A585 Windy Harbour to Skippool Improvement Scheme

TR010035

6.12 Environmental Statement Chapter 12: Road Drainage and the Water Environment

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

October 2018

Page Left Intentionally Blank

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning
(Applications: Prescribed Forms and
Procedure) Regulations 2009

A585 Windy Harbour to Skippool Improvement Scheme

Development Consent Order 201[ ]

ENVIRONMENTAL STATEMENT CHAPTER 12: ROAD DRAINAGE AND THE WATER ENVIRONMENT

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010035
Application Document Reference	TR010035/APP/6.12
Author:	A585 Windy Harbour to Skippool Improvement Scheme Project Team, Highways England

Version	Date	Status of Version
Rev 0	October 2018	DCO submission

Page Left Intentionally Blank

CONTENTS

LIST OF TABLES

LIST OF INSERTS

LIST OF FIGURES

12 ROAD DRAINAGE AND THE WATER ENVIRONMENT

12.1 Introduction

12.1.1 This Chapter presents the assessment of the road drainage and the water environment impacts associated with the Scheme. This Chapter presents the regulatory framework, assessment methodology, study area, existing and future baseline, mitigation measures, residual effects, monitoring and a summary.

12.1.2 This Chapter should be read in conjunction with Figures 12.1 – Waterbodies and Environment Agency Flood Zones, 12.2 - Aquifers and 12.3 – Water Framework Directive Waterbodies and the Flood Risk Assessment (FRA) (document reference TR010035/APP/5.2) and Water Framework Directive Compliance Assessment (document reference TR010035/APP/5.6).

12.2 Regulatory Framework / National Networks National Policy Statement (NN NPS) Requirements

12.2.1 This assessment has been undertaken considering current legislation, together with national, regional and local plans and policies. A list of plans is provided within Table 7-1 and further detail can be found in the Planning Statement and National Policy Statement Accordance (document reference TR010035/APP/7.1).

Table 12-1: Road Drainage and the Water Environment – Regulatory Framework and NN NPS Requirements

Policy / Legislation
NN NPS (2014)
The EU Water Framework Directive (WFD) 2000; Council Directive 2000/60/EC
The Flood and Water Management Act 2010
The Water Resources Act 1991/2003
National Planning Policy Framework (2018)
Adopted Wyre Local Plan (1999) policies ENV13 and ENV15
AdoptedWyre Local Plan (1999) policies ENV16 and ENV17
Wyre Local Plan to 2031 (emerging document – due to be adopted 2018)
Adopted Fylde Borough Local Plan (2005) policy EP30
Fylde Local Plan to 2032 (emerging document – due to be adopted 2018)
Flood Risk Assessments: climate change allowances (Environment Agency, 2017)
Groundwater Protection Position Statements (Defra / Environment Agency, 2018)

12.3 Methodology

Items Scoped in and out of the Assessment

12.3.1 The potential for the Scheme to affect baseline groundwater quality and flow regimes, surface water quality, flooding and the land drainage regime have been

scoped into the assessment. The effects have been assessed during both construction and operation of the Scheme. No elements relevant to road drainage and the water environment have been scoped out of the assessment.

Baseline Information

12.3.2 Baseline information has been gathered (within the draft order limits, within 500m of the draft order limits for surface waterbodies and within 1km for groundwater bodies) by undertaking a desk study informed by published and internet-based information from the following sources:

- British Geological Survey Geology of Britain Viewer (Accessed via http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html)
- Cranfield Soil and Agrifood Institute Soilscapes map viewer (Accessed via http://www.landis.org.uk/soilscapes/)
- Defra Magic Maps (Accessed via http://magic.defra.gov.uk/MagicMap.aspx)
- Environment Agency long term flood risk information (Accessed via https://flood-warning-information.service.gov.uk/long-term-flood-risk)
- Environment Agency Catchment Data Explorer (Accessed via https://environment.data.gov.uk/catchment-planning/)

12.3.3 Data collected from these sites were supplemented with responses to direct consultation requests to the Environment Agency, Lancashire County Council as the Lead Local Flood Authority (LLFA), Wyre Council and Fylde Borough Council.

12.3.4 Modelling assessments have been undertaken to quantify baseline flood risk from rivers and the sea and calculations have been undertaken to quantify rainfall runoff rates, informing the drainage design (document reference TR010035/APP/5.2). Data from a site-specific Ground Investigation has supplemented the understanding of ground conditions and hydrogeology (document reference TR010035/APP/7.6).

Post-Scoping and Preliminary Environmental Information Consultation

12.3.5 Further consultation has been undertaken since the receipt of the responses to the Environmental Impact Assessment (EIA) Scoping Report and the Preliminary Environmental Information Report (PEIR) to agree a range of issues relevant to this Chapter, Table 3-1 of Chapter 3: Consultation (document reference TR010035/APP/6.3) provides full details.

Identifying Mitigation and Enhancement Measures and Assessing Residual Effects

12.3.6 The Scheme has been designed to avoid or reduce effects on groundwater resources, flood risk and water quality have been shaped by the results of the modelling studies and investigations described in paragraphs 12.3.3 and 12.3.4. Embedded mitigation is listed within Table 2-4 in Chapter 2: Description of the Scheme (document reference TR010035/APP/6.2). Additional mitigation measures have been identified with reference to Protecting Groundwater and Preventing Groundwater Pollution Guidance (Environment Agency, March 2017) and various Construction Industry Research and Information Association (CIRIA) publications which set out current best practice measures toward preventing and mitigating construction phase impacts on surface and groundwater resources in agreement with the Environment Agency and the LLFA.

12.3.7 The assessment of residual effects has been undertaken in accordance within the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10 (HD45/09). The Planning Inspectorate's (the Inspectorates) Advice Note 18 The Water Framework Directive (June 2017) has informed the approach to assessing the compliance of the Scheme with WFD legislation.

12.3.8 The assessment method outlined in HD45/09 has a number of stages. The first is to give a value (or sensitivity) to identified receptors, using the categories defined in Table 12-2.

Table 12-2: Road Drainage and the Water Environment – Estimating the Value of Water Environment Attributes

Value (Sensitivity)	Criteria
Very High	High quality and rarity on a regional or national scale, with very limited potential for substitution. Examples: Designated Salmonid fishery, WFD waterbody achieving class of High, waterbody protected under UK or EU legislation; Principal aquifer providing a regionally important resource, SPZ1; Floodplain or defence protecting more than 100 residential properties
High	High quality and rarity on a local scale with limited potential for substitution. Examples: Major Cyprinid fishery, WFD waterbody achieving class of Good; Principal aquifer providing a locally important resource, SPZ2; Floodplain or defence protecting between 1 and 100 residential properties
Medium	Medium quality and rarity on a local scale, some potential for substitution Examples: WFD waterbody achieving class Moderate; Secondary aquifer providing a local source of water for agricultural or industrial use, SPZ3; Floodplain or defence protecting 10 or fewer industrial properties
Low	Low quality and rarity on local scale, good substitutability Examples: WFD waterbody achieving class Poor; Unproductive strata; Floodplain with limited constraints and a low probability of flooding residential and industrial properties.

12.3.9 The next step is to take into account the likely magnitude of environmental change (or impact) caused by the Scheme. Definitions are provided in Table 12-3 and consider the nature, scale / extent and duration of change.

Table 12-3: Road Drainage and the Water Environment – Estimating the Magnitude of Impact

Magnitude of Change (Impact)	Criteria
Major Adverse	Results in the total loss of an attribute/function of a waterbody Examples: Loss or extensive change to a fishery or designated nature conservation site Failure of both soluble and sediment bound pollutant tests in the DMRB Highways Agency Water Risk Assessment Tool (HAWRAT) and compliance failure with Environmental Quality Standard (EQS) values Loss of, or extensive change to an aquifer, potential high risk of pollution to groundwater from routine runoff (risk score > 250) Increase in peak 1% (1 in 100) flood levels > 100mm
Moderate Adverse	Results in an effect on integrity of attribute, or loss of part of attribute. Examples: Partial loss in productivity of a fishery Failure of both soluble and sediment bound pollutant tests in HAWRAT but compliance with EQS values Partial loss or change to an aquifer and medium risk of groundwater pollution (risk score 150 – 250) Increase in peak 1% flood levels of between 50mm and 100mm
Minor Adverse	Results in some measurable change in attribute quality or vulnerability. Examples: Failure of either soluble or sediment bound pollutant tests in HAWRAT Low risk of groundwater pollution (risk score < 150) Increase in 1% flood levels of between 10mm and 50mm
Negligible	Results in effect on attribute of insufficient magnitude to affect the use or integrity. Examples: Pass all pollution risk tests in HAWRAT No risk of pollution of groundwater Negligible change in 1% peak flood levels
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of a negative effect occurring. Examples: HAWRAT assessment of either soluble or sediment bound

Magnitude of Change (Impact)	Criteria
	pollutant becomes a Pass at a site where the baseline was a Fail condition; Reduction in spillage risk to an aquifer of 50% or more; Reduction in peak flood level (1% event) of 10mm to 50mm
Moderate Beneficial	Results in moderate improvement of attribute quality. Examples: HAWART assessment of both soluble and sediment bound pollutant becomes a Pass at a site where the baseline was a Fail condition Reduction in peak flood level (1% event) of > 50mm < 100mm
Major Beneficial	Results in major improvement in attribute quality Examples: Removal of an existing polluting discharge to a surface watercourse or aquifer Recharge of an aquifer Reduction in peak flood level (1% event) of > 100mm

12.3.10 The overall significance of effects is then derived by combining the value (sensitivity) of the receptor with the magnitude of the impact (change). Where more than 1 significance outcome is possible, professional judgement is used to determine which is most appropriate on a case-by-case basis and ensuring regard to the precautionary principle.

Table 12-4: Road Drainage and the Water Environment – Estimating the Significance of Potential Effects

Magnitude of Impact	Value (Sensitivity) of Attribute			
	Very High	High	Medium	Low
Major	Very Large	Large / Very Large	Large	Slight / Moderate
Moderate	Large / Very Large	Moderate / Large	Moderate	Slight
Minor	Moderate / Large	Slight / Moderate	Slight	Neutral
Negligible	Neutral	Neutral	Neutral	Neutral

12.3.11 Effects have been assigned using the criteria in Tables 12-2 to 12-4. These are residual effects that account for measures embedded in the Scheme design to prevent or reduce effects, best practice construction methods and bespoke

additional measures identified as necessary by the flood modelling study. Based on professional judgement effects assigned an overall significance of Neutral to Slight are considered to be 'non-significant' in respect of the EIA Regulations. Moderate, Large and Very Large effects are considered 'significant' for the purposes of EIA.

Assumptions and Limitations

12.3.12 Flood risk to the Scheme has been defined and assessed using bespoke modelling studies. Full details of the key assumptions informing these studies are provided in the FRA (document reference TR010035/APP/5.2).

12.3.13 No water quality monitoring surveys have been carried out and the value (sensitivity) of the water quality attributes of waterbodies in the study area have been assigned based on available published data. This is considered appropriate given the availability of existing, contemporary data sets, and this approach has been agreed with the Environment Agency (document reference TR010035/APP/5.6).

12.3.14 The assessment assumes that borrowpits would be used as this represents the worst case. If the Contractor decides, once appointed, not to use the borrowpits the impacts would be equal to or less than those presented.

12.3.15 Groundwater risks to the Scheme have been defined and assessed using available data, inclusive of site-specific data from a Ground Investigation carried out in 2018 (document reference TR010035/APP/7.6). This data is assumed to provide a robust understanding of baseline conditions.

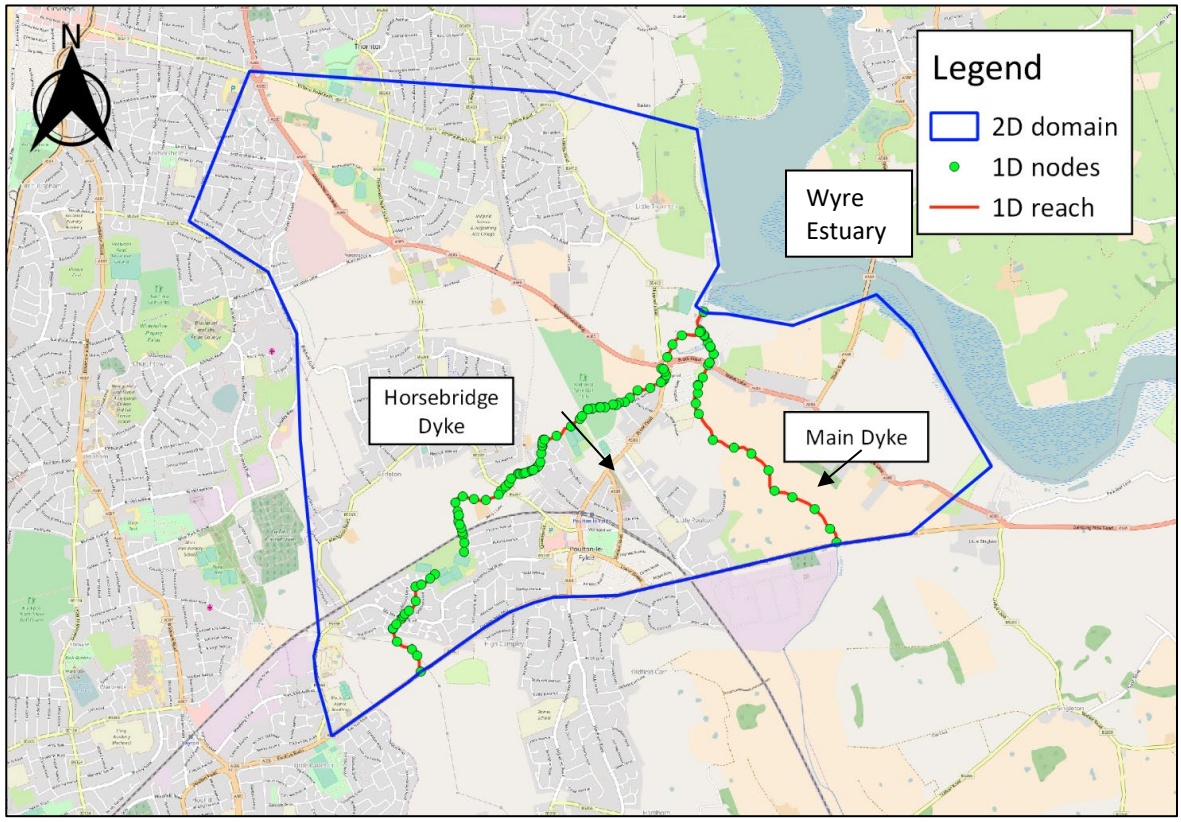
12.4 Study Area

12.4.1 Study areas, described in paragraphs 12.4.2 to 12.4.4, have been defined to reflect the water environment local to the Scheme and following consideration of the distance over which significant effects can reasonably have the potential to occur. This approach is in line with guidelines set out in HD45/09 of the DMRB. The desk study, flood modelling study areas and WFD assessment Zones of Influence (ZoI) have also been confirmed as being suitable by the Environment Agency.

12.4.2 The desk study to characterise baseline conditions and the WFD compliance assessment share common study areas, illustrated in Figure 12.3. This figure shows ZoI defined to cover the area within the draft order limits, in addition to surface waterbodies within 500m and groundwater bodies within 1km of these limits.

12.4.3 The flood modelling study has incorporated bespoke study areas for assessing river and tidal sources of flood risk. The coverage of the river model is illustrated in Insert 12-1. This has been defined to include all areas of the Scheme potentially within the fluvial floodplain, defined by the EA Flood Map for Planning.

Insert 12-1: Road Drainage and the Water Environment - Flood modelling study areas



12.4.4 The tidal model was supplied by the Environment Agency and covers the 2D domain extent shown in Insert 12-1 in addition to several additional km^2 of land, extending north, to the coastline and mouth of the Wyre Estuary, inclusive of the Wyre itself.

12.5 Existing and Future Baseline

Existing Baseline

Water Features

12.5.1 The Scheme is located to the south of the estuary of the River Wyre. In the study reach this waterbody is an Environment Agency Main River. It is tidally influenced and designated as part of the Wyre Estuary Country Park. The estuary is also a designated Site of Special Scientific Interest (SSSI) and has overlapping designations linked to the Morecambe Bay Ramsar site, Special Area of Conservation (SAC) and Special Protection Area (SPA). The river drains a catchment area of approximately 320km^2 and discharges into the Irish Sea at Fleetwood.

12.5.2 Other surface water features in the study area, illustrated in Figure 12.1, include the Main Dyke and the Horsebridge Dyke (both Environment Agency Main Rivers). These watercourses drain to the Wyre Estuary via the Skippool Creek at the western extent of the study area, with a combined catchment of approximately 40km^2.

12.5.3 There are also a number of field drains routing through the surface waterbodies study area. The Scheme crosses a total of 7 of these, including the Pool Foot Creek, in the east of the study area. Many of the agricultural fields also contain ponds.

Soils, Geology and Aquifers

12.5.4 The study area is underlain by soils that are described as reddish fine loamy over clayey soils with slowly permeable sub soils. Its topography is relatively flat and low lying with the terrain dominated by a north-west to south-east running ridge to the south of the River Wyre. This rises from around 13m Above Ordnance Datum (AOD) at Skippool to 24m AOD at Little Singleton.

12.5.5 The underlying geology of the study area is described in Chapter 13: Geology and Contaminated Land (document reference TR010035/APP/6.13). The bedrock geology supports an aquifer designated as 'Secondary B'. Aquifers of this type typically store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.

12.5.6 Overlying the bedrock geology are superficial (drift) deposits. The superficial deposits are Till (clays) and an extensive but thin layer of Glaciofluvial sands and gravels near the ground surface. Across the majority of the study area these deposits support an aquifer classified as Secondary (undifferentiated). In most cases, this means that the rock has variable characteristics, designated previously as both minor and non-aquifer. These rocks store and yield limited amounts of groundwater. Groundwater SPZs have been defined by the Environment Agency to safeguard wells or springs used for drinking water from contamination. The Environment Agency website confirms that there are no published groundwater SPZs within the study area.

12.5.7 Aquifer status is also assessed under the Environment Agency's commitments to the WFD and for the study area is reported in the River Basin Management Plan (RBMP) for the north west (Environment Agency, 2015). There is 1 groundwater body underlying the study area, the West Lancashire Quaternary Sand and Gravel Aquifer (Waterbody ID GB41202G912700). The current quantitative quality of this groundwater unit is 'Good'. This means that the level of groundwater in the aquifer (as affected by direct and indirect abstractions) meets the criteria set out in Annex V (2.1.2) of the WFD.

12.5.8 During recent Ground Investigations 3 in-situ rising head tests and 30 particle size distribution samples were analysed for hydraulic conductivity. This defines the ease with which water can move through pore spaces or fractures in the ground. The results of the combined data are shown in Table 12-5. The results are typical of the generic material types present in the study area. The Glaciofluvial deposits have an average hydraulic conductivity of between 1 and 2 orders of magnitude greater than the Glacial Till and Tidal Flat deposits. This suggests that these units of lower permeability would act as aquitards and confining layers where present above and below the Glaciofluvial Deposits aquifer.

Table 12-5: Road Drainage and the Water Environment – Hydraulic conductivity of strata

Material type	Number of samples	Maximum hydraulic conductivity (m/s)	Minimum hydraulic conductivity (m/s)	Average hydraulic conductivity (m/s)
Glaciofluvial Deposit	17	$1.66x10^{-4}$	$2.20x10^{-7}$	$3.70x10^{-6}$
Glacial Till	15	$4.60x10^{-6}$	$8.93x10^{-11}$	$7.10x10^{-8}$
Tidal Flat Deposits	3	$4.32x10^{-7}$	$1.36x10^{-8}$	$5.76x10^{-8}$
Weathered Singleton Mudstone	1	$1.79x10^{-7}$	$1.79x10^{-7}$	$1.79x10^{-7}$

12.5.9 Groundwater level information has been obtained from data collected during the Ground Investigation. Levels were monitored at 17 locations across the study area. Manual readings were collected on 29 occasions between January 2018 and July 2018. Automated water level collection also took place at 3 selected locations around the proposed new Lodge Lane bridge – where the Scheme would be in cutting. Data from the loggers compared well against manual readings at the same sites. The locations of the monitoring sites are shown in Figure 12.2.

12.5.10 Overall, the available data confirms the presence of a shallow water table within the superficial deposits. Across the study area groundwater levels were found to vary from 0.1m below ground level (bgl) to 6.1m bgl, with an average level of 2.4m bgl. Local to the proposed Lodge Lane bridge an average groundwater level of 3m bgl was recorded, with levels ranging between 1m bgl and 6m bgl. The groundwater level around the Main Dyke is approximately 1m bgl and is likely to be in hydraulic connection with the Main Dyke through the Quaternary Tidal Flat Deposits.

12.5.11 The general groundwater flow direction follows the surface topography. A recharge area is present at the highest part of the route (50m east of Lodge Lane) where Glaciofluvial deposits are at outcrop. A groundwater divide is caused by the recharge in this area and the water table falls from here to the east, west and south. As the topography decreases on hill sides the Glaciofluvial deposits are occasionally confined beneath Till, depending on the thickness of Till cover.

Surface and Groundwater Quality

12.5.12 Water quality has been defined using available data from the Environment Agency. The River Wyre and Main Dyke are both monitored under the WFD. Based on the second cycle of WFD RBMPs the River Wyre (Waterbody ID GB531207212200) within the study area is a heavily modified, transitional waterbody (estuarine) and is classified as having an overall ecological status of Moderate Potential. Potential is limited by a number of supporting elements/conditions, including dissolved inorganic nitrogen concentrations and the tidal/freshwater flow regime. A target of reaching Good ecological potential by 2027 has been set and a number of mitigation measures are detailed in the RBMP that are not yet in place. These include managed realignment of flood defences and replacement of hard bank reinforcement with soft engineering solutions. This water body achieves a chemical status of Fail against the

priority substances and priority hazardous substances categories.

12.5.13 Main Dyke, included in the WFD waterbody the Hillylaid Pool (Waterbody ID GB112072066120) is classified as a heavily modified waterbody within the study area, having an overall ecological status of Moderate Potential. The RBMP does not contain details of the factors that limit ecological potential but sets a target for this waterbody of reaching Good ecological potential by 2027. The Main Dyke achieves Good status with regard to chemical quality under the WFD.

12.5.14 The Horsebridge Dyke, the Pool Foot Creek and unnamed field drains that flow through the study area are not monitored under the WFD. No data is available to define the water quality supported by these waterbodies. However, it is considered that their quality can be inferred according to their function, surrounding land uses and flow regimes. These attributes are summarised in Table 12-6.

12.5.15 The WFD groundwater body underlying the study area achieves a current chemical quality status of 'Good'. This means that the concentrations of pollutants in the groundwater body do not currently exceed the criteria set out in Article 3 of the Groundwater Daughter Directive (2006/118/EC) and there is no upward chemical trend.

12.5.16 The Environment Agency has supplied details of pollution incidents that have had an effect on waterbodies in the study area. In the period of record (2004 to 2016) a total of 16 incidents were recorded, all of which were classified as Category 3 (Minor) incidents. Pollutants comprised raw sewage, oils / fuel and fire-fighting runoff and predominantly impacted the Main Dyke.

Flood Risk

12.5.17 Existing flood risk has been determined using published data sources, in addition to bespoke modelling studies. Baseline risks of flooding from rivers, tides, surface water and groundwater have been characterised and are summarised below. Further detail is provided in the FRA (document reference TR010035/APP/5.2).

12.5.18 The EA Flood Map for Planning illustrates that the Scheme crosses land that is considered at high risk of flooding from rivers (Flood Zone 3). The source of risk is the Main Dyke / Horsebridge Dyke. These watercourses have been modelled. Results show that the existing A585 crossing of the Main Dyke, via a twin culvert arrangement, causes a restriction to water flowing downstream during larger flood events. The restriction causes water to spill out of bank and accumulate upstream of the crossing. The flow regimes of the Main Dyke and Horsebridge Dyke are also influenced by tidal water levels in the Wyre Estuary. During high tide, flap gates prevent tidal water flowing up the watercourses but also prevent river water from discharging into the estuary. When larger river floods combine with 'tide locked' conditions, water can spill out of bank on the Main Dyke, causing flooding of land downstream of the existing A585 and along the Horsebridge Dyke both up and downstream of the crossing.

12.5.19 The study area is defended from regular direct inundation from the Wyre Estuary by Environment Agency maintained flood defences and areas of higher ground along the estuary frontage. These were built or improved in the 1980s and comprise flood walls and embankments. A standard of protection ranging from 25 years in the immediate vicinity of the Main Dyke and Horsebridge Dyke to 50 years at the Windy Harbour Holiday Park, some 3.5km to the east, is provided. Environment Agency

policy is for continued maintenance of existing defences and major assets, taking action to improve assets to an appropriate standard where they fail to meet target conditions.

12.5.20 Land use is predominantly agricultural and the fields either side of the Main Dyke either drain directly into the watercourse, perpendicular to the contours, or via a network of field boundary ditches. Sub-surface mole drains may also be present to assist with draining the land. Anecdotal evidence indicates that fields adjacent to the Main Dyke are prone to waterlogging and standing water during wet winter periods.

12.5.21 The risk of flooding from surface water is defined by Environment Agency mapping as very low (land assessed as having a less than 0.1% AEP (1 in 1000 annual chance) of flooding from this source) along the majority of the existing alignment of the A585 between Skippool and Windy Harbour. There are local areas at high risk (greater than 3.3% AEP (1 in 30 annual chance)), for example, an area that spans the existing A585 alignment near Barnfield Manor.

12.5.22 Mapping produced by the British Geological Survey shows that the majority of the Scheme is classified as having limited potential for groundwater flooding to occur at the surface. However, site specific data, described in paragraph 12.5.10, has identified a shallow water table, which is expected to contribute to waterlogged conditions in some parts of the study area.

Highway Drainage

12.5.23 As built records and data from the Highways Agency Drainage Data Management System (HADDMS) have been used to understand existing highway drainage systems in the study area. With the exception of the drainage network provided for the recently upgraded Windy Harbour Junction, records show that the A585 is currently served by gullies connecting to carrier drains. These discharge into field ditches and watercourses. Eleven primary drainage catchments within the Scheme limits have been identified, discharging to the Horsebridge Dyke / Skippool Creek, the Main Dyke and to the Wyre via land drains. Currently there are no specific measures to treat highway discharges. Some of the outfalls are provided with flap valves to prevent backflow of water from larger watercourses or tides.

Abstractions and Discharges

12.5.24 In consultation with the Environment Agency it has been confirmed there is a single abstraction licence located approximately 275m north of the eastern end of the Scheme. The licence permits abstraction of groundwater from the superficial aquifer to serve a supply for domestic, commercial, industrial and public services uses. The operation of this licence has recently been renewed by the Environment Agency to March 2030 and permits abstraction at a maximum daily rate of 109m^3 and annual rate of 28,162m^3.

12.5.25 Requests for information on unlicensed (private) supplies within a 3km search radius were made to Wyre and Fylde Borough Councils and Lancashire County Council. The councils each confirmed that they have no records of any private water supplies within the search area.

12.5.26 The Environment Agency hold records of 6 consented discharges within the study area, illustrated in Figure 12.1. These comprise discharges from the public sewer network, trade effluent and a recreational facility. Discharges are received by the

Wyre Estuary, the Skippool Creek, the Main Dyke and a tributary of this watercourse.

Future Baseline

12.5.27 The current cycle of WFD management plans ends in 2021. The effects of the implementation of specific measures in this plan on the ecological and chemical quality of surface and groundwater waterbodies have been considered when assigning value to water environment resources and receptors.

12.5.28 With regard to flood risk and drainage, future baseline conditions have been forecast, drawing on current best practice guidelines, taking into account the likely impacts of climate change on river flows, rainfall intensities, tidal flood levels / storm surge and groundwater levels. Change anticipated for the 2020s is considered when assigning baseline value to water environment resources and receptors.

12.5.29 Climate change allowances applicable to the design life of the Scheme has been represented in the quantitative modelling assessments undertaken to inform the Scheme drainage design and FRA (document reference TR00035/APP/5.2).

Receptors Potentially Affected (including value / sensitivity)

12.5.30 Table 12-6 presents a list of receptors potentially affected by the Scheme together with its value (sensitivity).

Table 12-6: Road Drainage and the Water Environment – Receptors Potentially Affected

Receptor	Attribute	Value / Sensitivity and Rationale
River Wyre / Wyre Estuary and associated defended tidal floodplain	Water quality	High - rare at the local scale with no potential for substitution. Designated under UK and EU nature conservation legislation. Current overall WFD ecological status of Moderate (2016) but targeting Good by 2027, with some progress towards this target expected by 2021. However, WFD chemical quality status of Fail.
	Flow conveyance and storage	High - tidal Flood Zone 3 within study area, with a floodplain and defences protecting between 1 and 100 residential properties and industrial premises from flooding.
	Water supply / transport and dilution of waste effluents	Medium - no licensed abstractions supported within the study area but receives consented discharges from the

Receptor	Attribute	Value / Sensitivity and Rationale
		public sewer network.
Main Dyke/Horsebridge Dyke and associated tidal/fluvial floodplain	Water quality	High / Medium – locally important with limited potential for substitution. Current overall ecological status of Moderate Potential but targeting Good by 2027, with some progress towards this target expected by 2021. Good WFD chemical status (inferred for Horsebridge Dyke).
	Flow conveyance and Storage	High - tidal and fluvial Flood Zone 3 within study area, with a floodplain and defences protecting between 1 and 100 residential properties and industrial premises from flooding.
	Water Supply / Transport and dilution of waste effluents	Medium - no licensed abstractions supported within the study area but receives consented discharges from the public sewer network.
Pool Foot Creek and Unnamed land drains	Water quality	Medium – common-place at the local scale, with potential for substitution. No WFD data but likely to receive agricultural runoff and be subject to ephemeral drying out/pooling of water, impacting water quality.
	Flow conveyance and Storage	Medium - serve a land drainage function at the local scale.
Superficial aquifer	Water quantity/water supply	Medium - Secondary (undifferentiated) aquifer, known to support 1 licensed abstraction within the study area.
Bedrock aquifer	Groundwater quality	High - achieves Good WFD chemical water quality status
	Water quantity / water	Medium - current quantitative

Receptor	Attribute	Value / Sensitivity and Rationale
	supply	quality of this groundwater unit is 'Good' but within the study area there are no SPZs and the aquifer is not known to support any licensed abstractions.

12.6 Mitigation and Enhancement Measures

Construction

12.6.1 A Construction Environmental Management Plan (CEMP) would be produced to ensure the quality of the water environment does not deteriorate during construction of the Scheme. The CEMP would include best practices for the management of environmental impacts during construction. An Outline CEMP has been prepared (document reference TR010035/APP/7.2) together with a Record of Environmental Actions and Commitments (REAC) (document reference TR010035/APP/7.3). The Outline CEMP and REAC require a Pollution Control Plan to be prepared by the Contractor prior to the start of construction to safeguard the quality of surface water and groundwater and the downstream designated SPA / Ramsar site, drawing on best practices and relevant CIRIA publications. These include CIRIA (2001) Control of water pollution from construction sites: guidance for consultants and contractors (C532) and CIRIA (2015) Environmental Good Practice on Site' (C741). This Plan would need to include protocols for undertaking regular visual checking of waterbodies located near areas of construction works for changes in water colour, transparency and for signs of oil sheen, scum or foam build up. The preparation of the Pollution Control Plan is secured through Requirement 4 of the draft Development Consent Order (document reference TR010035/APP/3.1). Further details regarding measures to safeguard the integrity of the Morecambe Bay and Duddon Estuary SPA and Morecambe Bay Ramsar Site are provided within Chapter 8: Biodiversity (document reference TR010035/APP/6.8).

12.6.2 Method statements and management plans would be prepared by the successful Contractor(s) and built into the CEMP, detailing their approach to controlling site activities to prevent pollutant releases and to monitor potentially polluting activities on site. Likely measures have been detailed in the REAC (document reference TR010035/APP/7.3).

12.6.3 The Outline CEMP (document reference TR010035/APP/7.2) and REAC (document reference TR010035/APP/7.3) also require the preparation prior to construction of an Emergency Spillage Response Plan. This would document measures to prevent pollutants migrating downstream if accidentally released to a surface waterbody or infiltrating into the soils beneath the site and reaching underlying groundwater. Appropriate equipment to contain and isolate spills and to allow rapid clean-up (e.g. absorption mats) would be made easily accessible on site to deal with accidental spillages. The Plan would also provide a full list of protocols and communication channels with the Environment Agency in the event of an accidental pollution incident. The sites of any temporary fuel or chemical storage associated with the construction work would be screened to avoid areas in proximity to watercourses and the single licensed groundwater abstraction site.

12.6.4 Where existing properties are served by septic tanks that could be affected by construction of the Scheme, appropriate mitigation measures would be put in place to ensure no detriment to foul drainage provision, nor to the local water environment.

12.6.5 As groundwater control (dewatering) activities would be required, the Outline CEMP (document reference TR010035/APP/7.2) and REAC (document reference TR010035/APP/7.3) require the Contractor to prepare prior to construction a Dewatering Management Plan. This Plan, prepared in consultation with the Environment Agency, would detail measures to limit the effects on groundwater levels and flows during construction including:

- A method statement detailing dewatering techniques and roles and responsibilities for this activity
- Opportunities to maximise reuse of dewatering effluent on site to reduce the amount of disposed effluent
- Details of methods of disposal and a monitoring plan to ensure compliance with Environment Agency permits for dewatering and the subsequent discharge of dewatering effluents

12.6.6 During construction, the appointed Contractor(s) would also be required to produce an Emergency Flood Response Plan (EFRP) and monitor Environment Agency Flood Warnings. The EFRP would detail the actions to be taken in response to the receipt of an Environment Agency flood warning for tidal flooding from the Wyre Estuary. The FRA (document reference TR010035/APP/5.2) has demonstrated that the proposed compound located to the north east of the proposed Skippool junction is at risk of flooding during an extreme (0.5% annual chance) tidal event and a compound and laydown area at the proposed Grange footbridge is situated within the defended floodplain. Flood risk data generated from the FRA would be used to inform the EFRP. For example, if flood warnings are received, actions include the removal of plant, materials and construction personnel from work sites located within the flood warning area prior to the flood event. If movement of plant or materials is not practical, protective measures could be implemented to safeguard these components. The Plan would also identify evacuation routes and muster points for construction site personnel. The preparation of this plan is required in Outline CEMP (document reference TR010035/APP/7.2) and REAC (document reference TR010035/APP/7.3).

12.6.7 Land affected by the creation of borrowpits would be subject to re-instatement. Measures, including those to ensure appropriate drainage, would be detailed in a Restoration and Aftercare Plan, forming an appendix to the Outline CEMP (document reference TR010035/APP/7.2).

12.6.8 Modelling has identified a temporary increase in flood risk from the Main Dyke during construction of the Scheme. This impact is limited to the duration when road embankments are being constructed prior to placement of the new open span crossing of the river. Increases in flood extents and depths would occur in fields on the left bank of the Main Dyke behind Little Poulton Lane, also impacting Fouldrey Avenue during larger flood events. To mitigate this impact an area of land on the right bank of the Main Dyke immediately downstream of the A586 is included in the Scheme. This land would be permanently lowered to provide floodplain storage and offset the temporary losses of storage caused by the road embankment during its

construction. As detailed in the FRA (document reference TR010035/APP/5.2) a modelling assessment has proven the concept of this mitigation strategy in reducing flood depths and extents back towards baseline conditions. A commitment to provision of compensation storage is provided in the REAC (document reference TR010035/APP/7.3) and a detailed floodplain compensation scheme would be developed at the next stage of design in consultation with the EA.

12.6.9 To promote the sustainable use of water resources, measures would be implemented during construction to promote general water use efficiency and particularly reduce the use of potable water. Examples that could be adopted include rainwater harvesting, to provide water supply for welfare facilities and for use in dust suppression; the collection of greywater for use in wheel washing facilities; and leakage prevention. These measures would be set out in a Construction Water Management Plan as detailed in the Outline CEMP (document reference TR010035/APP/7.2) and REAC (document reference TR010035/APP/7.3).

Operation

12.6.10 A drainage design has been developed for the operational Scheme that rapidly removes water and prevents flooding of the carriageway. The Scheme would discharge to the receiving water environment via existing and new outfalls. Attenuation would be provided to achieve agreed discharge rates, inclusive of an allowance for climate change resilience. The drainage design also includes appropriate measures to manage the quality of highway runoff. Measures include vortex oils and grit separators, vegetation treatment systems (constructed wetlands) and shut off valves to contain pollutants in the event of an accidental spillage. Indicative drawings illustrating key elements of the drainage design are provided in Appendix E of the FRA (document reference TR010035/APP/5.2). These treatment measures have been tested using the HAWRAT. All outfalls achieve a Pass with the proposed mitigation measures in place.

12.6.11 Where an existing watercourse would be severed by the proposed carriageway alignment, a culvert would be installed to maintain the existing land drainage regime. Five new culverts on ordinary watercourses are proposed and 2 existing culverts, on ordinary watercourses, would be extended to accommodate the Scheme.

12.6.12 The new culverts have been sized, as part of the drainage design, to maintain the current land drainage regime and to convey flood flows without causing any detriment to baseline flood risk. Culvert inverts would also be buried below existing bed levels to allow baseline bed levels, slopes and bed materials to be maintained. Suitable mammal ledges would be provided and bankside vegetation would be re-instated. These measures would reduce the effects of culverting on flood risk, riverine habitats, mammal passage and geomorphology.

12.6.13 Replacement of the existing Horsebridge Dyke culvert is also proposed. Design of the new structure would ensure that the existing flow conveyance properties of the culvert are maintained or improved. The other features of culvert design described above would also be adopted to reduce the effects of this change on all other attributes of this watercourse.

12.6.14 Where the Scheme interacts with Environment Agency Main Rivers (the Main Dyke / Horsebridge Dyke and the Wyre Estuary) the vertical alignment prevents flooding of the carriageway (including during tide locked conditions, when high water levels

in the estuary prevent free discharge of the rivers). A new clear span crossing of the Main Dyke, replacing the existing twin culvert arrangement, would also mitigate existing flood risk. As detailed in the FRA (document reference TR0100035/APP/5.2), this measure causes a reduction in the extent of the Main Dyke floodplain, bringing benefit in terms of a reduction in river flooding risk upstream of the A585 crossing.

12.6.15 Residual risks of tidal flooding to the Scheme have been identified in 2 small areas, 1 to the east of Skippool junction and 1 to the west of Windy Harbour Junction. It is not possible to fully design out the risk of tidal flooding at these 2 locations as it is necessary for the Scheme to tie into existing road levels. Risk would therefore be managed through notifying road users via appropriate signage and social media, with warnings, and where necessary road closures, implemented using intelligence provided by the Environment Agency flood warning service.

12.6.16 Effects on groundwater levels and flows would be mitigated by implementing an appropriate drainage solution for the section of the Scheme that would be in cutting.

12.7 Residual Effects

Construction

Surface and Groundwater Quality

12.7.1 The potential for impacts on surface water and groundwater quality during construction arise from construction works in / near watercourses or excavations, including for borrowpits, opening pollution pathways to groundwater, and indirectly, due to the receipt of contaminated surface water runoff. The Scheme requires construction of new culverts, replacement of the existing Horsebridge Dyke culvert, a clear span river crossing of the Main Dyke, extensions to existing culverts crossings and the creation of cuttings, which could open pollution pathways to water receptors, including the downstream SPA / Ramsar site. Sources of pollutants include fuels and oils, cement-based products and sediments from earthworks. Additional hazards arising from construction activities include the accidental release of floatable material, loss of material during storm events and mobilisation of contamination and migration into controlled waters, as well as the potential for the entrainment of fine sediment in runoff, which could increase siltation in receiving watercourses.

12.7.2 However, once appropriate mitigation measures (as detailed in Section 12.6) are in place, it is considered there would be a **Negligible** magnitude of change (impact) on the baseline water quality characteristics of the Wyre Estuary and SPA / Ramsar site. There is no potential for direct effects on this waterbody and construction works sites would be managed to prevent pollution of the watercourses that flow into the estuary. Given the **High** value (sensitivity) of the water quality attributes of this waterbody, the overall effect of the Scheme would be classified, in accordance with Table 12-4, as **Neutral** and deemed to be **Not Significant** in terms of the EIA Regulations.

12.7.3 Localised and temporary change of **Minor adverse** magnitude is predicted for the water quality attributes of the Main Dyke, Horsebridge Dyke, Pool Foot Creek and those unnamed watercourses that would be crossed by the Scheme. These waterbodies would have construction works sites in close proximity and / or would be temporarily physically disturbed by construction works. The Main Dyke and Horsebridge Dyke share water quality attributes of **High** value and the Pool Foot

Creek and unnamed watercourses are assigned **Medium** value with regard to water quality. Temporary effects with an overall significance locally of **Slight Adverse** are therefore predicted for these waterbodies. Predicted effects on surface water quality are deemed to be **Not Significant** in terms of the EIA Regulations.

12.7.4 Groundwater resources, in terms of their water quality attributes are assigned **High** importance given the Good WFD chemical status of the underlying groundwater body. It is considered there would be a **Minor adverse** magnitude of change (impact) on these baseline characteristics locally, in particular where the proposed Lodge Lane cutting is created. Temporary effects with an overall significance locally of **Slight Adverse** are therefore predicted, deemed to be **Not Significant** in terms of the EIA Regulations.

Flood Risk

12.7.5 Throughout the construction phase along much of the Scheme, the greatest risk of flooding is linked to periods of heavy rainfall, when soils become saturated and runoff may pond in lower lying areas and collect in excavations. During the initial earthworks phase, topsoil and subsoil would be exposed and water-logging and ponding may occur more frequently. Additionally, there is a higher risk of entrained sediment in runoff, leading to blockage or reduced conveyance capacity in local drains / ditches / culverts and components of the existing highway drainage system.

12.7.6 However, the application of good construction site management practices (as outlined in Section 12.6), would facilitate the early identification of any blocked drains or areas of rainfall ponding, and remedial action would be taken to minimise or prevent surface water flood events occurring.

12.7.7 During more extreme events, which have a lower likelihood of occurring during the relatively short duration of the construction period, the Main Dyke and the tidal Wyre could also pose a source of flood risk to localised areas of the Scheme. Construction works sites would be provided with Environment Agency Flood Warnings and Emergency Flood Response protocols in place. In addition, land lowering would provide floodplain storage to offset the losses and resulting temporary flood risk increase during the period prior to construction of the new open span crossing of the Main Dyke.

12.7.8 The value of the flow conveyance and storage attributes of the waterbodies in the study area range from **Medium** (local drains) to **High** (Environment Agency Main Rivers and Wyre Estuary). The measures outlined would reduce the potential magnitude of temporary and localised change to **Minor adverse,** resulting in effects with an overall significance of **Slight Adverse.** Predicted effects on flow conveyance and flood risk are deemed to be **Not Significant** in terms of the EIA Regulations.

Groundwater / Hydrogeology

12.7.9 During construction it is expected that groundwater levels would be reduced in an area around the Lodge Lane bridge where the Scheme would be in cutting (called ‘the area of influence’). The extent of the area of influence is dependent on the duration of drainage activity, the hydraulic conductivity of the aquifer and the amount of lowering of the water table (drawdown). Drawdown would be produced by infiltration of groundwater into a passive, longitudinal temporary drainage system installed within the cutting. It is expected that the shallow Glaciofluvial aquifer would be locally dewatered at the cutting as a result. The radius of influence for the steady

state, operational period is calculated in Table 12-7 to be a maximum of 350m. The radius of influence during construction is likely to less due to the limited duration of the construction period.

12.7.10 The worst-case volume of groundwater calculated to be discharged from the cutting of less than 5 L/s. Assumptions inherent to the calculation are that the aquifer is 3m thick and it is fully saturated at the radius of influence, that recharge is a constant average rate and that the conditions are in steady state. Based on the worst-case assessment, the groundwater drainage volumes during construction would be over 20 m^3/d and therefore dewatering operations would require a permit from the Environment Agency. Due to their limited depth, the creation of borrowpits is not considered to have any significant groundwater drainage effects.

12.7.11 Groundwater resources in the study area, in terms of quantity, have been classified as having **Medium** value, as the Glaciofluvial deposits are likely to be an aquifer that could provide water for industrial or agricultural use. At the cutting the drainage required during construction could lead to a localised draining of the saturated zone in the near surface Glaciofluvial deposits. The drawdown effects would be local to the cutting, with a predicted **Minor** magnitude of impact (partial loss of an aquifer but with no effects on groundwater dependent terrestrial ecosystems (GWDTE) or existing abstractions). The overall significance of the effect on the Glaciofluvial Deposits superficial aquifer is classified as **Slight Adverse**. This is deemed **Not Significant** in terms of the EIA Regulations.

Abstractions and Discharges

12.7.12 A single licensed abstraction borehole, 18m deep, and with a small yield of 109 m^3/d, is located 275m north of the eastern end of the Scheme at Windy Harbour Holiday Park. The abstraction site is 1.39km east of the easternmost location where drainage associated with construction of the Lodge Lane bridge and associated cutting would take place and is also remote from the locations of the proposed borrowpits. Using analytical methods described in Table 12-7 the calculated radius of influence for the borehole is 210m. The radius of influence of the cutting has been calculated to be 350m maximum**.** Therefore, no groundwater drawdown (lowering of groundwater levels) at the well would be caused, based on the calculations. Rainfall recharge to the Glaciofluvial Deposits would be locally reduced in the Lodge Lane cutting area. However that is unlikely to affect the licensed abstraction given the large distance between the well and the proposed cutting. It is considered that this reduction in recharge would be negligible in comparison to the total recharge catchment for the borehole. A **Negligible** magnitude of change (impact) is therefore predicted on the groundwater resource that supplies the borehole (of **Medium** value), resulting in a **Neutral** overall effect that is **Not Significant** in terms of the EIA Regulations.

12.7.13 A residual **Negligible** magnitude of change (impact) is predicted on the function of transporting and diluting waste water effluents in the Main Dyke and Wyre Estuary. This is because there would be no reduction in flow quantity in these watercourses during the construction of the Scheme and existing flow corridors would be maintained. These attributes of the watercourses have been assigned **Medium** value, resulting in an overall significance that is **Neutral** and is **Not Significant** in terms of the EIA Regulations.

Operation

Water Quality

12.7.14 During operation, road drainage, which could be contaminated by spills and leaks of oil and fuel, and by other materials deposited onto the drained surfaces such as road salts, would be discharged to surface watercourses. The Main Dyke, Horsebridge Dyke and Pool Foot Creek would receive routine highway runoff. Furthermore, there is a risk that polluting materials may be spilt onto the road surface because of a road accident. These pollutants also have the potential to enter these watercourses and shallow aquifers.

12.7.15 However, the pollution potential of the Scheme has been tested, during both routine runoff and accidental spillage scenarios, using HAWRAT. The findings, detailed in the drainage strategy, which is appended to the FRA (document reference TR010035/APP/5.2), have informed the drainage design. The design would include treatment measures (described in paragraph 12.6.7). With these measures in place residual effects on the water quality attributes of these watercourses (having **High** to **Medium** value) are quantified as having a **Negligible** magnitude. The overall significance of effects would be **Neutral**, and **Not Significant** in terms of the EIA Regulations.

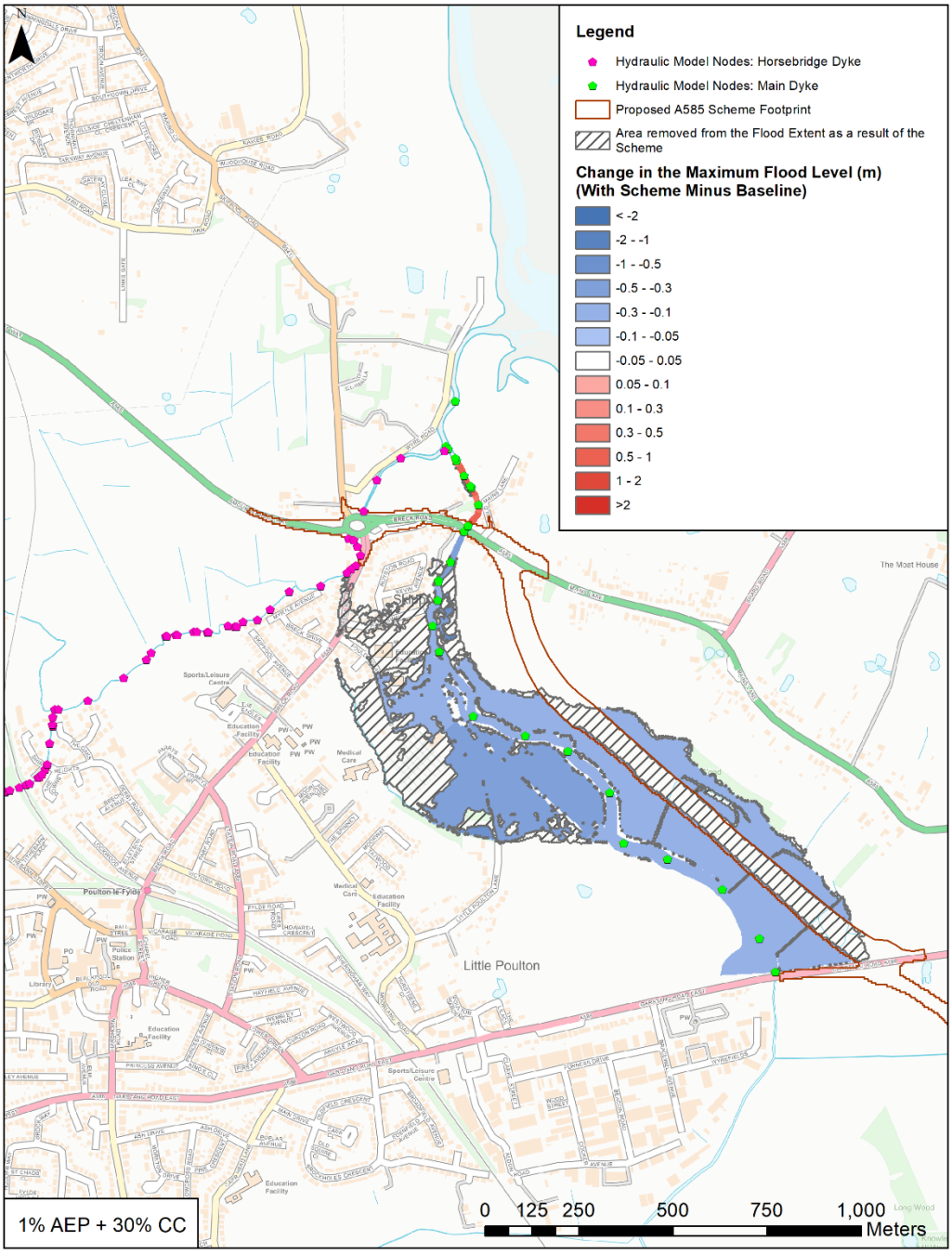
Flood Risk

12.7.16 With regard to flood risk impacts, the Scheme would create new impermeable areas of land cover and consequently generate higher rates and volumes of rainfall runoff, with the potential for increased surface water flood risk. Requirement for alterations to existing watercourse crossings and the creation of new culverts has the potential to impact on the flow conveyance and capacity of watercourses and flood risk from these sources.

12.7.17 Following the application of mitigation measures described in Section 12.6, including culvert design and the management of highway runoff, there would be a **Negligible** magnitude of change on surface water flood risk/the land drainage regime (assigned **Medium** to **High** value). The overall significance of the residual effects would be **Neutral**, and **Not Significant** in terms of the EIA Regulations.

12.7.18 Flood risk from Main Rivers has been assessed. Hydraulic modelling results show that, by removing an existing restriction to flow (a twin culvert) on the Main Dyke, the Scheme provides a flood risk benefit for areas upstream of the A585 crossing of the river. Baseline flood extents and depths are reduced, as illustrated in Insert 12-2.

Insert 12-2: Road Drainage and the Water Environment - Maximum Flood Depth Difference Between Baseline and with Scheme Scenarios (1% AEP plus 30% climate change event)



12.7.19 The magnitude of this change is assessed as **Moderate Beneficial**, combined with the **High** value of the flood flow / storage attributes of the Main Dyke, resulting in an overall significance of **Moderate to Large Beneficial**. In terms of the EIA Regulations this effect is considered **Significant** (positive).

12.7.20 As illustrated, minor increases in baseline flood levels are predicted downstream of the A585 along the Main Dyke to the Skippool tidal gates due to more water passing

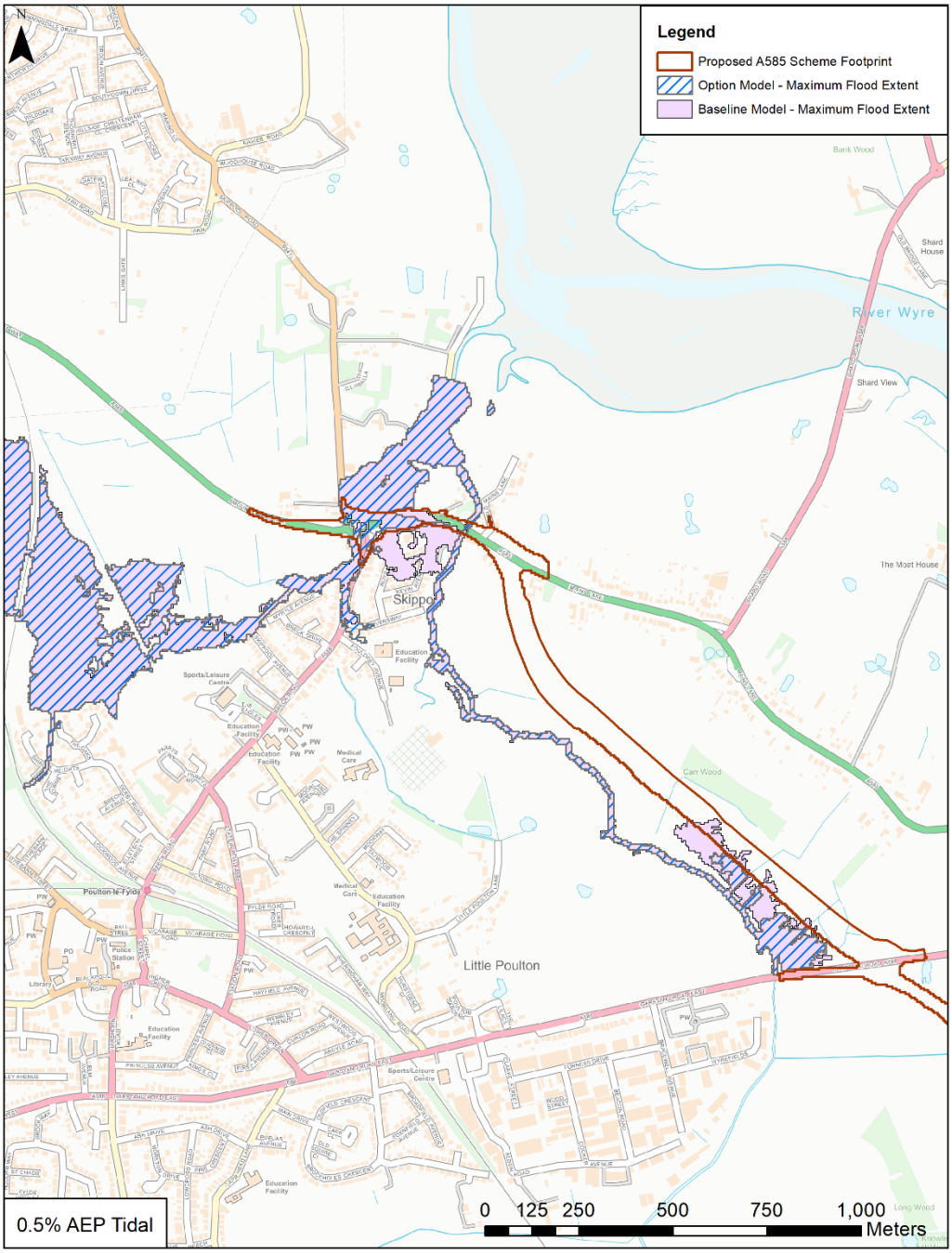
through the new clear span bridge. However, increases in flood depths are marginal and baseline flood extents would not be increased. The magnitude of this change is assessed as **Minor Adverse** on an attribute assigned **High** value, resulting in an overall significance of **Slight Adverse**. In terms of the EIA Regulations this effect is considered **Not Significant**.

12.7.21 **Negligible** magnitude effects are predicted on baseline flood risk linked to culverted ordinary watercourses and the proposed replacement of the Horsebridge Dyke culvert. The overall significance of these effects is **Neutral**, and **Not Significant** in terms of the EIA Regulations.

12.7.22 Flood risk to the Scheme from tidal inundation has also been assessed. Two flood events have been modelled (the 0.5% annual chance and the 0.5% annual chance inclusive of an allowance for climate change) to define baseline flooding and any effects of the Scheme. Climate change allowances have been applied in accordance with EA (2017) Flood risk assessment climate change allowance guidelines and have been agreed to be appropriate with the EA. Results show that during events of this magnitude, the Wyre flood defences are overtopped. Land in some parts of the study area is predicted to be flooded, for example around Skippool junction, where tidal waters propagate up the Horsebridge Dyke, overtopping the existing A585 and inundating existing properties between Breck Road and the Main Dyke.

12.7.23 During the 0.5% annual chance event, as illustrated in Insert 12-3, with the Scheme in place there is a reduction in flood risk to these properties, that are predicted to be prevented from flooding. This is because an increase in the vertical alignment of the Scheme at this location prevents water from overtopping the road and flowing into this area. Instead, more water pools behind the road embankment to the north and flows upstream (south) along the Horsebridge Dyke. The magnitude of change is assessed as **Moderate Beneficial**. Combined with the **High** value of the flood flow/storage attributes of the tidal floodplain, this results in an effect with an overall significance of **Moderate Beneficial**. In terms of the EIA Regulations this effect is considered **Significant** (positive).

Insert 12-3: Road Drainage and the Water Environment - Maximum flood Extents in Baseline and with Scheme (option model) Scenarios (0.5% AEP tidal event)



12.7.24 When climate change allowance is included over the lifetime of the Scheme, model results predict that the development proposals increase baseline flood depths locally by up to 10cm. Although baseline flood depths are increased, changes in flood extents are negligible due to the nature of the topography and the well-defined tidal floodplain. Also, the increase in the context of baseline floodwater depths of up to 1m is relatively small.

12.7.25 Key mechanisms driving the changes in flood depths along the Main Dyke are an increase in tidal flows propagating upstream through the widened A585 bridge. The magnitude of this change is assessed as **Moderate Adverse**, combined with the **High** value of the flood flow/storage attributes of the Main Dyke, resulting in an overall significance of **Moderate Adverse**. In terms of the EIA Regulations this effect is considered **Significant**.

12.7.26 The key mechanism driving the changes in flood depths along the Horsebridge Dyke is also the increased flood flows on the Main Dyke through the widened A585 crossing. This in turn increases flood levels on the Main Dyke and restricts the volume of flow which can pass from the Horsebridge Dyke into the Main Dyke via the floodplain. Consequently, flood levels increase in the Horsebridge Dyke and a small increase in floodplain flood depths is observed. The magnitude of this change is assessed as **Moderate Adverse**, combined with the **High** value of the flood flow / storage attributes of the Horsebridge Dyke, resulting in an overall significance of **Moderate Adverse**. In terms of the EIA Regulations this effect is considered **Significant**.

Groundwater / Hydrogeology

12.7.27 During operation it is expected that groundwater levels in the shallow Glaciofluvial aquifer would be reduced in an area around the Lodge Lane cutting. As discussed in paragraph 12.7.9, the degree of change would depend on both the hydraulic conductivity of the aquifer and the amount of lowering of the water table (drawdown). The average thickness of the Glaciofluvial deposits in the cutting is 3m and it is, on average, unconfined and at an elevation of between 1.5m bgl and 4.5m bgl in the zone of cutting. The Glacial Till lies beneath the Glaciofluvial deposits and is a non-aquifer.

12.7.28 The maximum radius of influence of the cutting can be calculated iteratively (Niccoli & Marinelli, 1998) following the equation provided in Table 12-7. The calculations and conceptual model shown in Insert 12-4f, indicate that the maximum radius of influence of the cutting would be 350m. This is a very conservative assessment as the hydraulic conductivity used in the worst-case assessment is 100 times larger than the geo-mean average for the Glaciofluvial Deposits aquifer.

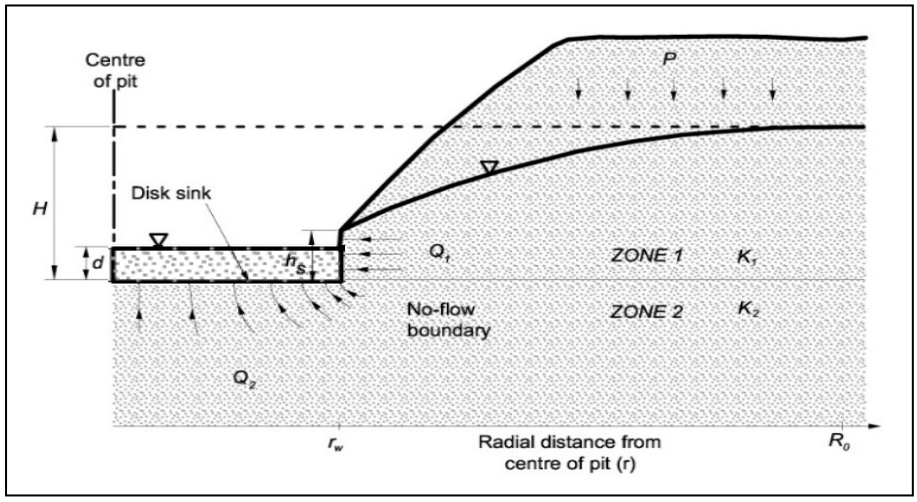
12.7.29 The worst-case volume of groundwater calculated to be collected from the cutting is less than 5 L/s. Assumptions inherent to the calculation are that the aquifer is 3m thick and it is fully saturated at the radius of influence, that recharge was a constant average rate and that the conditions are in steady state.

Table 12-7: Road Drainage and the Water Environment – Dewatering Calculations

Parameter	Value	Justification
Calculation of radius of influence	$H = \sqrt{h_s^2} + \frac{P}{K_{h1}}\left[R_o^2 ln\left(\frac{R_o}{r_w} - \frac{R_o^2 - r_w^2}{2}\right)\right]$	
H (height of the water table at the radius of influence, m)	3	Assuming a fully saturated 3m thick aquifer for a conservative worst case scenario
h_s (saturated thickness at the	0	Assuming the aquifer is fully dewatered at the intersection of the aquifer with the

Parameter	Value	Justification
seepage face (m)		cutting wall
P (recharge, m3/m2/s)	$5x10^{-9}$	This is equivalent to 0.43 mm/d, a relatively low rate for the UK (and therefore, conservative) and representing that the clay Till cover would inhibit recharge in general
r_w (radius of excavation, m)	17.5m	Half the width of the carriageway
K_{h1} (Layer 1 horizontal hydraulic conductivity, m/s)	Worst case: $1.66x10^{-4}$	Worst case: The highest hydraulic conductivity data recorded from particle size distribution analysis for the Glaciofluvial deposits. It is noted that the worst-case parameters used in the assessment are 100 times larger than the average conditions.
R_o = (Radius of influence, m)	Worst case: 350m	Calculated iteratively by varying the radius of influence to calculate the desired value for H
Calculation of inflow to cutting	$Q = \left[0.73 + 0.23\left(\frac{p}{H}\right)\right]\frac{K_{h1(H^2-h_s^2)}}{l_o}$ $l_o = 1750(K_{h1} - h_s)\sqrt{K}$	
Q	Worst case: $K=1.66x10^{-4}$	1.61x10-5 $m^3/s/m$
L (Length of cutting below water table)	270m	Distance between Chainages 2975 and 3245 in which the carriageway is below the groundwater table
Q_L (the inflow expected into the whole cutting length, L/s)	Worst case: 4.35 L/s	The flow rate per meter multiplied by the length over which dewatering may be expected.

Insert 12-4: Road Drainage and the Water Environment: Analytical Conceptual Model Associated with Dewatering Calculations



12.7.30 Groundwater resources supported by the Glaciofluvial deposits have been classified as having **Medium** value. This is because the aquifer could provide water for industrial or agricultural use. At the proposed cutting the drainage required could lead to a localised draining of the saturated zone in the near surface. The drawdown effects would be local to the proposed cutting and the magnitude of change is assessed as **Minor to Moderate Adverse** (partial loss of an aquifer but with no effects on GWDTEs or existing abstractions). The overall significance of the effect on the Glaciofluvial deposits superficial aquifer is classified as **Moderate to Slight Adverse**. A **Moderate Adverse** effect is considered **Significant** in terms of the EIA Regulations.

12.7.31 For the reasons described in paragraph 12.7.13, a **Negligible** magnitude of change (impact) is predicted on the function of the single licensed abstraction borehole within the study area. The overall effect on this receptor during operation of the Scheme is assessed as **Neutral** and **Not Significant** in terms of the EIA Regulations.

12.7.32 Commonplace at the local scale, ponds within the radius of influence (of **Low** value) could be affected if hydraulically connected to underlying Glaciofluvial deposits. The magnitude of change is assessed as **Moderate Adverse** as a worst case, resulting in an overall effect of **Slight Adverse**. The effect is **Not Significant** in terms of the EIA Regulations.

Human Health

12.7.33 The Scheme would result in a number of effects that could be beneficial to the health and wellbeing of the local population. The Scheme would result in a reduction in flood risk upstream of the proposed crossing of the Main Dyke. This is also the case where areas of the Scheme alignment and surrounding areas are at risk of flooding from the tidal Wyre Estuary during more extreme flood events (0.5% annual chance). This results in flood risk to an area of existing development being reduced and, therefore, reduces the potential exposure of the population to flood waters. In particular, properties that reside to the south of the Scheme on Kevin Avenue and Royston Road will benefit most from this reduction in tidal flood risk.

12.7.34 Any potential for pollutants to enter watercourses would be mitigated by the measures outlined above in Section 12.7 and therefore it is predicted that no significant adverse effects would occur on human health**.**

12.8 Monitoring

12.8.1 Visual inspection by construction personnel for signs of pollution, including duration dewatering operations is proposed. It is also proposed that Environment Agency flood warnings for the tidal Wyre Estuary are monitored during both construction and operation of the Scheme further detail is outlined in the REAC (document reference TR010035/APP/7.3).

12.8.2 During operation of the Scheme key components of the drainage system, such as the proposed wetland ponds, would be subject to routine inspection and maintenance activities. These activities are detailed in the drainage strategy, which is appended to the FRA (document reference TR010035/APP/5.2).

12.9 Summary

12.9.1 During construction the Scheme would implement measures to prevent pollution / water quality degradation and to manage work site drainage and runoff. During operation of the Scheme, the design would include for climate change resilience and would also offer potential for betterment in treating highway runoff prior to discharge to the surface water environment. There would also be a reduction in fluvial flood risk upstream of the proposed crossing of the Main Dyke during operation of the Scheme as an existing flow restriction would be removed, and a local reduction in tidal flood risk during the present day 0.5% chance event.

12.9.2 Baseline information for surface and groundwater quality has been drawn from the WFD 2015 second cycle and watercourses within the study area achieve 'Moderate' or 'Good' overall status. There is limited possibility of sedimentation and pollution during the construction phase, following the application of design mitigation measures (which would be documented in and secured via the REAC (TR010035/APP/7.3), meaning that potential impacts from the proposed Scheme are generally considered **Negligible,** resulting in an overall effect of **Neutral.** Where works would be required in channel or in close proximity to watercourses, and at the proposed Lodge Lane cutting, there is potential for minor, temporary impacts that are considered to be **Not Significant** in terms of the EIA Regulations.

12.9.3 Temporary **Minor Adverse** effects on baseline rainfall runoff regimes and fluvial flood risk are associated with converting greenfield land to impermeable cover and construction in the Main Dyke floodplain prior to removal of an existing flow restriction. These effects have an overall significance of **Slight Adverse** and are deemed **Not Significant** in terms of the EIA Regulations.

12.9.4 During operation it is considered that the Scheme would result in betterment to the existing attenuation and treatment of highway runoff as well as reduce accidental spillage related pollution risk. A **Negligible** to **Minor Beneficial** magnitude of impact is predicted for all receptors that receive discharges of highway runoff, resulting in an overall effect of **Neutral/Slight Beneficial.** This is deemed **Not Significant** in terms of the EIA Regulations.

12.9.5 Upstream of the crossing of the Main Dyke, by removing an existing restriction to flow (a twin culvert), the Scheme provides a flood risk benefit, reducing baseline flood

depths and extents. This is assessed as having a **Moderate Beneficial** magnitude of impact and an effect of **Moderate Beneficial** significance. This is deemed **Significant** (positive) in terms of the EIA Regulations.

12.9.6 Baseline information indicates that 2 parts of the Scheme alignment and surrounding areas of land are at risk of flooding from the tidal Wyre Estuary during more extreme flood events (0.5% annual chance). Baseline flood depths reach up to approximately 1m. With the Scheme is place baseline flood risk to any area of existing development is reduced. This change is assessed as having a **Moderate Beneficial** magnitude of impact and an effect of **Moderate Beneficial** significance. This is deemed **Significant** (positive) in terms of the EIA Regulations.

12.9.7 However, when an EA agreed allowance for climate change is considered over the lifetime of the Scheme, the Scheme proposals are predicted to increase baseline flood depths on the Horsebridge Dyke and Main Dyke by up to 0.1m. Baseline flood extents are not increased.

12.9.8 The construction of a cutting in the Lodge Lane area is predicted to have a **Minor to Moderate Adverse** impact on groundwater resources within the **Medium** value surface Glaciofluvial Deposits aquifer. The Scheme during its construction and operation would dissect this aquifer resulting in drainage of it local to the cutting, with an overall effect of **Slight/Moderate Adverse** significance. A **Moderate Adverse** effect is deemed to be Significant under the EIA Regulations. However, the assessment methodology applied is highly conservative and a **Slight Adverse** effect is considered more likely, in which case this is deemed **Not Significant** in terms of the EIA Regulations.

12.9.9 During the operational phase, due to the embedded design measures a **Negligible** impact is predicted on the water quality attributes of waterbodies receiving highway drainage (the Main Dyke, Horsebridge Dyke and Pool Foot Creek) which, combined with their **High** and **Medium** value, results in an overall effect that is **Neutral** and **Not Significant** in terms of the EIA Regulations.

12.9.10 No significant impacts on the abstraction located in the study area are predicted during construction or operation of the Scheme.

12.10 References

CIRIA (2006) *C649 Control of Water Pollution from Linear Construction Projects: Technical Guidance*

CIRIA (2015a) *C753 The SuDS Manual*

CIRIA (2015b) *C741 Environmental Good Practice on Site (4th Edition)*

Department for Communities and Local Government (2018) *National Planning Policy Framework*

Department for Transport (2014) *National Policy Statement for National Networks*

Defra / Environment Agency (2018) *Groundwater Protection Position Statements*

Environment Agency (2017) *Flood Risk Assessments: Climate Change Allowances*

Fylde Borough Council (2005) *Adopted Local Plan*

Fylde Council, (2018) *Fylde Local Plan to 2032* [Online] Available at: http://www.fylde.gov.uk/council/planning-policy--local-plan-/local-development-framework/www-fylde-gov-uk-submission/ [last accessed August 2018].

Highways England (2009) *Volume 11, Section 3, Part 10 of the Design Manual for Roads and Bridges HD45/09*

The EU Water Framework Directive 2000; Council Directive 2000/60/EC

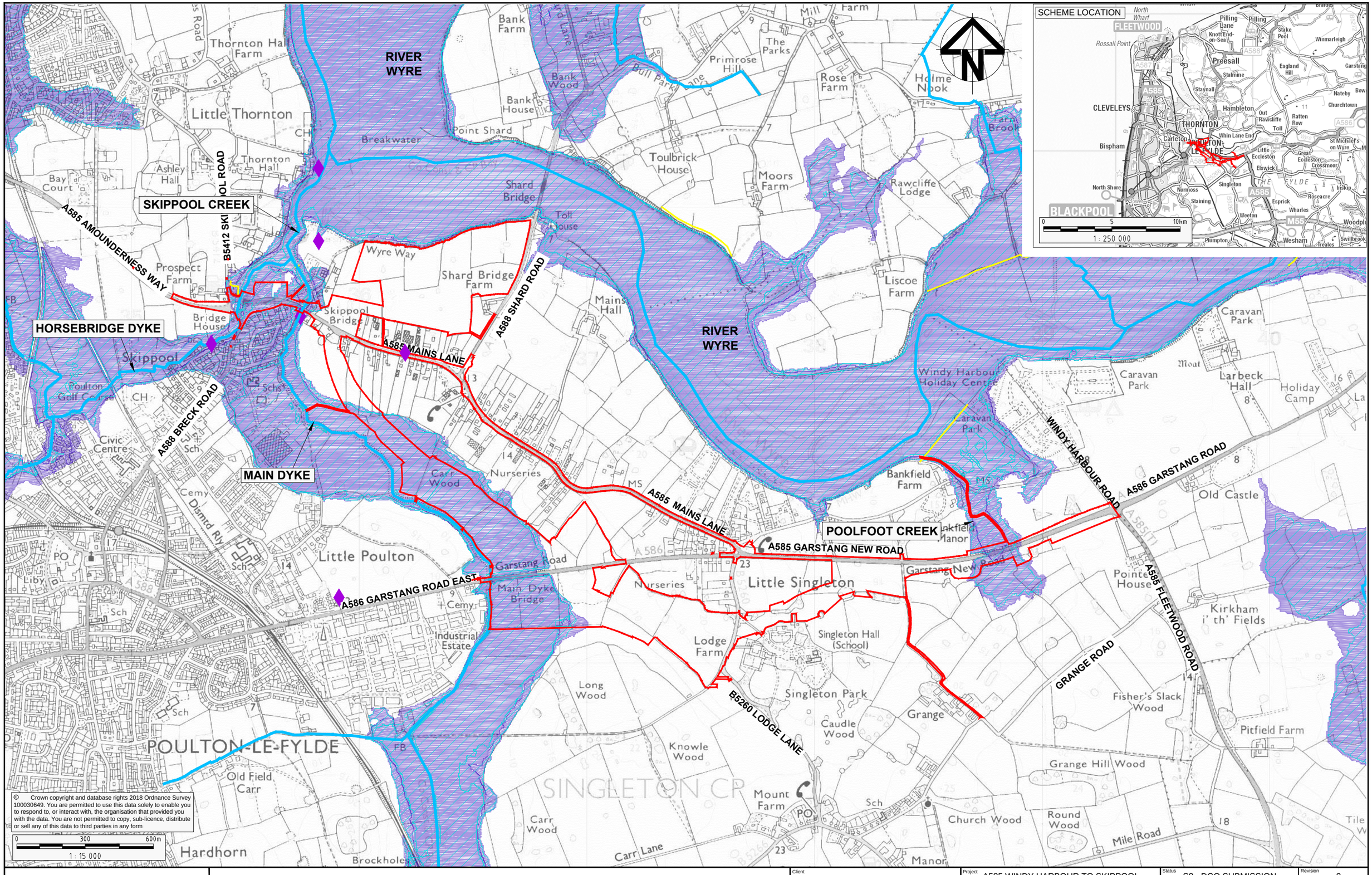
The Flood and Water Management Act 2010

The Water Resources Act 1991/2003

Wyre Council (1999) *Adopted Local Plan*

Wyre Council (2018) *Wyre Local Plan to 2031* [Online] Available at: http://www.wyre.gov.uk/info/200319/wyres_emerging_new_local_plan (last accessed August 2018).

12.11 Figures



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
0	S8	OCT18	S8 - DCO -SUBMISSION	JN	KB	NH

Client: highways england

Project	A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME
Drawing Title	ENVIRONMENTAL STATEMENT REGULATION 5(2)(a) ROAD DRAINAGE AND WATER ENVIRONMENT: WATERBODIES AND ENVIRONMENT AGENCY FLOOD ZONES

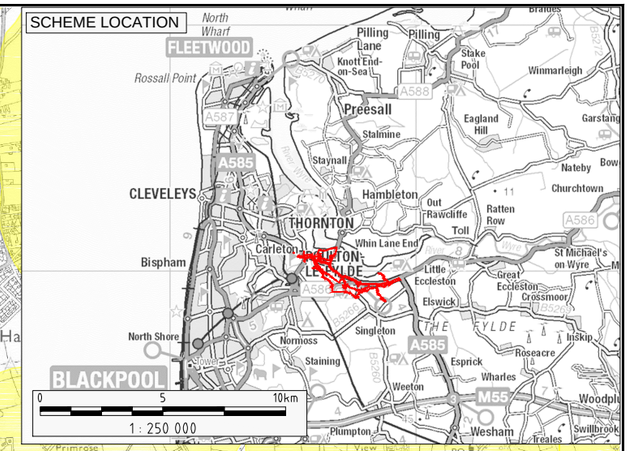
Status	S8 - DCO SUBMISSION	Revision	0
Scale	1:15 000 @ A3	Date	OCT 2018
Drawn By	J.NORMAN		
Checked By	K.BURROWS		
Approved By	N.HENDERSON		
PINS No.	TR010035		FIGURE 12.1

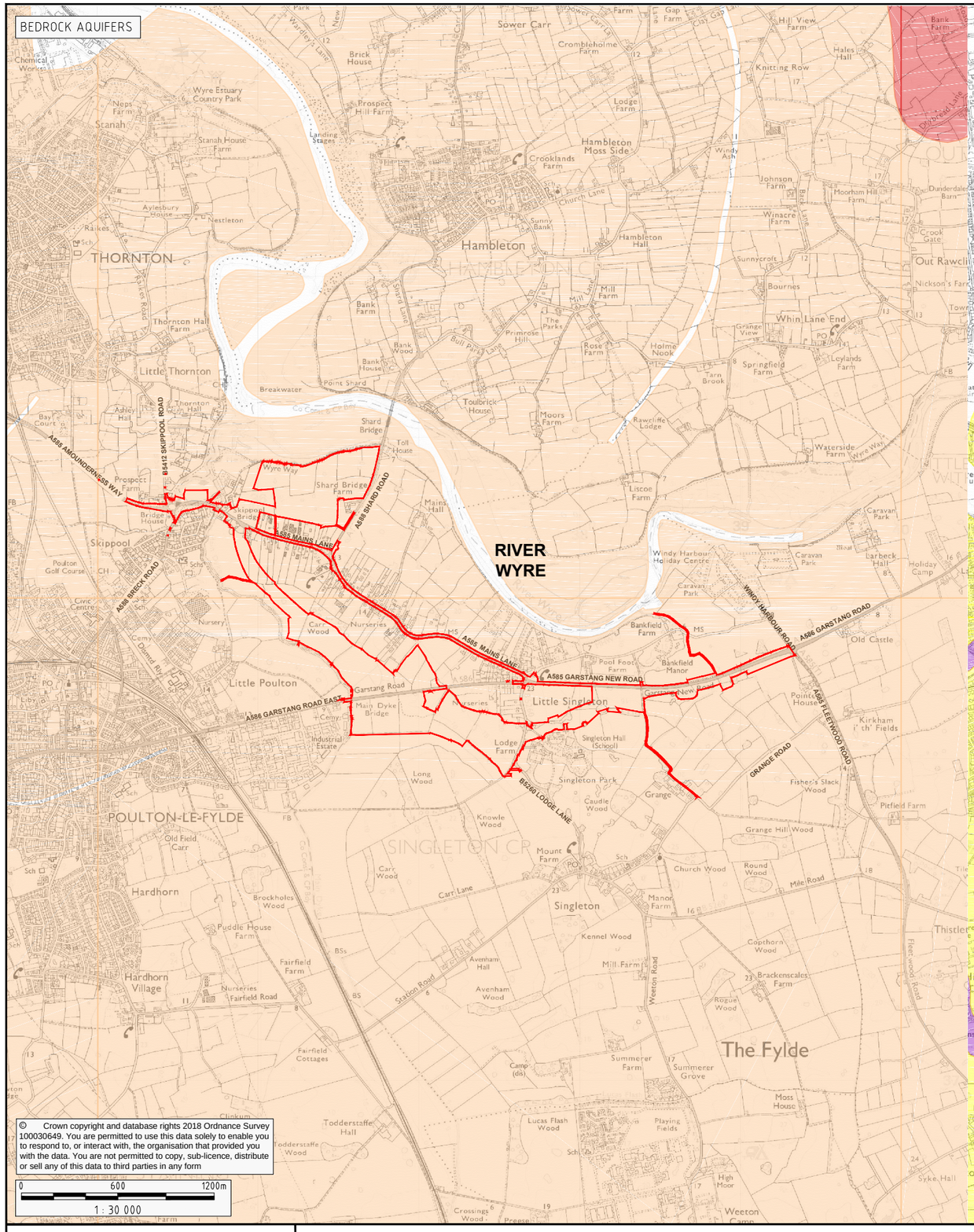
Drawing number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE548643-ARC-EGN-SZ_ZZ_000-DR-LE-3076

BEDROCK AQUIFERS

SUPERFICIAL AQUIFERS

SCHEME LOCATION





0 600 1200m
1 : 30 000

KEY:

Draft Order Limits

500m Study Area

Bedrock Aquifers
- Principal
- Secondary B

Superficial Aquifers
- Secondary A
- Secondary (Undifferentiated)

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
0	S8	OCT18	S8 - DCO SUBMISSION	JN	KB	NH

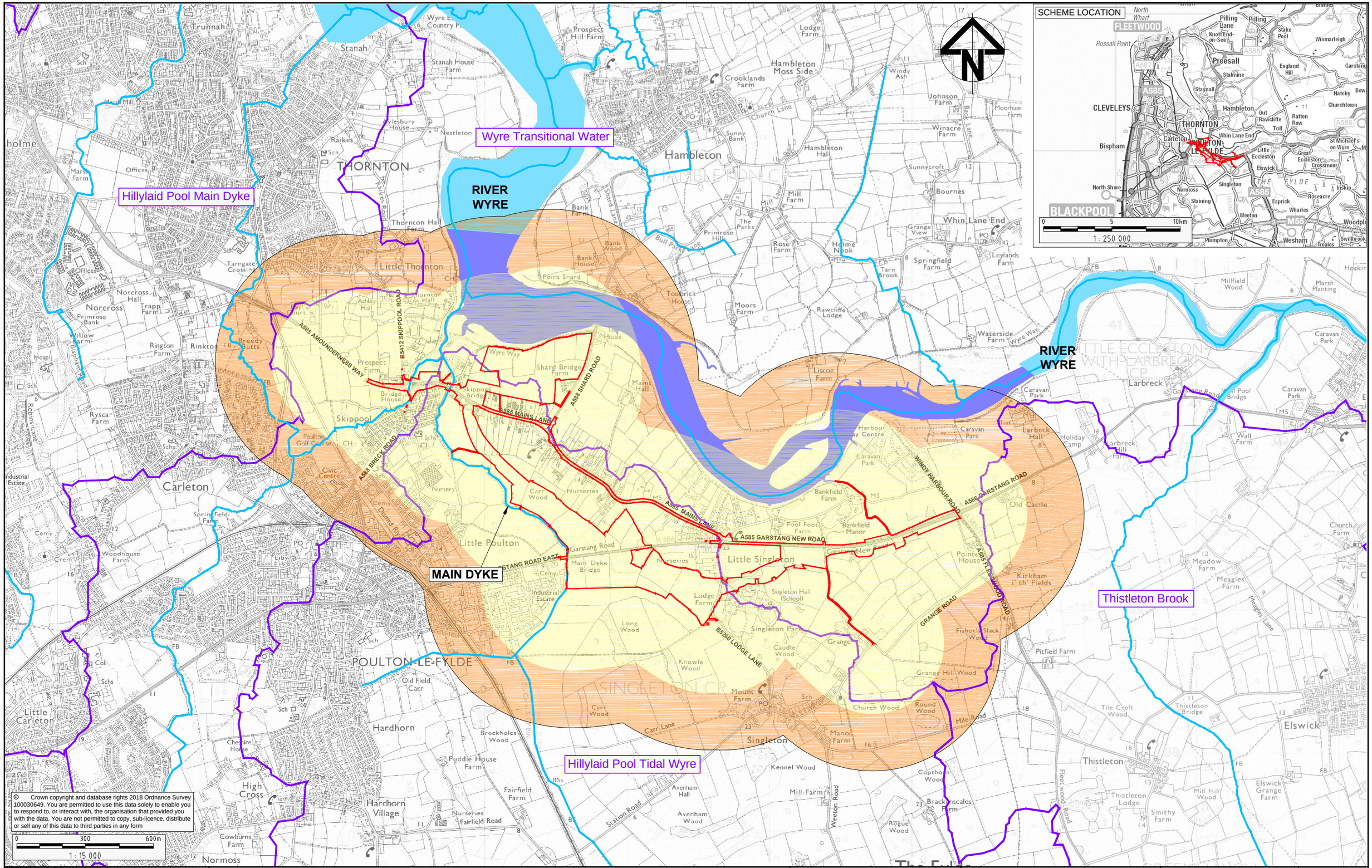
Client: highways england

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT REGULATION 5(2)(a) ROAD DRAINAGE AND WATER ENVIRONMENT: AQUIFERS

Status	S8 - DCO SUBMISSION	Revision	0
Scale	1:30 000 @ A3	Date	OCT 2018
Drawn By	J.NORMAN		
Checked By	K.BURROWS		
Approved By	N.HENDERSON		
PINS No.	TR010035		FIGURE 12.2

Drawing number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE548643-ARC-EGN-SZ_ZZ_000-DR-LE-3077



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
0	S8	OCT18	S8 - DCO SUBMISSION	JN	KB	NH

KEY:

- Draft Order Limits
- Main Rivers
- River Basin District Operational Catchment Boundaries
- Transitional Water Zone of Influence
- Surface Water 500m Zone of Influence
- Surface Water 1000m Zone of Influence

Client: highways england

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing Title: ENVIRONMENTAL STATEMENT REGULATION 5(2)(a) ROAD DRAINAGE AND WATER ENVIRONMENT: WATER FRAMEWORK DIRECTIVE WATERBODIES

Status	S8 - DCO SUBMISSION	Revision	0
Scale	1:15 000 @ A3	Date	OCT 2018
Drawn By	J.NORMAN		
Checked By	K.BURROWS		
Approved By	N.HENDERSON		
PINS No.	TR010035		FIGURE 12.3

Drawing number (HE PIN | Originator | Volume | Location | Type | Role | Number): HE548643-ARC-EGN-SZ_ZZ_000-DR-LE-3078