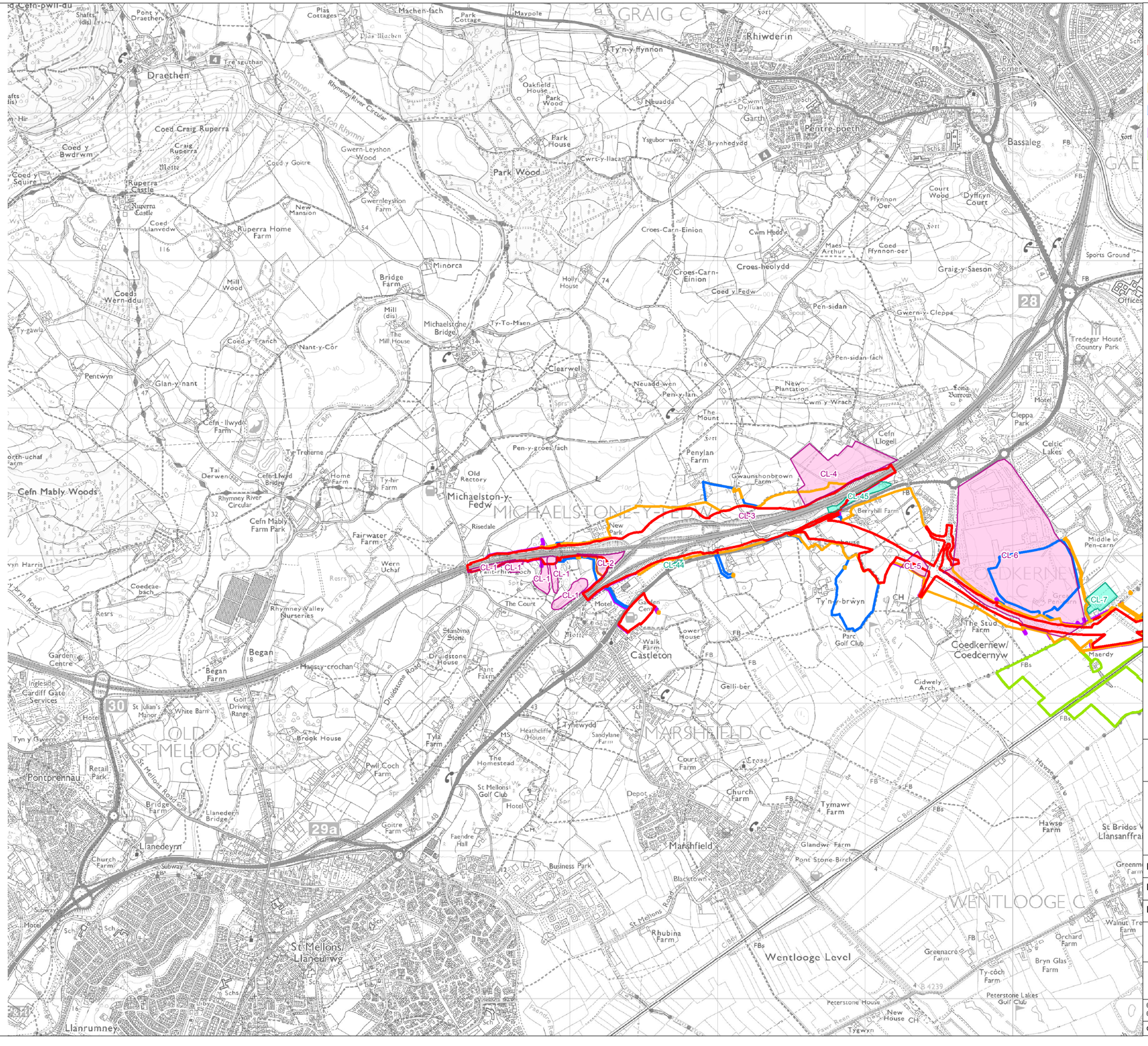
Environment Agency (2013) Regulatory Guidance Note, RGN9: Surrender, Version 3, May 2013.

Environment Agency (2016) Aggregate from waste steel slag: quality protocol, May 2016.

SURF UK (2010) A Framework for Assessing the Sustainability of Soil and Groundwater Remediation.

Welsh Local Government Agency (WLGA) and Environment Agency Wales (2012) Development of Land Affected by Contamination: A Guide for Developers.

Figures



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Ecological Mitigation
- Sites of Potential Land Contamination Sources Affected by the Scheme
- Sites of Potential Land Contamination Sources Unlikely to be Affected by the Scheme

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Appendix R11.2

Sites with Potential Land Contamination Source Areas

Figure: 1a	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000
0 500 1,000 m

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dwg ref: JER6591_FigureR11-1_PotentialLandContaminationSites

Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Ecological Mitigation
- Sites of Potential Land Contamination Sources Affected by the Scheme
- Sites of Potential Land Contamination Sources Unlikely to be Affected by the Scheme

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Appendix R11.2

Sites with Potential Land Contamination Source Areas

Figure: 1b	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000
0 500 1,000 m

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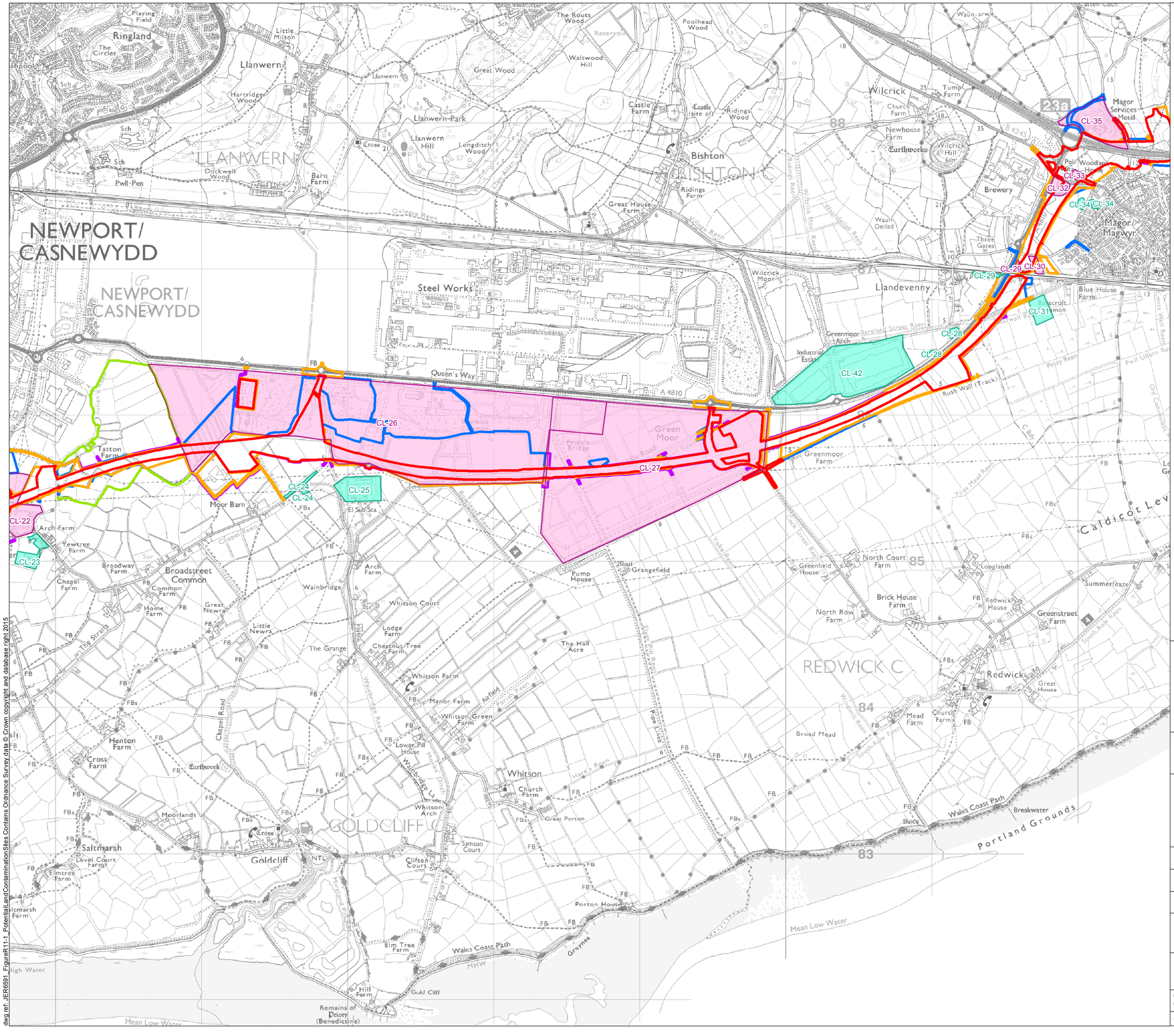
dwg ref: JER6591_FigureR11-1_PotentialLandContaminationSites



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Ecological Mitigation
- Sites of Potential Land Contamination Sources Affected by the Scheme
- Sites of Potential Land Contamination Sources Unlikely to be Affected by the Scheme

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Appendix R11.2

Sites with Potential Land Contamination Source Areas

Figure: 1c	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000
0 500 1,000 m

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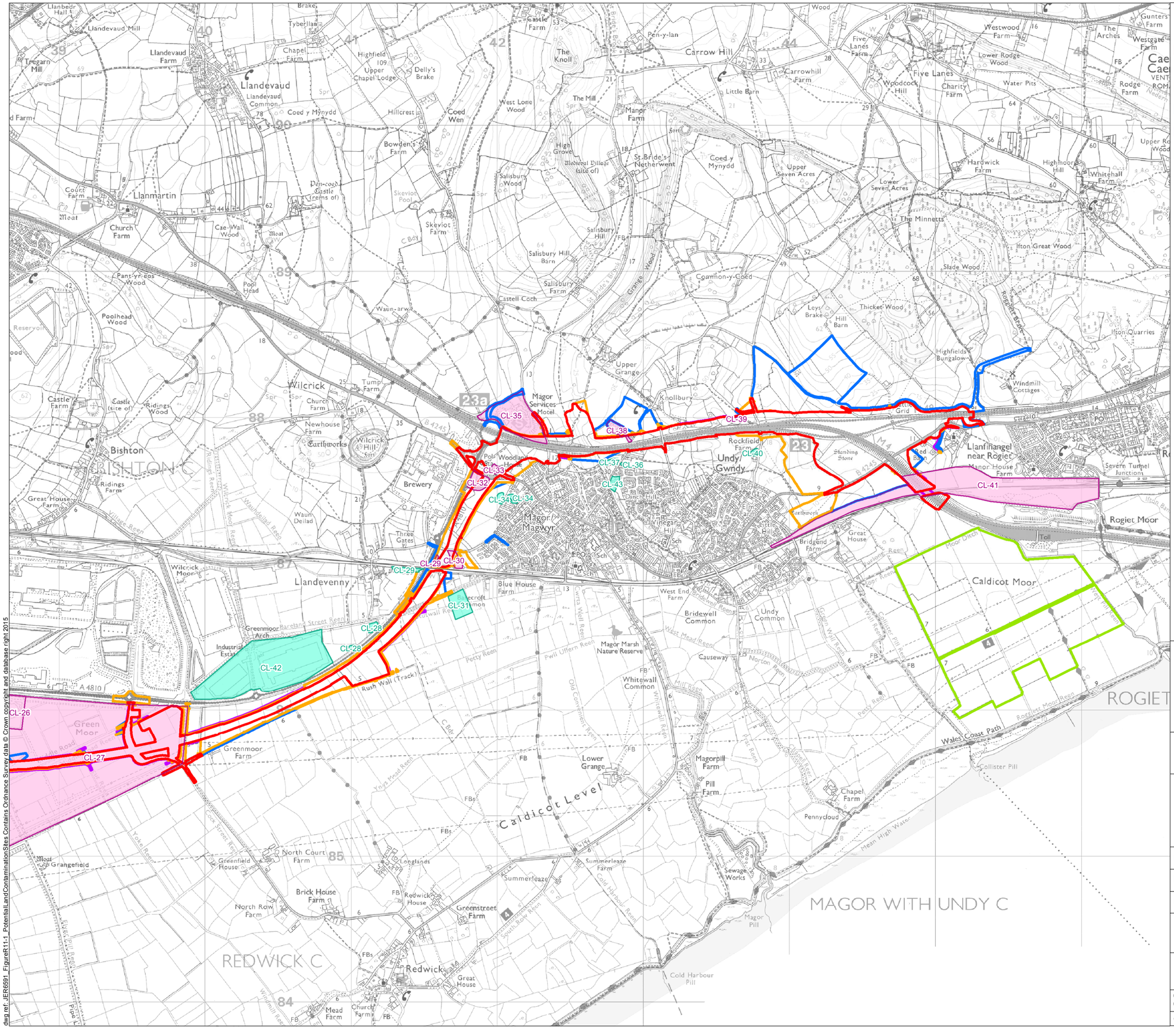
dwg ref: JER6591_FigureR11-1_PotentialLandContaminationSites



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Ecological Mitigation
- Sites of Potential Land Contamination Sources Affected by the Scheme
- Sites of Potential Land Contamination Sources Unlikely to be Affected by the Scheme

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Appendix R11.2

Sites with Potential Land Contamination Source Areas

Figure: 1d	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000

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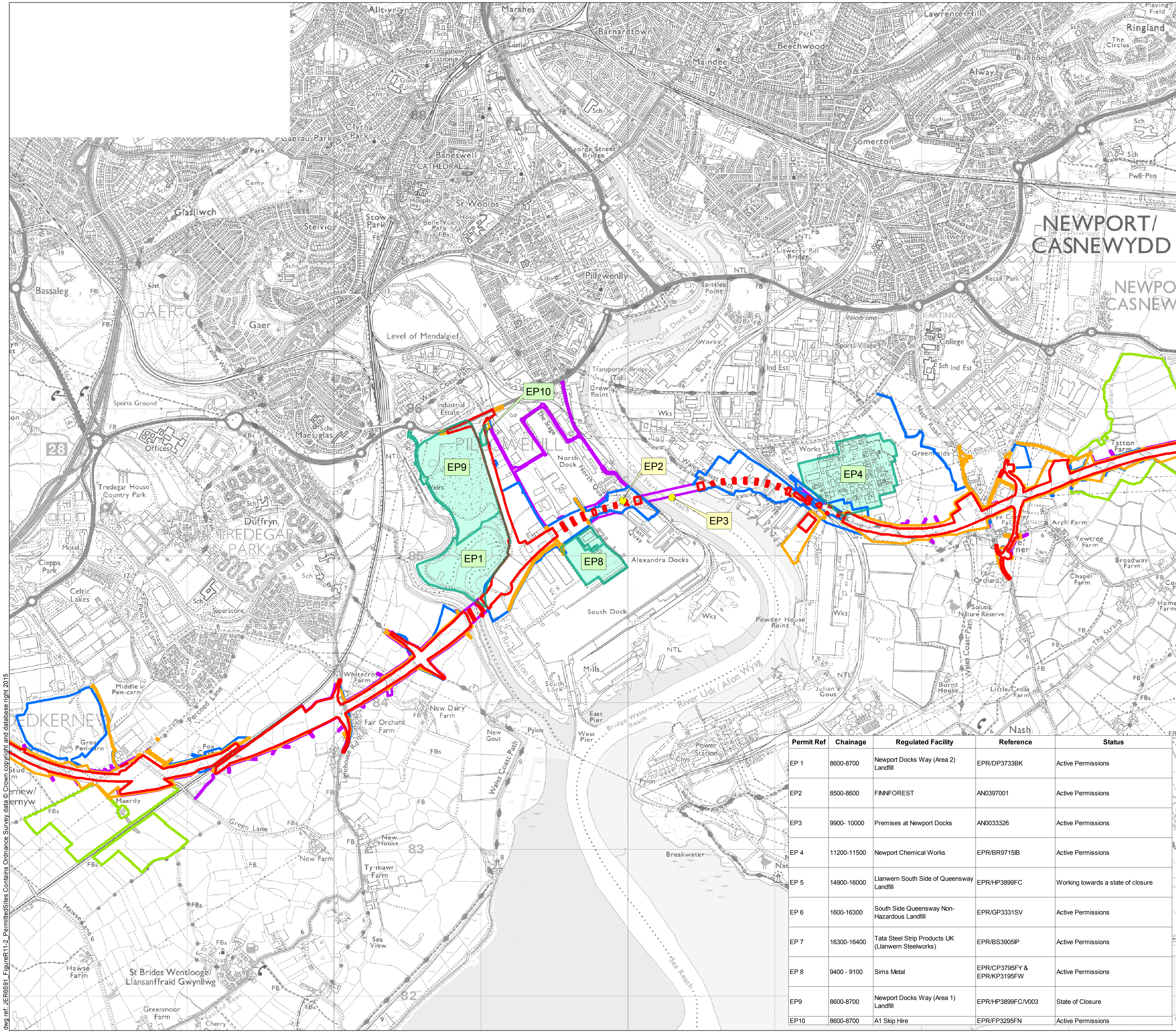

Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Ecological Mitigation
- Permit Boundary
- Permit Location

Permit Ref	Chainage	Regulated Facility	Reference	Status
EP 1	8600-8700	Newport Docks Way (Area 2) Landfill	EPR/DP3733BK	Active Permissions
EP2	8500-8600	FINNFOREST	AN0397001	Active Permissions
EP3	9900- 10000	Premises at Newport Docks	AN0033326	Active Permissions
EP 4	11200-11500	Newport Chemical Works	EPR/BR9715IB	Active Permissions
EP 5	14900-16000	Llanwern South Side of Queensway Landfill	EPR/HP3899FC	Working towards a state of closure
EP 6	1600-16300	South Side Queensway Non-Hazardous Landfill	EPR/GP3331SV	Active Permissions
EP 7	16300-16400	Tata Steel Strip Products UK (Llanwern Steelworks)	EPR/BS3905IP	Active Permissions
EP 8	9400 - 9100	Sims Metal	EPR/CP3795FY & EPR/KP3195FW	Active Permissions
EP9	8600-8700	Newport Docks Way (Area 1) Landfill	EPR/HP3899FC/V003	State of Closure
EP10	8600-8700	A1 Skip Hire	EPR/FP3295FN	Active Permissions

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Appendix R11.2

Permitted Sites

Figure: 2a | Revision: 1
Date: September 2016 | Status: At Issue
Drawn: RJJ | Checked: AJC

Scale: A3 @ 1:25,000
0 500 1,000 m
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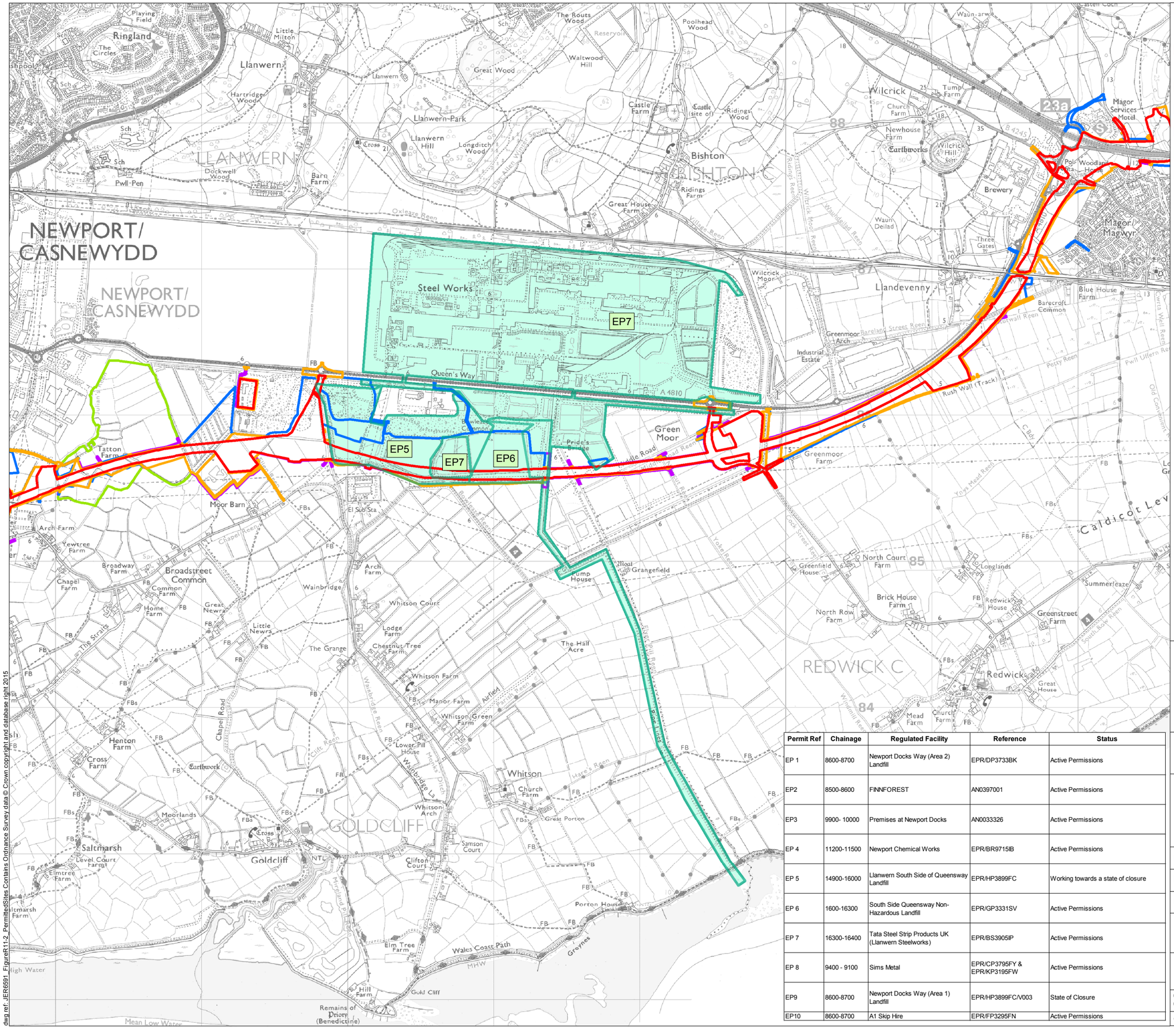
dwg ref: JER6591_FigureR11-2_PermittedSites



Legend

- Permanent Highway Land within Fenceline (including Water Treatment Areas)
- Other Permanent Land Take
- Temporary Construction Land
- Easement Only
- Ecological Mitigation
- Permit Boundary
- Permit Location

Permit Ref	Chainage	Regulated Facility	Reference	Status
EP 1	8600-8700	Newport Docks Way (Area 2) Landfill	EPR/DP3733BK	Active Permissions
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EP9	8600-8700	Newport Docks Way (Area 1) Landfill	EPR/HP3899FC/V003	State of Closure
EP10	8600-8700	A1 Skip Hire	EPR/FP3295FN	Active Permissions

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Appendix R11.2

Permitted Sites

Figure: 2b	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000
0 500 1,000 m

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dwg ref: JER6591_FigureR11-2_PermittedSites

Legend

- Limit of Permanent and Temporary Works for New Section of Motorway
- Sites of Potential Land Contamination
- Area Requiring Discovery Strategy
- Area Requiring Site-Specific Remediation
- Area Requiring Compliance with Material Re-Use Acceptability Criteria

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Appendix R11.2

Outline Remediation Strategy

Figure: 3a	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000
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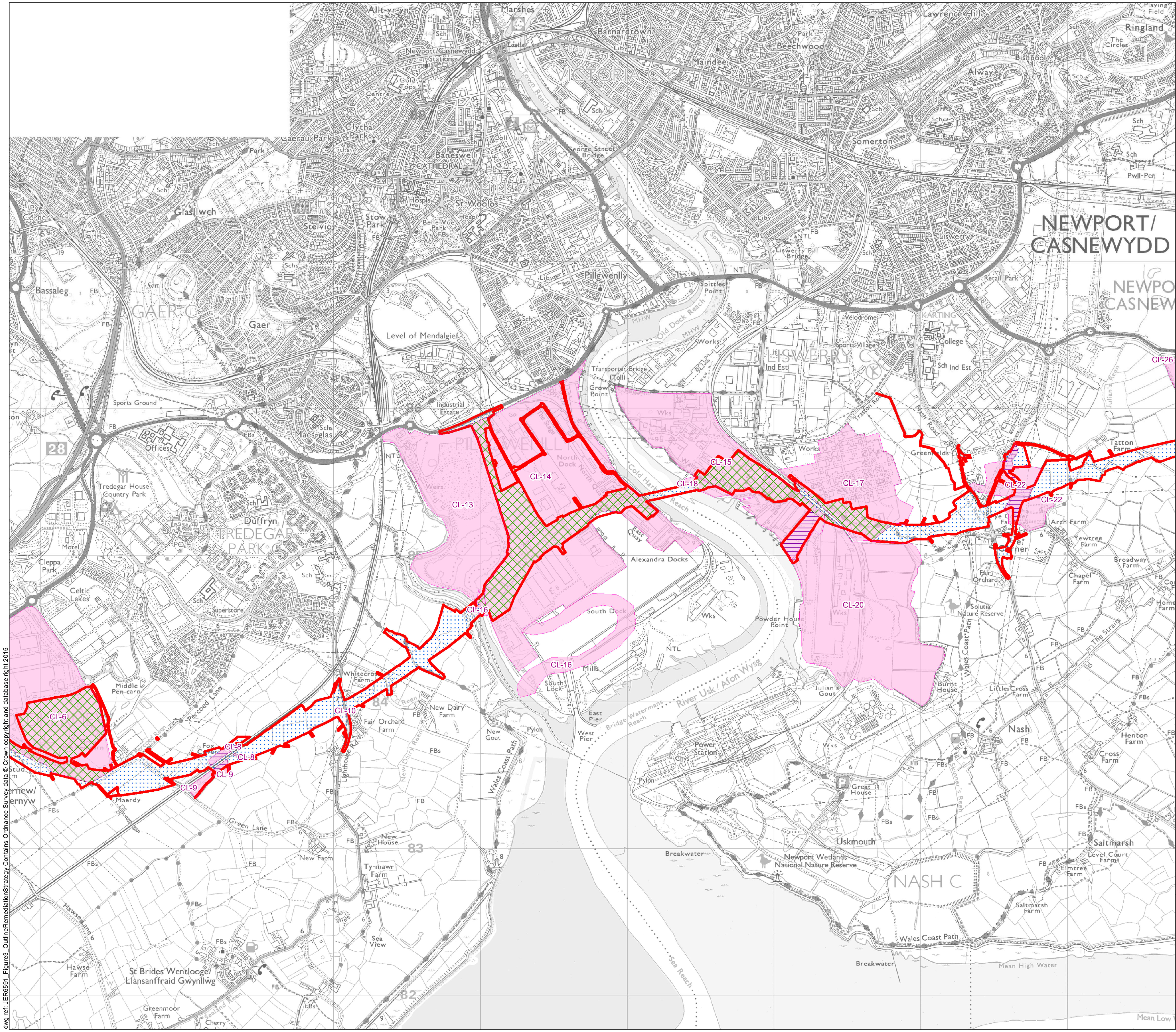

Legend

- Limit of Permanent and Temporary Works for New Section of Motorway
- Sites of Potential Land Contamination
- Area Requiring Discovery Strategy
- Area Requiring Site-Specific Remediation
- Area Requiring Compliance with Material Re-Use Acceptability Criteria

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Appendix R11.2

Outline Remediation Strategy

Figure: 3b	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000
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dwg ref: JER6591_Figure3_OutlineRemediationStrategy

Legend

- Limit of Permanent and Temporary Works for New Section of Motorway
- Sites of Potential Land Contamination
- Area Requiring Discovery Strategy
- Area Requiring Site-Specific Remediation
- Area Requiring Compliance with Material Re-Use Acceptability Criteria

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Appendix R11.2

Outline Remediation Strategy

Figure: 3c	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

Scale: A3 @ 1:25,000

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dwg ref: JER6591_Figure3_OutlineRemediationStrategy

Legend

- Limit of Permanent and Temporary Works for New Section of Motorway
- Sites of Potential Land Contamination
- Area Requiring Discovery Strategy
- Area Requiring Site-Specific Remediation
- Area Requiring Compliance with Material Re-Use Acceptability Criteria

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CL-29
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CL-35
CL-38
CL-39
CL-41

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Appendix R11.2

Outline Remediation Strategy

Figure: 3d	Revision: 1
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: AJC

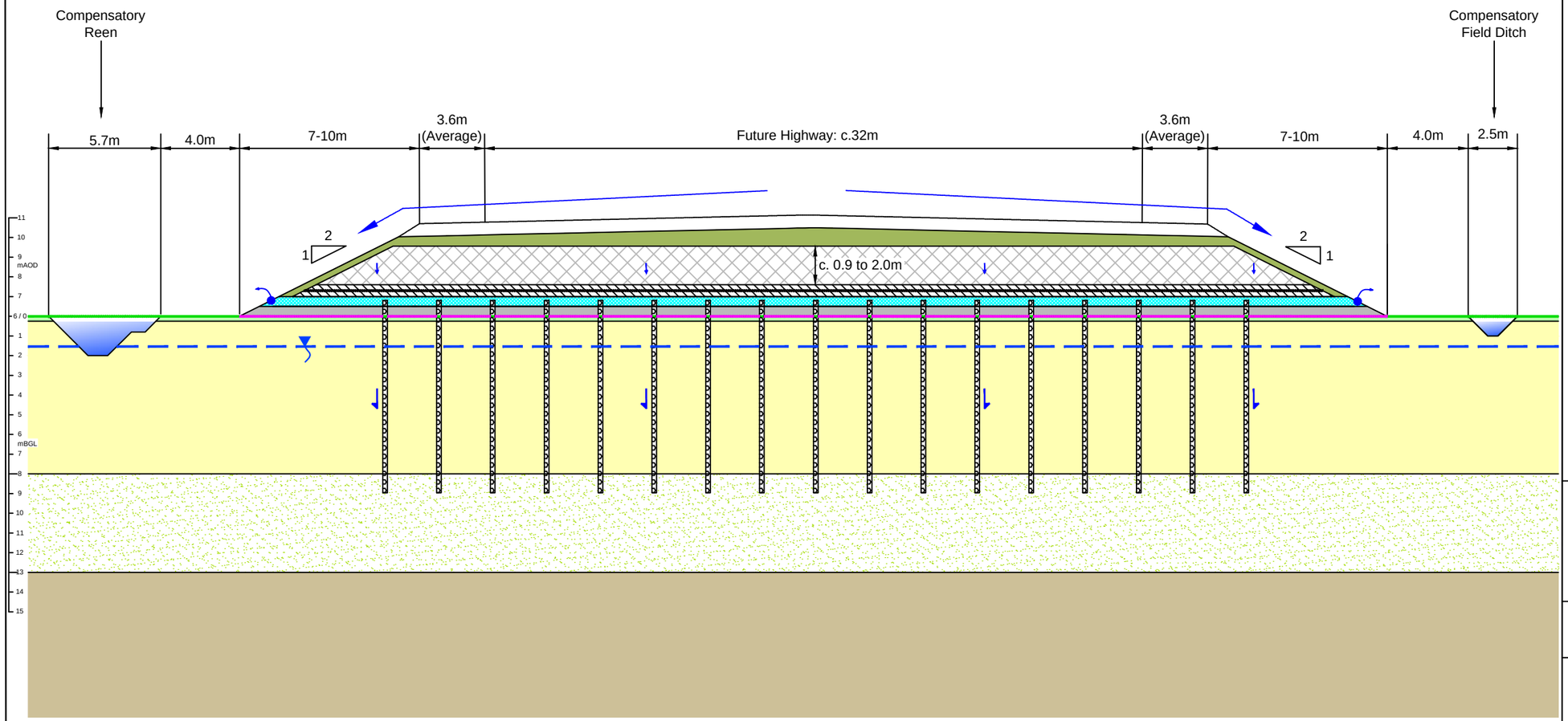
Scale: A3 @ 1:25,000
0 500 1,000 m

N

dwg ref: JER6591_Figure3_OutlineRemediationStrategy

MODEL 1A: SURCHARGING PHASE (CONSTRUCTION)

(<5.0m EMBANKMENT IN THE GWENT LEVELS (BAND DRAINS)



NOTE: Indicative elevations shown between geological stratum

metres

Legend

Geology & Hydrogeology

- Indicative Ground Level
- Topsoil
- Tidal Flat Deposits (TFD)
- Glaciofluvial Deposits (GFD)
- Mercia Mudstone Group (MMG)
- Potentiometric Surface of GFD/MMG Aquifer (c.4.5mAOD)

Highway Structure

- Cover Layer (c.0.3m on Slopes, c.1.0m on Platform)
- General Embankment Fill (c.0.9 to 2.0m)
- Reinforcement Blanket (c.0.6m)
- Geotextile Reinforcement
- Drainage Blanket (c.0.5m)
- Working Platform (c.0.5m)
- Geotextile Separator
- Compensatory Reen (c.2.0m Deep)
- Compensatory Field Ditch (c.1.0m Deep)
- Band Drain (c.2.5m Spacing)
- Surface Run-Off
- Potential Infiltration through Embankment Fill
- Potential Discharge from Drainage Blanket
- Potential Leakage through Band Drain

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Appendix R11.2

Schematic Conceptual Embankment - Surcharging Phase: <5m Height within the Gwent Levels

Figure: 4a	Revision: -
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: ARG

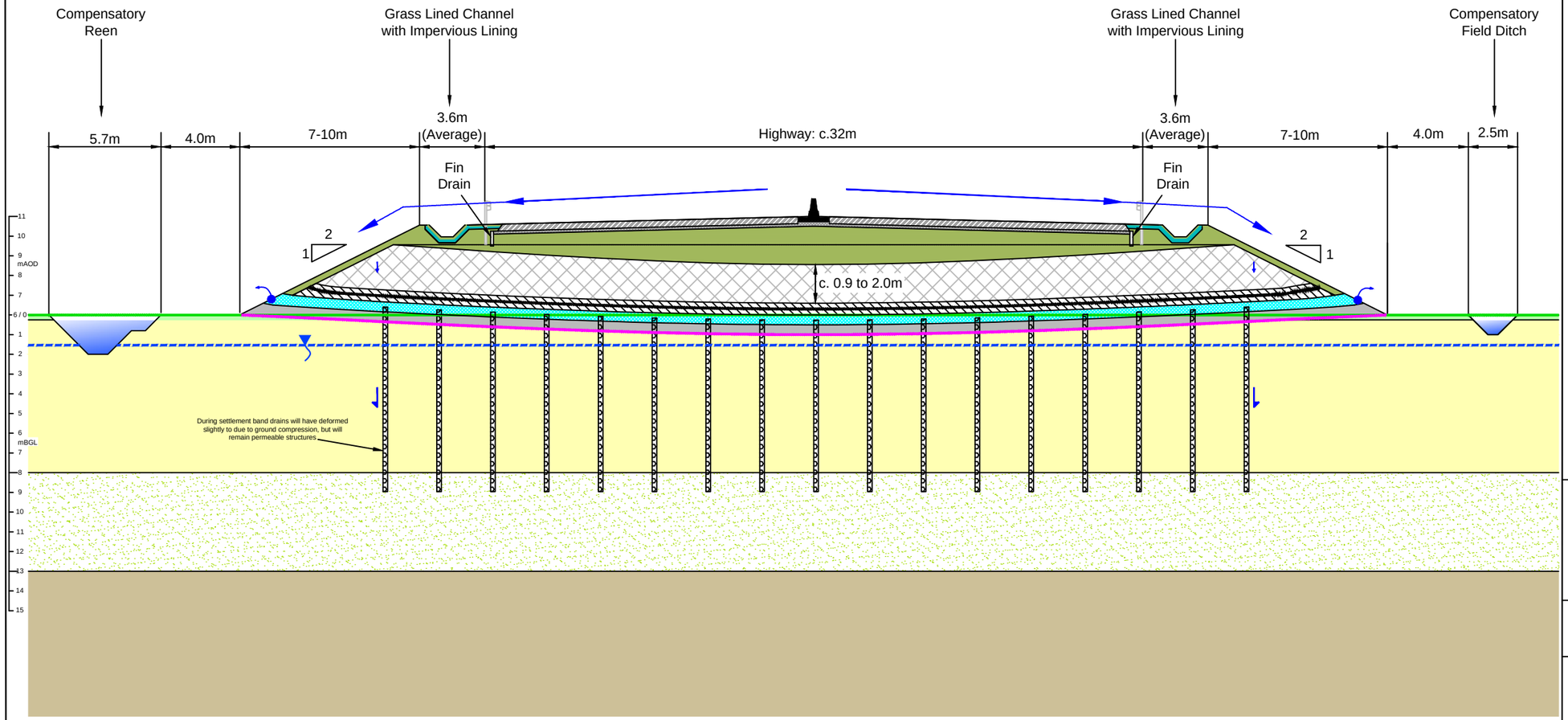
Scale A3 @ 1:250

dwg ref:JER6591_Figure4a_EmbankmentUnder5MSurcharging

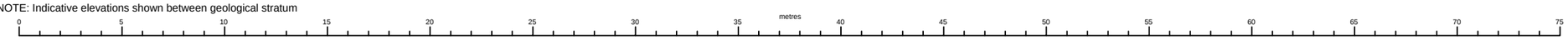
dwg ref: JER6591_Figure4a_EmbankmentUnder5MSurcharging

MODEL 1B: POST-SURCHARGE PHASE (OPERATIONAL)

(<5.0m EMBANKMENT IN THE GWENT LEVELS (BAND DRAINS)



NOTE: Indicative elevations shown between geological stratum



Legend

Geology & Hydrogeology

- Indicative Ground Level
- Topsoil
- Tidal Flat Deposits (TFD)
- Glaciofluvial Deposits (GFD)
- Mercia Mudstone Group (MMG)
- Potentiometric Surface of GFD/MMG Aquifer (c.4.5mAOD)

Highway Structure

- Tarmac (c.0.35m)
- Sub-Base (c.0.15m)
- Cover Layer (c.0.3m on Slopes)

c. Up to 2.0m on Platform

- Grass-Lined Channel with Impervious Lining
- General Embankment Fill (c.0.9 to 2.0m)
- Reinforcement Blanket (c.0.6m)
- Geotextile Reinforcement
- Drainage Blanket (c.0.5m)
- Working Platform (c.0.5m)
- Geotextile Separator
- Compensatory Reen (c.2.0m Deep)
- Compensatory Field Ditch (c.1.0m Deep)
- Band Drain (c.2.5m Spacing)
- Highway Run-Off
- Surface Run-Off
- Potential Infiltration through Embankment Fill
- Potential Discharge from Drainage Blanket
- Potential Leakage through Band Drain

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Appendix R11.2

Schematic Conceptual Embankment - Post-Surcharge Phase: <5m Height within the Gwent Levels

Figure: 4b	Revision: -
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: ARG

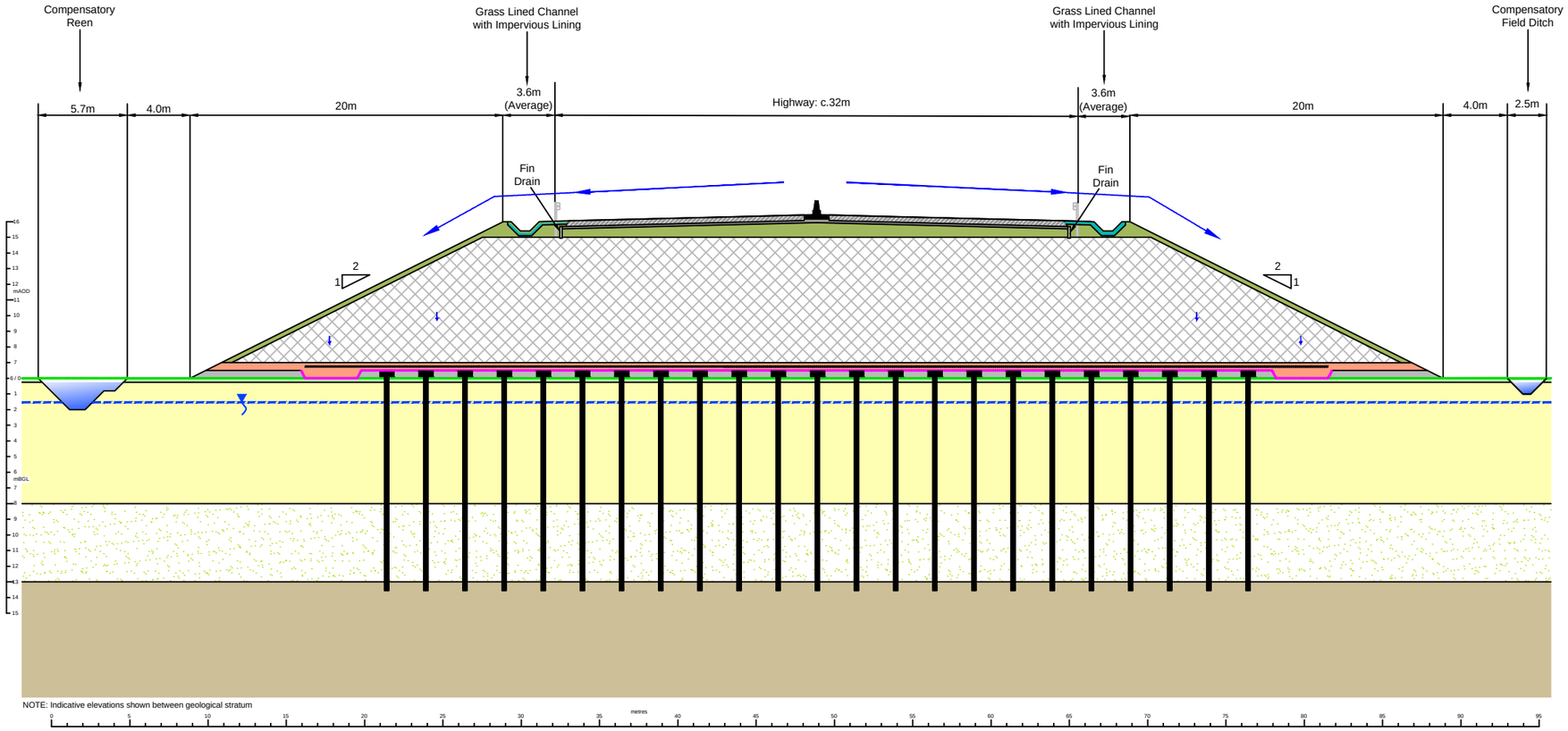
Scale A3 @ 1:250

dwg ref:JER6591_Figure4b_EmbankmentUnder5MPostSurcharge

dwg ref: JER6591_Figure4b_EmbankmentUnder5MPostSurcharge

MODEL 2: CONSTRUCTION & OPERATION

(10m EMBANKMENT IN THE GWENT LEVELS (PILED FOUNDATIONS - NO BAND DRAINS)



Legend

Geology & Hydrogeology

- Indicative Ground Level
- Topsoil
- Tidal Flat Deposits (TFD)
- Glaciofluvial Deposits (GFD)
- Mercia Mudstone Group (MMG)
- Potentiometric Surface of GFD/MMG Aquifer (c.4.5mAOD)

Highway Structure

- Cover Layer
- General Embankment Fill
- Longitudinal Geogrid
- Basal Layer - Compacted Granular Material
- Piling Platform - Compacted Granular Material (c.0.5m)
- Transverse Geogrid
- Compensatory Reen (c.2.0m Deep)
- Compensatory Field Ditch (c.1.0m Deep)
- Driven Pile (0.275m Width with 0.9 x 0.35m Cap) - Indicative 2.5m Spacing Shown
- Highway Run-Off
- Surface Run-Off
- Potential Infiltration through Embankment Fill

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Appendix R11.2

Schematic Conceptual Embankment - Post-Surcharge Phase: >5m Height within the Gwent Levels

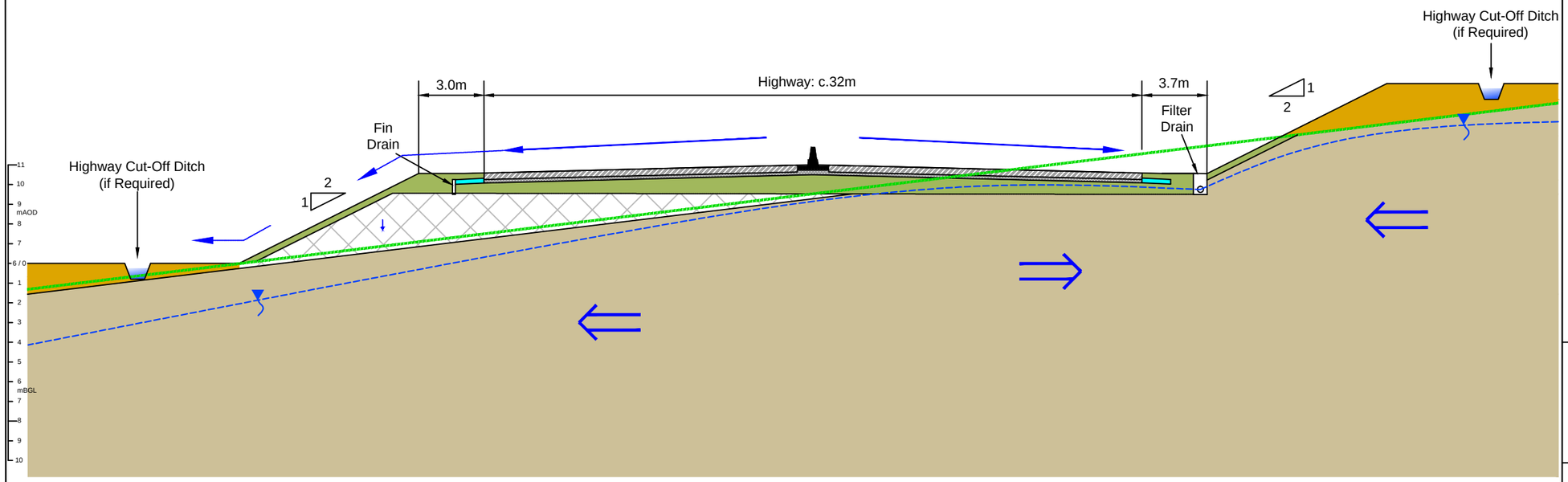
Figure: 4c	Revision: -
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: ARG

Scale A3 @ 1:350

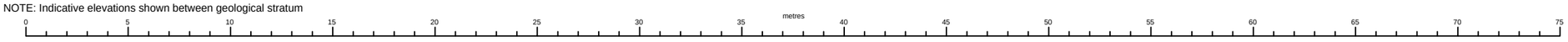
dwg ref:JER6591_Figure4c_EmbankmentOver5m

dwg ref: JER6591_Figure4c_EmbankmentOver5m

MODEL 3: CUT & FILL (OUTSIDE OF GWENT LEVELS)



NOTE: Indicative elevations shown between geological stratum



Legend

Geology & Hydrogeology

- Indicative Ground Level
- Mercia Mudstone Group (MMG)
- Potentiometric Surface of GFD/MMG Aquifer (c.4.5mAOD)

Highway Structure

- Tarmac (c.0.35m)
- Sub-Base (c.0.15m)
- Cover Layer (c.0.3m on Slopes)

c. Up to 2.0m on Platform

- General Embankment Fill (c.0.9 to 2.0m)
- Fill Material
- Highway Cut-Off Ditch
- Highway Run-Off
- Surface Run-Off
- Potential Infiltration through Embankment Fill
- Potential Discharge from Drainage Blanket
- Potential Leakage through Band Drain

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Appendix R11.2

Schematic Conceptual Embankment - Cut & Fill:
Outside of Gwent Levels

Figure: 4d	Revision: -
Date: September 2016	Status: At Issue
Drawn: RJJ	Checked: ARG

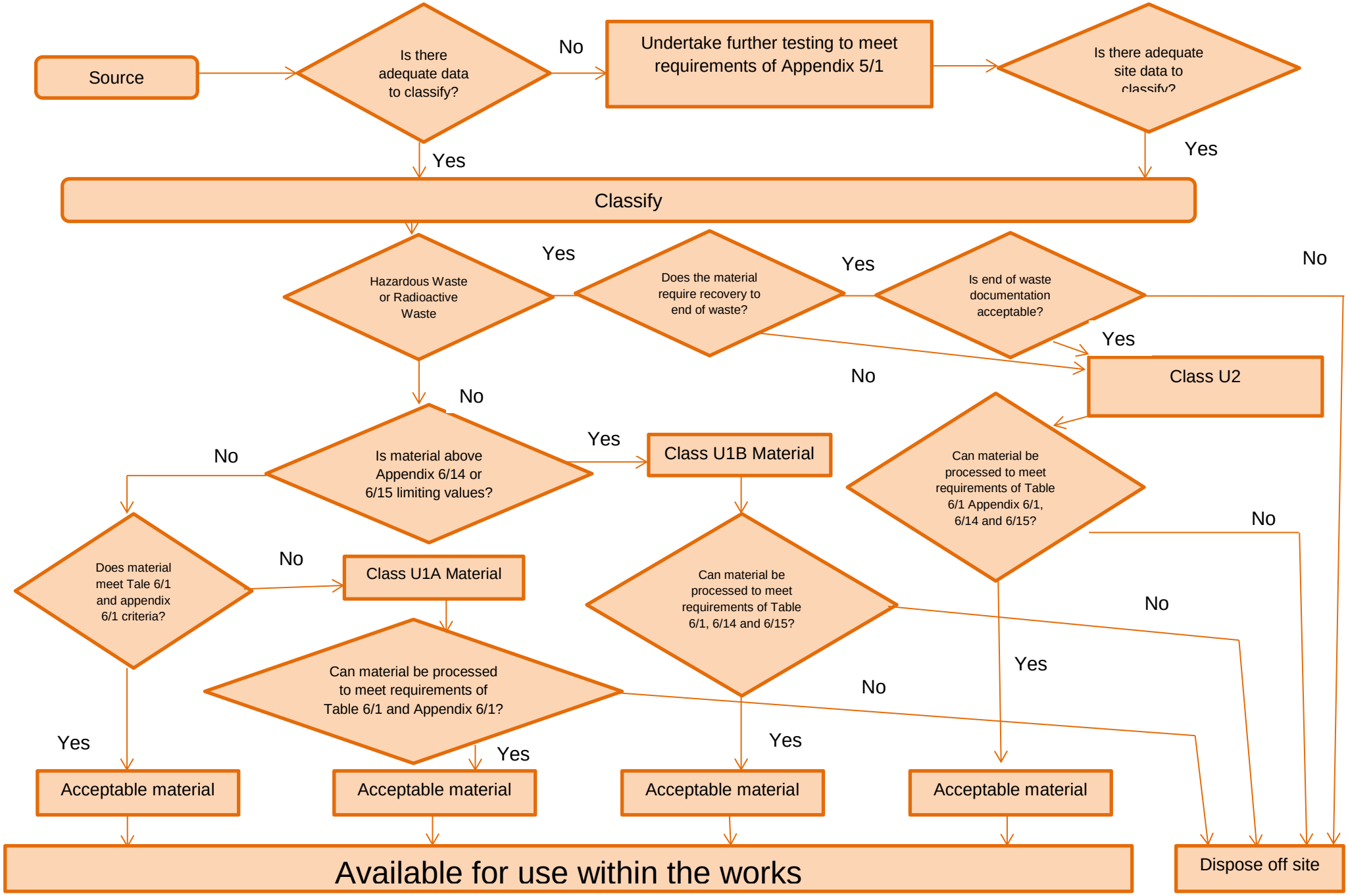
Scale A3 @ 1:250

dwg ref:JER6591_Figure4d_EmbankmentCut&Fill

dwg ref: JER6591_Figure4d_EmbankmentCut&Fill

Annexes

Annex A: Material Management Flow Chart



M4CaN Contaminated Materials Flow Chart