

Havant Thicket Reservoir Project

Environmental Statement Volume 2 – Main Report Chapter 15 Water

Portsmouth Water Ltd.

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Notice

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15. Water (including flows, quality and groundwater)

Competent expert evidence

- 15.1 This Water chapter has been prepared by the following individuals who have used their knowledge and professional judgement to undertake this assessment:
- The reservoir water quality analysis and water quality modelling was undertaken by an Associate Director (BA (Hons), DPhil, MSc, DIC, mCIWEM) with 30 years of experience in these technical areas, including work in academia, the water industry and consultancy.
 - The surface water quality assessment was undertaken by a qualified Senior Environmental Scientist (BSc, MSc, CSci, CEnv, CIWEM, CWEM) with over 15 years' experience in water quality and environmental assessments.
 - The hydrology assessment was undertaken by a qualified water scientist (BSc, MSc, CWEM) with over 15 years' experience in hydrological assessments working for both the water industry and government. including leading recent evidence reviews for Defra, linking hydrological changes to ecological impact risks.
 - The hydromorphology and Water Framework Directive (WFD) Assessment was led by an experienced Principal Fluvial Geomorphologist (BSc, MSc, FWEM, CSci, CEnv) with over 20 years of knowledge and experience in water resources, planning and managing rivers. They have led many significant WFD assessments across national infrastructure projects including the A14, East West Rail and Tilbury2.
 - The groundwater assessment and groundwater WFD compliance assessment was undertaken by a qualified Principal Hydrogeologist (BSc, MSc, CWEM, CSci, CEnv) with over 20 years of knowledge and experience in water resources and the water environment.
 - The flood risk assessment and Flood Risk Assessment appendix (Appendix A15.2 Flood Risk Assessment in ES Volume 4) was undertaken by a qualified Flood Risk expert (BEng, PhD, CIWEM) with 7 years of flood risk management experience, and with knowledge and experience in hydrology and flood risk modelling and assessment.
 - The flood risk assessment and flood risk section of this Water Chapter was reviewed by a qualified Flood Risk expert (BSc (Hons), CEnv, CWEM) with over 19 years' experience in flood risk management, FRAs and EIAs.
 - The Water chapter was checked by a qualified water specialist (BSc, MSc, CEnv and MCIEEM) with over 15 years' experience in environmental assessment.
 - The Water chapter was reviewed by a qualified water specialist (BSc, MSc, CSci, CEnv) with over 20 years' experience in environmental assessment in a wide range of infrastructure schemes including the A14, M25 widening and junction improvements, HS2, Wylfa power station and East West Rail.

Legislative and policy framework

- 15.2 This assessment of the water environment has been prepared taking account of legislation and policies at European, national and local levels.
- 15.3 The Department for Environment, Food and Rural Affairs (Defra) manages the coordination of policies for the water environment. Many flood risk and water quality requirements are set at European level, and then transposed into UK law. The Environment Agency manages the enforcement of flood risk and water quality requirements in England. The assessments have due regard to the European legislation and guidance.
- 15.4 The aim of water policy in England is to protect both public health and the environment by maintaining and improving the quality of natural waters. These include surface water bodies (e.g. rivers, streams, lakes, and ponds) and groundwater. European legislation is implemented in the UK through specific sets of Regulations (e.g. Flood Risk Regulations 2009, Groundwater (England and Wales) Regulations 2009, Private Water Supplies Regulations 2009). Defra is responsible for all aspects of water policy in England. Management and enforcement of water policy is the responsibility of Regulators, principally

the Environment Agency, but also Lead Local Flood Authorities (LLFA). There is extensive domestic legislation which regulates the water environment.

- 15.5 Local plan policies and Supplementary Planning Guidance state what is acceptable in terms of drainage, landscape, water quality and amenity within new development. Policy guidance is available from the various local authority websites. The site boundary straddles two Hampshire districts, Havant and East Hampshire. The boundary of these districts passes through the centre of The Avenue, effectively splitting the site in half. As a result, Local Planning Policy from both Havant Borough Council and East Hampshire District Council has been included.
- 15.6 A summary of the legislation and policy requirements, specific to the water environment, is set out in Table 15-1.

Table 15-1 - Legislation, regulatory, and policy framework for the water environment

Legislation/ Regulation/ Policy	Summary of requirements
European	
Water Framework Directive (WFD) (2000/60/EC)	The WFD legislation requires that all inland waters within defined river basin districts must achieve Good Ecological Status (GES) and Good Chemical Status. The River Basin Management Plans (RBMP) outline the actions required to enable natural waterbodies to achieve GES. For Heavily Modified Waterbodies (HMWB) like the Hermitage Stream and Langstone Harbour, the WFD recognises that these provide important socio-economic benefits which would be lost through removal of the modifications. The WFD requires these waterbodies to attain Good Ecological Potential (GEP) through the implementation of a series of mitigation measures. Any new project must not cause deterioration of the water environment or prevent the future attainment of GES/GEP.
Environmental Quality Standards Directive (2008/105/EC, and update 2013/39/EU)	Lists environmental quality standards (EQS) for priority substances and certain other pollutants as provided for in Article 16 of the Water Framework Directive 2000/60/EC (WFD), with the aim of achieving Good surface water chemical status. It includes certain metals that are associated with runoff from highways.
Groundwater Directive (2006/118/EC)	Complements the WFD. It requires measures to prevent or limit inputs of pollutants into groundwater to be operational so that WFD environmental objectives can be achieved.
Habitats Directive (92/43/EEC)	Promotes the maintenance of biodiversity by taking measures to maintain or restore natural habitats and wild species at a favourable conservation status, introducing robust protection for those habitats and species of European importance. Sites or species that come under this Directive will heighten the importance of water features that sustain them.
Nitrates Directive (91/676/EEC)	The aim of this Directive is to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures.
Floods Directive (2007/60/EC)	The aim of this Directive is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. It sets the strategic level for flood risk that any development will need to comply with.
Draft National Policy Statement (NPS) for Water Resources Infrastructure	Identified as a material consideration as part of the Scoping Report, the NPS sets out the need and government's policies for development of nationally significant infrastructure projects relevant to water resources in England. The types of infrastructure that the NPS will specifically apply to are reservoirs, water transfer and desalination projects in England.

Legislation/ Regulation/ Policy	Summary of requirements
A Green Future: Our 25 Year Plan to Improve the Environment (HM Government, 2018)	This 25 Year Environment Plan sets out government action to help the natural world regain and retain good health. It aims to deliver cleaner air and water in our cities and rural landscapes, protect threatened species and provide richer wildlife habitats. It calls for an approach to agriculture, forestry, land use and fishing that puts the environment first. The aim is to work with nature to protect communities from flooding, slowing rivers and creating and sustaining more wetlands to reduce flood risk and offer valuable habitats. Policies relevant to flood risk include expanding the use of natural flood management solutions, putting in place more sustainable drainage systems, aiming to protect and grow our natural capital, making 'at-risk' properties more resilient to flooding, and tackling climate change.
Environment Agency Groundwater Protection (previously known as GP3)	Guidance on the protection of groundwater for those proposing an activity which may cause groundwater impacts. The guidance aims to protect groundwater and prevent pollution. It covers requirements, permissions, risk assessments and controls.
National Planning Policy Framework (NPPF) (Department for Communities and Local Government (DCLG), 2019)	The NPPF sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow. It forms the basis of assessment of flood risk for projects.
National Planning Practice Guidance (NPPG) DCLG 2019	Guidance to accompany the NPPF. This advises on how local planning authorities can ensure water quality and the delivery of adequate water infrastructure and take account of the risks associated with flooding in the plan-making and the planning application process: Meeting the challenge of Climate Change, Flooding and Coastal Change Conserving and Enhancing the Natural Environment
Catchment Flood Management Plans (CFMPs) (Environment Agency)	CFMPs provide a large scale, strategic planning framework for the integrated management of flood risks to people, property and the environment in a sustainable manner over the next 50 to 100 years.
National	
Environment Act 1995	The Act provides for the establishment of a body corporate to be known as the Environment Agency, the key regulator for the water environment.
Environmental Protection Act 1990	This Act brings in a system of integrated pollution control for the disposal of wastes to land, water and air.
Flood and Water Management Act 2010	The key areas covered by this Act are: roles and responsibilities for flood and coastal erosion risk management; and, improving reservoir safety.
Highways Act 1980	The Act deals with the management and operation of the road network in England and Wales including the drainage of highways into environmental waters and sewers.
The Land Drainage Act 1991	This requires that a watercourse be maintained in such a condition that the free flow of water is not impeded. The 1994 Land Drainage Act amends it in relation to the functions of internal drainage boards and local authorities

Legislation/ Regulation/ Policy	Summary of requirements
Water Act 2003 and Water Act 2014	These Acts aim to improve water conservation, protect public health and the environment, and improve the service offered to consumers. The Acts relate to water resources, regulation of the water industry and other provisions.
Water Industry Act 1991	This sets out the responsibilities of the Environment Agency in relation to water pollution, resource management, flood defence, fisheries, and in some areas, navigation. The Act regulates discharges to controlled waters, namely rivers, estuaries, coastal waters, lakes and groundwaters
Water Resources Act 1991 (Amendment) (England and Wales) and Regulations (2009)	The Act regulates water resources, water quality and pollution, and flood defence. Sets out standards for Controlled Waters
Environment Bill (likely implementation in 2021 but currently under development)	At the time of writing, this Bill has not yet received Royal Assent but has been started in the House of Commons. The Environment Bill has been developed to implement (or not) European legislation into UK Law post Brexit. It makes provision for targets, plans and policies for improving the natural environment; for statements and reports about environmental protection; for the Office for Environmental Protection; about waste and resource efficiency; about air quality; for the recall of products that fail to meet environmental standards; about water; about nature and biodiversity; for conservation covenants; about the regulation of chemicals; and for connected purposes. All European Directives need to be followed and complied with until 31 December 2020.
The Water Framework (Standards and Classification) Directions (England and Wales) 2015	These Directions set out the environmental standards to be used for the second cycle of river basin plans. They transpose Directive 2013/39/EC on environmental quality standards for priority substances and supersede the 2008 version of the directive.
Anti-Pollution Works Regulations 1999	Where pollution occurs, or is likely to occur, the Environment Agency can serve a works notice under Section 161A of the Water Resources Act 1991 on any person who has caused or knowingly permitted the pollution (or risk of pollution) to controlled waters, requiring them to carry out anti-pollution/preventative works and operations. The Environment Agency can also recover the costs of any investigation and anti-pollution works carried out. The Anti-Pollution Works Regulations prescribe the content of anti-pollution works notices. They also prescribe the information to be placed on the pollution control registers maintained by the Environment Agency.
Control of Pollution (Oil Storage) (England) Regulations 2001	Regulations controlling the storage of more than 200 litres of oil above ground at an industrial, commercial or institutional site not used in refining or distribution oil. The Regulations apply in England only.
Environmental Damage (Prevention and Remediation) Regulations (England) 2015	The emphasis of these Regulations is on proactively putting in place appropriate pollution prevention measures to reduce risks to the environment.
Environmental Permitting (England and Wales) Regulations 2016	These Regulations provide a consolidated system of environmental permitting in England and Wales and transpose the provisions of 15 European Union (EU) Directives, which impose obligations requiring delivery through permits or which are capable of being delivered through permits.

Legislation/ Regulation/ Policy	Summary of requirements
	These cover Environment Agency permits for flood risk (on Main River) and certain discharges to watercourses. They also transpose the Groundwater Directive (2006/118/EC) into law in England and Wales.
Flood Risk Regulations 2009 Amended SI2011/2880 transpose directive 2007/60/EC	These aim to provide a consistent approach to managing flood risk. The Environment Agency are responsible for managing flood risk from main rivers, the sea and reservoirs. LLFAs are responsible for local sources of flood risk from surface water, groundwater and ordinary watercourses.
Water Environment (Water Framework Directive) (England and Wales) Regulations 2017	The EC Water Framework Directive is transposed into English and Welsh law by the 2017 Regulations. The 2017 Regulations place a general duty on the Secretary of State (SoS), the Welsh Ministers, the Environment Agency (EA), and Natural Resources Wales (NRW) to exercise their 'relevant functions' so as to secure compliance with the WFD (Regulation 3). The 2017 Regulations place a general duty on the Secretary of State (SoS), the Welsh Ministers, the Environment Agency and Natural Resources Wales to exercise their 'relevant functions' so as to secure compliance with the WFD (Regulation 3). Functions under the Planning Act 2008 (as amended) (PA2008) are not 'relevant functions' for this purpose. However, the SoS, the Welsh Ministers, Environment Agency, Natural Resources Wales and each public body have a specific duty to have regard to the relevant RBMP, and any supplementary plans made under it, in exercising their functions (Regulation 33); this would include functions under the PA2008. In this case, 'having regard to RBMP' includes taking account of and considering the environmental objectives and summary of measures contained within the plan when exercising any functions and the effects of those functions on the objectives and measures in the plan.
Water Environment (Water Framework Directive) (England and Wales) Regulations 2003	Langstone Harbour is designated as a shellfish water protected area under Regulation 7A. This regulation is now transposed by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.
The Water Resources (Environmental Impact Assessment) (England and Wales) Regulations 2003	These Regulations impose procedural requirements in relation to the consideration of applications or proposals for an abstraction or impounding licence under Chapter II of Part II of the Water Resources Act 1991 and require consent in other cases.
The Conservation of Habitats and Species Regulations 2017	Often referred to as the 'Habitats Regulations', these regulations transpose the EEC Habitats Directive into UK Law. Under these regulations, all competent authorities must consider whether any plan or project will have a 'likely significant effect' on a site designated under the Habitats Directive. If so, they must carry out an 'appropriate assessment'. This is known as Habitats Regulations Appraisal or (Fr
The Nitrate Pollution Prevention Regulations 2015	These regulations transpose the EEC Nitrates Directive into English Law. The regulations identify areas as 'nitrate vulnerable zones' if, using available scientific and technical data, they are considered at risk from agricultural nitrate pollution. They apply to about 55% of land in England.

Local

Legislation/ Regulation/ Policy	Summary of requirements
PUSH Integrated Water Management Study	With regard to the water environment, the Partnership for Urban South Hampshire (PUSH) was set up to support the sustainable growth of the sub region and to enable a coordinated approach to strategic planning matters. PUSH has commissioned an Integrated Water Management Study¹, which identified risks to water quality and achievement of WFD objectives as a result of future housing growth. The study highlighted the need for physical upgrades to seven Sewage Treatment Works (STW) and six sewer networks to cope with current and future increases in sewage volumes; tighter permit limits at 11 STWs to protect receiving waters; and catchment measures upstream of 20 STWs to help reduce nitrate loading to coastal waters. There is also a need for phasing of development in relation to some STWs. Further investigation and monitoring was also recommended to examine the existing gaps in the evidence base and potentially, further action, to ensure future growth is compliant with legislation. The following strategies with relevance to the water environment are summarised in Chapter 9 Biodiversity in ES Volume 2: • Havant Borough Core Strategy (2011) • Havant Borough Council Local Plan (Allocations) Adopted Version (2014) • East Hampshire District Council Local Plan: Joint Core Strategy (2014) • East Hampshire District Council Draft Local Plan 2017-2036 (2019)
South East Hampshire Catchment Flood Management Plan (CFMP)	The Environment Agency has developed a Catchment Flood Management Plan (CFMP)² for the South East Hampshire catchment. This identifies the risk of flooding within the South East Hampshire catchment both now and in the future under climate change. The Plan sets out the Environment Agency's recommended flood risk management policies and a preferred plan for the future direction and sustainable management of flood risk within the catchment. Havant (Policy 4) is identified as an area of low, moderate or high flood risk where flood risk is already being managed effectively but where there may need to be future intervention under a changing climate. Havant Borough Council (LPA) and East Hampshire District Council (LPA) have both set out Local Plans which include local policies for managing flood risk. The policies include: • Havant Borough Local Plan 2036: Policy E19 Managing flood risk in new development • Havant Borough Local Plan 2036: Policy E20 Drainage infrastructure in new development • East Hampshire District Council Local Plan 2017-2036: Policy S25: Managing Flood Risk • East Hampshire District Council Local Plan 2017-2036: Policy DM29 Water quality and water supply. Hampshire County Council have developed a strategy for local flood risk management within the county. This document aids individuals, communities, businesses and authorities to understand the flood risk within Hampshire and how to manage it. The focus is on local sources of flooding, for example, surface water or ordinary watercourses. The scheme development has taken account of these policies and further information on these policies is included in Appendix A15.2 Flood Risk Assessment (FRA) in ES Volume 4.

¹ Amec Foster Wheeler (2018). Integrated Water Management Study. [online] Available at: <https://www.havant.gov.uk/sites/default/files/documents/PUSH%20integrated%20water%20management%20study.pdf>

² Environment Agency, 2009. River Basin Management Plan South East River Basin District. Annex B: Water body status objectives. [online] Available at: < <https://www.gov.uk/government/publications/south-east-river-basin-management-plan>>

Legislation/ Regulation/ Policy	Summary of requirements
Havant Borough Council Position Statement on Nutrient Neutral Development	The Havant Borough Council have developed a nutrient neutral development plan in response to the development and regeneration of housing and its potential impact of reduction in water quality from such activities and the adverse impact on the natural environment that such a reduction may have. The statement sets out the agreement for mitigation measures to be undertaken by Havant Borough Council. The position statement identifies the requirement for mitigation measures to be emplaced in order to achieve nutrient neutrality with particular focus on nitrogen neutrality. This is based on nitrogen budget analysis and subsequent confirmation of the requirement of mitigation measures in the scheme. The statement details the Havant Borough Councils position regarding nitrogen neutrality and the suggested mitigation measures to ensure this is achieved. It is stated that the precise details of the mitigation measures will be detailed and set out through the 'Implementation Plan' that is associated with the position statement on nutrient neutral development. The statement concludes that the council will endeavour to develop a more defined mitigation strategy with information fed through from suggested monitoring and collaboration with stakeholder and relevant authorities. This information and collaboration will inform the Havant Borough Local Plan 2036.
Achieving Nutrient Neutrality for New Development in the Solent Region March 2020	The Advice on Achieving Nutrient Neutrality for New Development in the Solent Region is a guidance document providing a methodology for calculating how nutrient neutrality can be achieved. The document was produced by Local Authorities in association with Natural England and is tailored specifically to the Solent region with a focus on new housing developments. The document details the planning context, environmental context, worked approaches and mitigation approaches for achieving nutrient neutrality. The document provides specific examples for urban development including waste water treatment works and areas included in the Havant Reservoir study area such as Langstone Harbour. It covers surface water from upland fresh to transitional waterbodies, as well as groundwater all of which are relevant to the development of Havant Thicket Reservoir.

Technical guidance and standards

15.7 The assessment will also take into account the following technical guidance and standards as summarised in Table 15-2.

Table 15-2 - National guidance summary

Guidance	Description
Design Manual for Roads and Bridges (DMRB) LA113 Road drainage and the water environment (formerly HD 45/09)	Description of the requirements for assessment and management of the impacts that road projects can have on the water environment. The process of assessment can be applied to any development project. The guidance was last updated in March 2020 and is an update from DMRB Volume 11, Section 3, Part 10 (HD 45/09 Road Drainage and the Water Environment).
Transport Analysis Guidance (TAG), Department for Transport Unit A3 Environmental Impact Assessment (May 2019)	Guidance on tailoring level of detail for assessment to the stage of development of the scheme; the relationship between environmental impact appraisal (as set out in this manual) and Environmental Impact Assessment (EIA); the differing types of environmental impact and reporting requirements.
Pollution Prevention Guidelines (PPG) and Guidance for Pollution Prevention (GPPs)	PPG were a series of documents developed by the Environment Agency for England and Wales, the Northern Ireland Environment Agency for Northern Ireland and the Scottish Environmental Protection Agency for Scotland. Each PPG was targeted at a different business or activity. The PPGs were withdrawn from use in 2015, but are still considered good practice as they have, to date, not been replaced with other formal guidance. In Scotland, GPP have been developed by the Scottish Environmental Protection Agency as a replacement for PPG. Although they only apply in Scotland and Northern Ireland, GPPs provide environmental good practice guidance for the whole of the UK, accepting there may be some exceptions. Relevant PPG and GPP to this scheme include: • PPG 1: Understanding your environmental responsibilities - good environmental practices • PPG 3: Use and design of oil separators in surface water drainage systems • GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer • PPG/GPP 5: Works and maintenance in or near water • PPG 23: Maintenance of structures over water
Guidance Pollution Prevention for businesses (GOV.UK)	Guidance for businesses and organisations on prevention of pollution from oil and chemical storage, car washing, construction and other activities. These guidelines are specific to England.
CIRIA C753, 2007. SuDS Manual.	CIRIA (Construction Industry Research and Information Association) Guidance encompassing the best practice and framework for planning, design, construction and maintenance of SuDS (Sustainable Drainage Systems). The guidance is designed to aid and enable the effective delivery of SuDS, maximising the benefits from effective water management.
CIRIA C648, 2006. Control of water pollution from linear construction projects.	CIRIA (Construction Industry Research and Information Association) guidance encompassing information and best practice for clients through to regulators on how to best manage water pollution from linear construction projects.
NRW/NIEA/SEPA, 2017, Guidance for	Guidance developed by NRW (Natural Resources Wales), NIEA (Northern Ireland Environment Agency) and SEPA (Scottish Environment

Guidance	Description
Pollution Prevention: Works and maintenance in or near Water: GPP 5.	Protection Agency). The guidance is based on best practice and legislation from NRW, NIEA and SEPA. It should be noted it is not endorsed as regulatory guidance by the EA. The guidance is aimed at anyone undertaking works or activities near water and details pollution prevention for near water works including silt pollution, concrete, cement and grout, oils and chemical, bridge maintenance over water, pesticide use, INNS, waste management and incident reporting.

Study area

Overview

- 15.8 The location of the reservoir site and access roads and the pipeline corridor from Havant and Bedhampton Springs has been shown in context of local rivers and streams on Figure 15-1 in ES Volume 3. An overview of the reservoir site and access roads and pipeline corridor in context of groundwater bodies has been provided in Figure 15-10 in ES Volume 3.
- 15.9 The Havant Thicket Reservoir Project EIA Scoping Report – Addendum (Atkins 2019) for this Scheme (referred to as the ‘Scoping Report’ from this point onwards) required the baseline to consider a study area “generally within 1 km of the Scheme”. Practically, considering the footprint of the reservoir site and access roads as well as the pipeline corridor, for surface water, this comprises a large part of the Hermitage Stream’s hydrological catchment and associated floodplain including the Riders Lane Stream sub-catchment from its source. For groundwater, this study area comprises a total of four different WFD groundwater bodies.
- 15.10 The Hermitage Stream catchment includes two WFD waterbodies: Hermitage Stream (WFD waterbody ID GB107042016370), which is a freshwater river that has been designated as a HMWB; and Langstone Harbour (WFD waterbody ID GB580705130000), which is an enclosed transitional and coastal waterbody also designated as a HMWB.
- 15.11 All surface water catchments flow from north to south. Throughout the catchment, the surface water exhibits a transition in flow conditions from ephemeral/intermittent upper headwaters³⁴ to more perennial flows in the lower catchment. Headwater Streams are Priority Habitats⁵ and have been attributed ‘high distinctiveness’ as part of the Defra’s Biodiversity Net Gain approach. In the upper catchment, the ephemeral flows generally coincide with rainfall events, with exceptions occurring in summer months where the soil moisture deficit is too large to promote runoff into the Headwater Streams. Some periods of no flow have also been recorded in both the upper and lower catchments, including at the Environment Agency gauging station further downstream on the main Hermitage Stream.
- 15.12 Within the study area there are two Main Rivers, namely the Hermitage Stream up to OSNGR SU 68463 10365 (Park Wood) and SU 69243 10232 (The Queen’s Inclosure); and the Riders Lane Stream up to OSNGR SU 7174708787 (which is the confluence with The Lake Stream). The Hermitage Stream has an approximate catchment size of 20km², however 4.5km² of that area is attributed to the Riders Lane Stream catchment. The upper catchment of the Riders Lane Stream includes five Headwater Streams (HS1-HS5) which are all Ordinary Watercourses along with the uppermost section of the Riders Lane Stream.
- 15.13 HS1-HS5 range between 0.5 and 1.5 m in width and exhibit ephemeral/intermittent flows, sometimes only flowing briefly during periods of rainfall and/or high groundwater levels (‘ephemerality’). Headwater Stream 2 has a pond feature called ‘Upper Lake’ at Ordnance Survey National Grid Reference (OSNGR) SU 7142110030. All five Headwater Streams come together around OSNGR SU 71319 09440, which is under the reservoir site footprint. For the purpose of the EIA, it has been assumed that

³ The definition of ‘headwater’ as given by Furse (1995) is ‘a watercourse within 2.5km of its furthest source as marked with a blue line on Ordnance Survey (OS) Landranger maps with a scale of 1:50,000.’ Headwater Streams 1-5 and the Ordinary Watercourse section of Riders Lane Stream all fulfil these two criteria.

⁴ Furse, M.T. (1995) The faunal richness of headwater streams: Stage 4 – development of a conservation strategy. R & D Note 455, National Rivers Authority, Bristol.

⁵ JNCC, 2011. UK Biodiversity Action Plan Priority Habitat Descriptions. Rivers. Available at: <http://data.jncc.gov.uk/data/01d6ab5b-6805-4c4c-8d84-16bfebe95d31/UKBAP-BAPHabitats-45-Rivers-2011.pdf> [Accessed 30 May 2020]

this confluence is the start of the Riders Lane Stream. As mentioned above, the Riders Lane Stream is an Ordinary Watercourse between OSNGR SU 71319 09440 and the confluence with The Lake Stream at OSNGR SU 71747 08787.

- 15.14 To the east of the reservoir, some small unnamed watercourses are present within the reservoir site footprint (Gipsies Plain). These are also 'headwaters' but mainly ditch-like still water features and different in nature compared to Headwater Streams 1-3 in particular. They drain eastwards into the River Lavant⁶ WFD waterbody (WFD waterbody ID GB107042016420), rather than west into the Hermitage Stream. As these watercourses do not flow regularly, a shorter section of these headwater streams has been included as a study section for the water assessment, i.e. up to the culvert under Durrants Road B2149 (OSNGR SU 72613 09497).
- 15.15 To the west of the reservoir, the headwaters of Park Lane Stream (also part of the Hermitage Stream hydrological catchment) have been included as access to the south of the reservoir would be via roads in this catchment and there would also be improvement works in Bells Copse. These headwaters are mainly ephemeral/intermittent in their nature and flow through a shallow, wooded valley. The study reach starts at the northern end of Bells Copse (OSNGR SU 70563 10531) and stops at a culvert (OSNGR SU 70513 09001), from where the stream flows underground into the Hermitage Stream which it joins just downstream of Middle Park Way (OSNGR SU 70540 07975). The upper catchment of the Park Lane Stream (i.e. beyond the culvert at OSNGR SU 70513 09001) is also considered an Ordinary Watercourse, whereas the culverted section of Park Lane Stream is considered Main River.
- 15.16 The length of the Riders Lane Stream is 2.649 m between the confluence of the Headwater Streams and the confluence with the Hermitage Stream at OSNGR SU 71007 07503. There is one further tributary to Riders Lane Stream called The Lake Stream, which joins at OSNGR SU 71747 08787, the catchment of which includes Leigh Lake which receives flows from two relatively short unnamed streams. The Lake Stream would be crossed by the pipeline proposed as part of the reservoir development. The Riders Lane Stream is considered Main River from downstream of the confluence with The Lake Stream.
- 15.17 Hermitage Stream is heavily incised and shaded by trees. It's beds and banks are lined with concrete for most of its length as a result of a Flood Alleviation Scheme (FAS) undertaken in the 1970s. The total length of the Hermitage Stream, as reported on the Environment Agency catchment data explorer⁷, is 6.917 km, but this does not take account of its headwaters and some of the tributaries such as Park Lane Stream. The distance of Hermitage Stream between Riders Lane Stream and the Nominal Tidal Limit (NTL) just south of Meyrick Road (OSNGR SU 70511 06237) is 1.689 km. The Hermitage Stream flows over a large weir at this point (composed of 6 different smaller weirs), after which it becomes a transitional waterbody, Langstone Harbour.
- 15.18 The section of the Hermitage Stream between the Riders Lane Stream and the NTL has been included as one of the study sections. As the Hermitage Stream upstream of Riders Lane Stream is crossed by the pipeline constructed as part of the Scheme as well as road accessing the southern side of the reservoir, the section of the Hermitage Stream between the Riders Lane confluence and the A3(M) (OSNGR SU 69631 09096) has also been included as a study section.
- 15.19 Langstone Harbour is the centre of three linked harbours on Hampshire's southeast coast, with Portsmouth Harbour to the west and Chichester Harbour to the east. It is a tidal inlet which is almost completely landlocked, with a narrow channel connecting it to the Solent. This channel is flanked by two sand spits and has strong currents which allow substantial exchange of water with the Solent. It has a number of environmental designations, contains oyster shellfish beds and is also an important commercial shipping, fishing and recreation boating area. The eastern boundary of the harbour and the WFD waterbody is defined by the A3023 Langstone Road and the western limit is defined by the railway bridge over Hilsea Creek. It receives freshwater flows from the Hermitage Stream along with the River Lavant.
- 15.20 Langstone Harbour has the following environmental designations: Langstone Harbour Site of Special Scientific Interest (SSSI), Chichester and Langstone Harbour Special Protection Area (SPA), Solent

⁶ This watercourse is referred to as 'Lavant', 'River Lavant' and 'Lavant Stream' in different literature sources. For the purpose of this EIA, it has been referred to as River Lavant.

⁷ Environment Agency. 2020a. Environment Agency - Catchment Data Explorer. [online] Available at: <https://environment.data.gov.uk/catchment-planning/search?type=placename&k=HAVANT&q=http://environment.data.gov.uk/catchment-planning/so/Town/havant>

Maritime Special Area of Conservation (SAC) and Chichester and Langstone Harbour Ramsar Site. It is also designated as a shellfish water protected area under the WFD.

- 15.21 As stated above, the study area comprises four WFD groundwater bodies (i.e. East Hants Chalk (WFD waterbody ID GB40701G502700), East Hants Lambeth Group (WFD waterbody ID GB40702G500800), South Hants Lambeth Group (WFD waterbody ID GB40702G503700) and Chichester Chalk (WFD waterbody ID GB40701G505200)) which are present in the vicinity of the Scheme. The East Hants Chalk groundwater body is present both north and south of the reservoir although it is not shown in the vicinity of the reservoir as it is heavily confined by clays. The East Hants Lambeth Group groundwater body is present just north of the reservoir site and contains the headwaters of the three tributaries that flow south into the reservoir site. The South Hants Lambeth Group groundwater body is located to the south of the reservoir site and contains most of the Havant and Bedhampton springs. Finally, the Chichester Chalk groundwater body occurs to the east of the area of interest. A detailed review undertaken as part of the WFD Assessment (Appendix A15.1 WFD Assessment in ES Volume 4) concluded that the Chichester Chalk waterbody could be screened out of further assessment. This waterbody has, therefore, not been included in this ES chapter.

Study sections

- 15.22 For the purpose of the EIA, the surface waterbodies described above have been divided up into study sections, an approach which will be used to describe the baseline and undertaking the assessment. The eight sections identified have been set out in Table 15-3 below.

Table 15-3 - Study sections

Study section	Description	Status	OSNGR reference - upstream	OSNGR reference - downstream
1	Headwater Streams 1, 2 and 3 up to reservoir site	Ordinary Watercourse	HS1 - SU 71178 10789 HS2 - SU 71520 11000 HS3 - SU 71743 10398	HS1 - SU 71160 10368 HS2 - SU 71421 10346 HS3 - SU 71713 10253
2	3.6 km of Headwater Streams 1, 2, 3, 4, 5, Upper Lake and short section of Riders Lane Stream (RLS) all under reservoir site footprint.	Ordinary Watercourse	HS1 - SU 71160 10368 HS2 - SU 71421 10346 HS3 - SU 71713 10253 HS4 - SU 71934 09849 HS5 - SU 71799 09560 RLS - SU 71314 09436	HS1 - SU 71314 09436 HS2 - SU 71537 09816 HS3 - SU 71537 09816 HS4 - SU 71621 09697 HS5 - SU 71475 09570 RLS - SU 71327 09213
3	RLS between reservoir site footprint up to Hermitage Stream confluence. The Lake Stream (TLS) joining Riders Lane Stream from Leigh Lake.	Ordinary Watercourse up to confluence with The Lake Stream at OSNGR SU 71747 08787 Main River downstream of this up to the confluence with the Hermitage Stream.	RLS - SU 71327 09213 TLS - SU 71836 09095	RLS - SU 71007 07503 TLS - SU 71747 08787
4	Hermitage Stream – between A3(M) and confluence with Riders Lane Stream	Main River	SU 70525 07977	SU 71007 07503
5	Hermitage Stream – between confluence with Riders Lane Stream and Nominal Tidal Limit (NTL)	Main River	SU 71007 07503	NTL = SU 70511 06237

Study section	Description	Status	OSNGR reference - upstream	OSNGR reference - downstream
6	Langstone Harbour	Transitional/ Coastal	SU 70511 06237	SU 68652 00138
7	0.8 km of Headwater Streams under reservoir site footprint all draining east towards River Lavant	Ordinary Watercourse upstream of upstream of OSNGR SU 72474 09586	SU 71947 09871	SU 72613 09497
8	Park Lane Stream	Ordinary Watercourse upstream of OSNGR SU 70513 09001	SU 70563 10531	SU 70513 09001

Assessment methodology

Approach

- 15.23 The assessment methodology was described within the Scoping Report and has been reviewed by relevant stakeholders. No changes have been made to this methodology following consultation.
- 15.24 The method for the Scheme-wide water environment assessment is provided below. This chapter has a further three associated stand-alone assessments, which are provided as appendices in ES Volume 4:
- Appendix: A15.1 Water Framework Directive (WFD) Assessment
 - Appendix: A15.2 Flood Risk Assessment (FRA)
 - Appendix: A15.3 Water Quality (WQ) Modelling Report
 - Appendix: A15.4 Biodiversity Net Gain for Rivers
- 15.25 The appendices contain detail on their respective assessment methodologies. The results from the Water Framework Directive Assessment, Flood Risk Assessment and Water Quality Modelling Report in these appendices have fed into the overall impact assessment presented in this chapter. The results for the Biodiversity Net Gain for Rivers report have fed into the mitigation and compensation strategy.
- 15.26 The surface water environment assessment will consider the elements of the environment that support aquatic ecosystems and their ecology (fish, macroinvertebrates, plants and algae), water quality, hydrology (flow) and geomorphology (river shape and form). Hydromorphology is a term used in the WFD to describe the processes operating within, and the physical form of, a water body. The term encompasses both hydrological and geomorphological characteristics that, in combination, help support a healthy ecology. In line with WFD, the disciplines of hydrology and geomorphology have been combined as hydromorphology. Registered discharges and abstractions have also been described and assessed in this chapter in the context of surface water quality. The aquatic ecology baseline description including the associated ecological assessment and impacts from invasive non-native plant and animal species has been undertaken in Chapter 9 Biodiversity in ES Volume 2.
- 15.27 For flood risk, this chapter considers fluvial/tidal flood risk and surface water flood risk. Artificial flood risk (in this case from a reservoir), is specifically addressed in Appendix A15.2 Flood Risk Assessment (FRA), in ES Volume 4.
- 15.28 For groundwater, this chapter contains detail on geology and local hydrogeology, groundwater abstractions and discharges. Further detail, particularly regarding made ground, soils and local geology has been provided in Chapter 10 Ground Conditions in ES Volume 2.

Assessment criteria

- 15.29 The approach to determining the sensitivity of receptors is detailed in Table 15-5. In accordance with the Scoping Report, DMRB LA 113 guidance and for flood risk the WebTAG guidance have been used to describe the water baseline, including rating the sensitivity/importance of receptors, magnitude of potential impacts and overall significance for each of the study sections. The DMRB and WebTAG guidance has been developed for linear developments, notably roads and bridges, and thus is

considered appropriate for assessment of watercourses which may be crossed by a linear development such as a pipeline corridor. The watercourses to be crossed by the proposed development include Hermitage Stream, Riders Lane Stream and The Lake Stream. Using expert judgement, this approach has been extended to the Park Lane Stream, Headwater Streams and uppermost parts of the Riders Lane Stream (i.e. the part of Riders Lane Stream in study sections 1 and 2) and Park Lane Stream.

- 15.30 Using available baseline information from a range of reports, online sources and an Environment Agency⁸ and Portsmouth Water data request⁹, each water environment technical area (surface water, flood risk and groundwater) has identified the (baseline) importance of each technical element using the sensitivity descriptors set out in Table 15-5. These include water quality, hydromorphology, amenity value and WFD status for surface water, as well as aquifer designations and the presence of source protection zones for groundwater. Sensitivity descriptors for flood risk have considered the vulnerability of the receptors i.e. the properties at risk, A-roads or agricultural land rather than the waterbody itself, in line with the DMRB LA 113 and WebTAG guidance.
- 15.31 The importance of each technical element has been used in the impact assessment. As set out above, the study sections set out in Table 15-3 have been used as a guide to describe the baseline and undertake the impact assessment. To provide general context, the overall sensitivity of a study section has also been provided using the most sensitive element in each reach.

⁸ Environment Agency, 2020c, Data request on behalf of Portsmouth Water [received on 02/03/2020] Reference 200302 SSD160159

⁹ Portsmouth Water. 2020. Data request [received 23/03/2020]

Table 15-4 - Sensitivity descriptors

Importance	Criteria/descriptors	Surface water		Flood risk	Groundwater
		Water quality	Hydromorphology		
Very High	Very high importance and rarity, international scale and very limited (i.e. no potential for substitution/replacement)	- WFD waterbody with High status for water quality related classification elements (e.g. Physico-chemical quality elements). - Water quality supports habitats protected/designated under EU habitat legislation (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA)). - Watercourse is used for public potable water supply.	- WFD hydromorphological designation “not designated artificial or heavily modified”. - Hydromorphological and/or Hydrological Supporting Elements of WFD status “High”. - Conforms most closely to natural, unaltered state and will often exhibit signs of free meandering and possess well-developed bedforms (point bars and pool-riffle sequences) and abundant bank side vegetation: Conservation Status score of 8-10 (High). - Hydrology supports habitats protected/designated under EU habitat legislation.	- Floodplain or defence protecting more than 100 residential properties from flooding. - Areas which are highly vulnerable. These can include essential infrastructure, emergency services and basement dwellings.	- Principal aquifer providing a regionally important resource and/or supporting a site protected under European Commission (EC) and UK legislation for ecology and nature conservation. - Groundwater SPZ1.
High	High importance and rarity, national scale, and limited potential for substitution/replacement	- WFD waterbody with Good status for water quality related classification elements (e.g. Physico-chemical quality elements). - Water quality supports habitats protected/designated under UK habitat legislation (e.g. Site of Special Scientific Interest (SSSI), Local Nature Reserves (LNR)). - Waterbody is used for non-potable water supply.	- WFD hydromorphological designation can either be “not designated artificial or heavily modified” or “heavily modified”. - Hydromorphological and/or Hydrological Supporting Elements of WFD status “Supports Good”. - Shows signs of previous alteration but still retains many natural features or may be recovering towards conditions indicative of the higher category: Conservation Status score of 5-7 (Moderate).	- Floodplain or defence protecting between 1 and 100 residential properties or industrial premises from flooding. - Areas which are more vulnerable. These can include hospitals, residential units, educational facilities and waste management sites.	- Principal aquifer providing locally important resource or supporting a river ecosystem - Groundwater supports Groundwater Dependent Terrestrial Ecosystems (GWDTE). - Groundwater SPZ2

Importance	Criteria/descriptors	Surface water		Flood risk	Groundwater
		Water quality	Hydromorphology		
			Hydrology supports habitats protected/designated under UK habitat legislation.		
Medium	High or medium importance and rarity, regional scale and limited potential for substitution/replacement	WFD waterbody with Moderate status for water quality related classification elements (e.g. Physico-chemical quality elements).	- WFD hydromorphological designation "heavily modified" - Hydromorphological and/or Hydrological Supporting Elements of WFD status "Supports Good" - Substantially modified by previous engineering works and likely to possess an artificial cross-section (e.g. trapezoidal) and will probably be deficient in bedforms and bankside vegetation: Conservation Status score of 2-4 (Low) - Hydrology supports habitats with regional interest	- Floodplain or defence protecting 10 or fewer industrial properties from flooding - Areas which are less vulnerable. These can include retail, commercial and general industrial units, agricultural/ forestry sites and water/sewage treatment plants.	- Aquifer providing water for agricultural or industrial use with limited connection to surface water - Groundwater SPZ3
Low	Low or medium importance and rarity, local scale and considerable potential for substitution/replace ment	Non-WFD waterbody or WFD waterbody with Poor/Bad status for water quality related classification elements (e.g. Physico-chemical quality elements).	- WFD hydromorphological designation "heavily modified" or "artificial". - Hydromorphological and/or Hydrological Supporting Elements of WFD status "Does Not Support Good". - Channelised (reaches whose bed and banks have hard protection (e.g. concrete walls or sheet piling): Conservation Status score of 1. - Culverted (totally enclosed by hard protection): Conservation Status score of 1. - Hydrology supports habitats with local interest. - N/A (navigable)	- Floodplain with limited existing development. - Water compatible development.	Unproductive strata

Assessment of magnitude of impact

15.32 The magnitude of impacts that has been used in the assessment is further detailed in Table 15-5 with specific examples relating to the water environment.

Table 15-5 - Assessment criteria

Magnitude	Criteria	Example
High adverse	Results in loss of attribute and/or quality and integrity of the attribute	• Loss or extensive change to a fishery/designated nature conservation site • Loss of, or extensive change to, an aquifer/groundwater supported habitats • Potential high risk of pollution to groundwater • Change to the environmental status/classification of a water feature, including water quality classification • Permanent/irreversible damage to biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource • Changes to site resulting in an increase in discharge/runoff of >75% with flood/sewerage exceedance potential • Increase in peak flood level (1% annual probability event) > 100 mm • Loss of flood storage areas
Moderate adverse	Affects integrity of attribute, or loss of part of attribute	• Partial loss or change to a fishery/designated nature conservation site. Loss in the productivity of a fishery • Partial loss or change to an aquifer/groundwater supported habitats • Potential medium risk of pollution to groundwater • Permanent/irreversible damage to a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact negatively affects the integrity or key characteristics of the resource • Pollution of a receiving water body, but insufficient to change the environmental status/classification, including water quality classification • Changes to site resulting in an increase in discharge/runoff of >50% with flood/sewerage exceedance potential • Increase in peak flood level (1% annual probability event) >50 mm
Low adverse	Results in some measurable change in attribute's quality or vulnerability	• Minor change to an aquifer/groundwater supported habitats • Potential low risk of some pollution to a surface water or groundwater body, but insufficient to cause loss in quality, fishery productivity or biodiversity. • Permanent/irreversible damage to biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource • Changes to site resulting in an increase in discharge/runoff of >25% with flood/sewerage exceedance potential • Increase in peak flood level (1% annual probability event) >10 mm
Very low adverse	Affects attribute, but of insufficient magnitude to affect the use of integrity	• The Scheme may adversely affect the integrity of the water environment, but this is not considered measurable

Magnitude	Criteria	Example
		• Temporary/reversible damage to a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource • No measurable impact upon an aquifer and very low risk of pollution to groundwater • Negligible change in peak flood level (1% annual probability event) <10 mm
No change	Results in no change to the receptor	• No predicted adverse or beneficial impact to the receptor
Very low beneficial	Beneficial to attribute, but of insufficient magnitude to affect the use of integrity	• The Scheme may beneficially affect the integrity of the water environment, but this is not considered measurable • No measurable impact upon an aquifer • Temporary addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource
Low beneficial	Beneficial to attribute or a reduced risk of negative impact occurring	• Negligible change in peak flood level (1% annual probability event) <10 mm • Permanent addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact does not affect the integrity or key characteristics of the resource • Potential reduction in existing pollution risk to groundwater
Moderate beneficial	Results in moderate improvement of attribute quality	• Moderate improvement to a fishery/designated nature conservation site. Potential increase in the productivity of a fishery. • Reduced pollution of a receiving water body, but insufficient to change the environmental status/classification, including water quality classification • Permanent addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact positively affects the integrity or key characteristics of the resource • Changes to site resulting in a decrease in discharge/runoff >50% • Reduction in peak flood level (1% annual probability event) >50 mm
High beneficial	Results in major improvement of attribute quality	• Significant improvement to a fishery/designated nature conservation site • Removal of existing polluting discharge or removing the likelihood of polluting discharges occurring • Recharge of an aquifer • Permanent addition of, improvement to, or restoration of a biodiversity resource; and the extent, magnitude, frequency, and/or timing of an impact positively affects the integrity or key characteristics of the resource • Change to the environmental status/classification of a water feature, including water quality classification • Changes to site resulting in a decrease in discharge/runoff of >75% • Reduction in peak flood level (1% annual probability event) >100 mm

15.33 In identifying the impacts of the Scheme the following have been considered:

- Impact type - direct or indirect, positive or negative;
- Magnitude of impact – the ‘amount’ or intensity of an impact, e.g. distance in km;
- Extent of impact – the area over which the impact will be felt. It is noted that indirect effects such as habitat fragmentation and pollution can affect a wider area of habitat, for example by limiting movement of fish to spawning, feeding and nursery areas present upstream;
- Duration of impact – how long it will occur;
- Timing of impact – when it will occur, taking particular note of seasonality;
- Frequency of impact – how often it will occur (it is noted that the construction project is considered to be a single event which is not repeated and, therefore, frequency of impact is not considered further); and,
- Reversibility of impact – a reversible impact is one from which spontaneous/natural recovery is possible; or for which effective mitigation is both possible and an enforceable commitment to this can, in theory, be made.

Assessment of significance of effect

15.34 Once the sensitivity of receptors and magnitude of impacts have been established, the overall significance of effects have been assessed using the matrix in Table 15-6.

Table 15-6 - Significance of effects

		Receptor/resource sensitivity			
		Very high	High	Medium	Low
Impact magnitude	High	Major	Major	Moderate	Moderate
	Moderate	Major	Moderate	Minor	Minor
	Low	Moderate	Minor	Minor	Minor
	Very low	Minor	Negligible	Negligible	Negligible
	No change	None	None	None	None

15.35 All effects assessed as being of Moderate significance or above are considered to be significant in EIA terms for the purpose of this assessment. Effects of Minor or Negligible significance are not considered to be significant and have therefore not been reported as significant residual effects.

15.36 Appropriate mitigation measures to reduce and, wherever possible, avoid identified adverse effects have been explored, discussed and assessed within this ES chapter. These have been recorded in the REAC as part of the OEMP in Appendix A2.1 in ES Volume 4 and the outline Biodiversity Mitigation and Compensation Strategy that accompanies the planning applications.

15.37 Any residual effects of the Scheme on the water environment and flood risk following the inclusion of mitigation measures have been identified as part of the assessment.

Scoping and consultation

15.38 Consultation has been undertaken with statutory consultees during the development of the ES, notably the Environment Agency for the water environment. These have included a number of meetings on outline design and planning as well as agreeing the assessment methodology, including:

- Development and use of the water quality model used for assessment.
- Development and use of a hydrological (catchment) model for developing a reservoir compensation flow discharge regime.
- The approach towards mitigation and compensation.

15.39 There have been a number of meetings between Atkins, Portsmouth Water and the Environment Agency on the above topics, including recent meetings on 27 January 2020 (water quality, flood risk

and WFD¹⁰); 5 March 2020 (Compensation flow and WFD¹¹); 31 March 2020 (water quality, flood risk and WFD¹²) and 12 May 2020.

- 15.40 The following technical notes have been produced to support discussions with Environment Agency to date:
- HTS Havant Thicket Outline Design – Compensation Flow – Atkins, dated 2 March 2020¹³;
 - Havant Thicket Winter Storage Reservoir Project – Water Quality Inception Report – Atkins, April 2020¹⁴;
 - HTWSR¹⁵ Baseline flood model for review, and Atkins response dated 18 September 2019¹⁶;
 - HTWSR Emergency Discharge study – Flood study Report – Atkins, dated 10 January 2020¹⁷;
 - HTWSR FRA Scope Summary – Atkins, dated 22 January 2020¹⁸; and,
 - HTWSR Breach modelling approach technical note – Atkins, dated 13 May 2020¹⁹.
- 15.41 With regard to surface water, the consultations have resulted in an agreed approach to establishing a baseline and undertaking the impact assessment for hydrology (using CATCHMOD) and water quality (using Pywr – see Appendix A15.3 Water Quality Report in ES Volume 4). The water quality model applied in this study was developed in extensive consultation with the Environment Agency, who provided feedback during the model development and refinement phases. The Environment Agency confirmed that the model is a suitable basis for modelling water quality impacts of the new reservoir to support the Environmental Impact Assessment of the HTWSR scheme (28 February 2019). The bespoke model has provided a useful quantitative element for the assessment of impacts on water quality. It is worth bearing in mind the inherent limitations of all water quality models when considering the modelling results referred to in the impacts sections of this report. In the case of the water quality model applied for this study, these limitations include the following:
- Ammonium, reactive phosphorus²⁰ and biochemical oxygen demand (BOD) were treated as conservative;
 - Ammonia concentrations in the reservoir were difficult to predict, because of the complex links with biological activity.
 - Dissolved oxygen was treated conservatively and not considered to fall below a critical level. Dissolved oxygen modelling did not take into account a number of influences, including re-aeration, sediment oxygen demand and macrophyte growth.
 - Nitrogen losses in the reservoir were treated conservatively based on the scientific literature and knowledge of similar reservoirs
- 15.42 Full details on the model development and results are provided in the water quality modelling report.
- 15.43 With regards to flood risk, the Environment Agency is responsible for flood risk in relation to Main Rivers. Flood risk management of Ordinary Watercourses is the responsibility of LLFAs and / or District Councils. Formal consultation meetings have been held with:
- Environment Agency
 - Havant Borough Council (LPA)
 - Hampshire County Council (LLFA)
- 15.44 The purpose of consultation was to agree the scope of the Flood Risk Assessment, and specific approaches regarding:
- Assessment of the baseline flood risk - determining the required return periods for modelling;

¹⁰ Atkins reference HTR-ATK-XX-XX-MI-Z-0006

¹¹ Atkins reference HTR-ATK-XX-XX-MI-Z-0009

¹² Atkins reference HTR-ATK-XX-XX-MI-Z-0012

¹³ Atkins technical report, reference 5169117

¹⁴ Atkins reference HTR-ATK-XX-XX-RP-Z-0006

¹⁵ HTWSR = Havant Thicket Water Storage Reservoir

¹⁶ Appendix D & E, HTR-ATK-XX-XX-RP-Z-0062

¹⁷ Atkins reference HTR-ATK-XX-XX-RP-Z-0062

¹⁸ Atkins reference HTR-ATK-XX-XX-RP-Z-0063

¹⁹ Atkins reference HTR-ATK-XX-XX-RP-Z-0061

²⁰ Recorded as “phosphate” or “orthophosphate” by the Environment Agency but referred to as reactive phosphorus here for consistency.

- Emergency Drawdown Strategy – agreeing the parameters by which it can be determined whether the Drawdown Strategy is considered acceptable; and
- Assessment of the with-scheme impacts – determining the required return periods for modelling, and the approach to breach assessment.

15.45 As part of the consultation, an updated Infoworks ICM (v9.0.2) flood risk model was reviewed and approved by the Environment Agency in 2019. Consultation with the Environment Agency occurred in January 2020 to confirm the required return periods for the baseline assessment (as shown in Table 15-29)²¹. Further details from these consultations and the assessment parameters agreed can be found in in Appendix A15.2 Flood Risk Assessment in ES Volume 4.

Cumulative developments

- 15.46 An assessment of the in-combination effects between topic areas within the Scheme has been undertaken.
- 15.47 An assessment of likely significant cumulative effects of the Scheme with other developments and/or schemes has been undertaken with a list of schemes relevant to the individual topic area to be agreed in advance with the Local Authorities and other relevant statutory consultees.
- 15.48 The findings of this assessment have been reported in Chapter 19 Cumulative and In-combination Effects in ES Volume 2.

Assessment assumptions and limitations

- 15.49 The assessment has been undertaken using baseline data available at the time of writing.
- 15.50 It is noted that for a number of reasons, including access restrictions (due to COVID19), it has not been possible to undertake a site walkover of Park Lane Stream to the west of the site (study section 7 – see Table 15-3) and the Headwaters of the River Lavant to the east of the site (study section 8 - see Table 15-3) prior to the development of this ES chapter. Professional judgement has, therefore, been used to describe the baseline and undertake the assessment.
- 15.51 The assessment is based on design parameters developed at preliminary design stage up to May 2020. These parameters will inform the detail design and more detailed information will be made available as the design is developed.
- 15.52 The mitigation measures contained within the REAC as part of the OEMP in Appendix A2.1 in ES Volume 4 will inform the detail design development for the Scheme and will look to avoid likely significant effects and provide betterment where possible. They are likely to comprise measures such as maintaining channel capacity and enhancing watercourse habitats (some elements of which will be undertaken ahead of the construction) as set out in the outline Biodiversity Mitigation and Compensation Strategy and included as part of the planning applications.

Baseline conditions including value/sensitivity of resources and receptors

Surface water

Surface water quality

- 15.53 The Atkins Scoping Report²² required, for the surface water quality baseline section:
- A review of freshwater water quality data collected by Portsmouth Water as part of the monitoring strategy against WFD standards, as set out in the 2015 Directions (WFD, 2015); and
 - Interpretation of Langstone Harbour results against SSSI conservation objectives and JNCC CSM guidance²³.
- 15.54 For the assessment, the Scoping Report also required a review and update to the 2011 Assessment of the Impact on Water Quality in the Hermitage Catchment of the Reservoir (Walls, 2011). This update report was issued to Portsmouth Water and the Environment Agency as a standalone report

²¹ Atkins reference HTR-ATK-XX-XX-MI-Z-0006

²² Atkins, 2019a. Havant Thicket Reservoir Project. EIA Scoping Report – Addendum. 22 November 2019.

²³ JNCC, 2015. Common Standards Monitoring Guidance [online]. Available at: <<https://jncc.gov.uk/our-work/common-standards-monitoring-guidance>>

ahead of the ES development (Atkins, 2020b). A baseline description of Havant and Bedhampton Springs was also contained within this report.

15.55 With regard to Langstone Harbour, the SSSI conservation objectives relevant to water quality are linked to the 'littoral sediment' feature. The most recent condition assessment was undertaken in 2018 and indicated that WFD 'Good' status should be attained for winter inorganic nitrogen, phytoplankton and opportunistic green microalgae (NE, 2020).

15.56 With regard to the 2015 JNCC reference stated in the Scoping Report, unlike freshwater SSSI²⁴, there are no estuarine water quality standards for nitrogen. The 2015 WFD Directions²⁵ dissolved inorganic nitrogen (DIN) standards have, therefore, been used as a water quality benchmark for Langstone Harbour.

WFD status – water quality

15.57 Full details of the WFD status and objectives for the Hermitage Stream, River Lavant and Langstone Harbour WFD waterbodies are provided in Appendix A15.1 WFD Assessment in ES Volume 4. A summary of water quality parameters for the WFD waterbodies containing the freshwater Hermitage Stream and River Lavant has been provided in Table 15-8 (Environment Agency, 2020a).

15.58 Table 15-5 provides a summary of water quality parameters for the transitional Langstone Harbour WFD waterbody²⁶. Although the most recent interim WFD classification available was from 2016, this did not cover all determinands quoted. Where available, for these determinands, previous classifications, e.g. for 2014 and 2015, have been provided at the bottom of each table.

15.59 Where WFD status is presented in this report (i.e. for surface water and groundwater), it has been coloured coded consistently with categories set out in the 2015 Directions. The colour coding set out in Table 15-7 has been used.

Table 15-7 - WFD classification colour coding

	Classification
Ecological Status	High
	Good
	Moderate
	Poor
	Bad
Chemical Status	Pass
	Fail

15.60 With regard to Ecological status for the Hermitage Stream, 2016 water quality classifications were generally Good or High status for physico-chemical determinands and specific pollutants, with the exception of reactive phosphorus (Moderate status). With regard to Chemical status, all priority (hazardous) substance and other pollutant water quality classifications were at Good or High status.

15.61 Where provided, status for water quality classifications for both Ecological and Chemical status for the River Lavant and Langstone Harbour Transitional and Coastal (TraC), were Good or High, i.e. Reasons for Not Achieving Good (RNAG) were not water quality related (see Appendix A15.1 WFD Assessment in ES Volume 4 for further details).

²⁴ JNCC, 2016. Common Standards Monitoring Guidance for Rivers, Version September 2016, ISSN 1743-8160 [online] Available at: <<http://data.jncc.gov.uk/data/1b15dd18-48e3-4479-a168-79789216bc3d/CSM-Rivers-2016-r.pdf>>

²⁵ The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

²⁶ Environment Agency 2020f, Environment Agency -Catchment Data Explorer (Langstone Harbour) [online] Available at: <https://environment.data.gov.uk/catchment-planning/WaterBody/GB107042016420>

Table 15-8 - WFD Classification - water quality parameters – freshwater

Water body name	Hermitage Stream	Lavant (Hants)
Water body ID	GB107042016370	GB107042016420
National Grid Reference (OSNGR)	SU 69947 08585	SU 72528 07491
River Basin District	South East	South East
Management catchment	East Hampshire	East Hampshire
Operational catchment	East Hampshire Rivers	East Hampshire Rivers
A/HMWB	Heavily Modified	Not designated artificial or heavily modified
Classification	2016	2016
Overall Water Body	Moderate	Poor
Ecological	Moderate	Poor
Physico-chemical quality elements	Moderate	High
- Acid Neutralising Capacity	High	-
- Ammonia	High	High
- Biochemical Oxygen Demand	High	-
- Dissolved Oxygen	High	High
- pH	High	High
- Reactive phosphorus	Moderate	High
- Temperature	High	High
Specific pollutants	High	-
- Triclosan ¹	High	-
- Copper ¹	-	-
- Zinc ¹	-	-
Chemical	Good	Good
Priority substances ²	Does not require assessment	Does not require assessment
- Lead and its compounds ²	-	-
- Nickel and its compounds ²	-	-
Other Pollutants	Does not require assessment	Does not require assessment
Priority hazardous substances	Good	Does not require assessment
Cadmium and its compounds ²	-	-
Di(2-ethylhexyl)phthalate (Priority hazardous) ²	-	-
Nonylphenol ²	Good	-
Tributyltin Compounds ²	-	-

Table Notes

1 - 2014 classification – High

2 - 2014 classification – Good

Table 15-9 - WFD Classification – water quality parameters- transitional

Water body name	Langstone Harbour
Water body ID	GB580705130000
National Grid Reference (OSNGR)	SU 69514 02666
River Basin District	South East
Management catchment	South East TraC
Operational catchment	Hampshire East TraC
A/HMWB	Heavily Modified
Classification	2016
Overall Water Body	Moderate
Ecological	Moderate
Physico-chemical quality elements	Good
- Dissolved inorganic Nitrogen	Good
- Dissolved Oxygen	High
Specific pollutants	-
- Arsenic ¹	-
- Copper ¹	-
- Zinc ¹	-
Chemical	Good
Priority substances ²	Does not require assessment
- Fluoranthene ²	-
- Lead and its compounds ²	-
- Nickel and its compounds ²	-
Other Pollutants	Does not require assessment
Priority hazardous substances	Good
- Benzo(a)pyrene ²	-
- Cadmium and its compounds ²	-
- Hexachlorobenzene	Good
- Hexachlorobutadiene	Good
- Mercury and its compounds ³	-

Table notes

1 - 2014 classification – High

2 - 2014 classification – Good

3 - 2014 classification - Fail

Portsmouth Water quality data

- 15.62 The baseline data review included all physico-chemical determinands specified under WFD (i.e. dissolved oxygen, Biochemical Oxygen Demand (BOD), ammoniacal nitrogen, reactive phosphorus, temperature and pH for freshwaters) as well as Specific Pollutants and Priority (Hazardous) Substances.
- 15.63 Where data could be directly compared against relevant WFD standards (i.e. where the standard aligns with the type of parameter measured e.g. dissolved, total, bioavailable) it has been processed in line with the methodology described in the 2015 WFD Directions using alkalinity and site altitude to derive the WFD surface water body types shown in
- 15.64 Table 15-11. Where this was not possible, e.g. where a different fraction was monitored, data have been included for wider catchment context (this was the case for selected metals, nutrients and sanitary determinands). Where applicable, the interpretation also used the appropriate statistics (annual average, 10/90/95th percentiles etc.) The interpretation is, however, not a formal WFD status classification.
- 15.65 Portsmouth Water have undertaken spot water quality sampling at 11 sampling locations within the study area, with analysis undertaken at the Portsmouth Water laboratory for the majority of parameters (with the exception of BOD, dry residues, suspended solids and total organic carbon which were undertaken at South East Water Scientific Services). Sampling locations are shown in Figure 15-3 in ES Volume 3. Sampling locations relevant to each of the study sections have been provided in Table 15-10. It is noted that no data were available for study sections 7 and 8 (see Table 15-3).
- 15.66 Monitoring data were made available for the following parameters:
- Aluminium - Total (µg/l)
 - Ammonium as N (mg/l as N)
 - BOD (mg/l)
 - Cadmium - Total (µg/l)
 - Calcium - Total (mg/l as Ca)
 - Chloride (mg/l as Cl)
 - Chromium - Total (µg/l)
 - Colour (mg/l Pt/Co)
 - Copper - Total (mg/l)
 - Depth of Water (Metres)
 - Dry Residues (mg/l)
 - Electrical Conductivity (µS/cm)
 - Electromagnetic Flow Reading (m/s)
 - Hydrogen Ion Content (pH Units)
 - Iron - Total (µg/l)
 - Magnesium - Total (mg/l)
 - Manganese - Total (µg/l)
 - Nickel - Total (µg/l)
 - Nitrate (mg/l as NO₃)
 - Nitrite (mg/l as NO₂)
 - Reactive phosphorus (µg/l)
 - Phosphorous - Total (µg/l)
 - Potassium - Total (mg/l)
 - Sodium - Total (mg/l)
 - Sulphate (mg/l as SO₄)
 - Suspended Solids (mg/l)
 - Temperature (Celsius)
 - Total Alkalinity as CaCO₃ (mg/l as CaCO₃)
 - Total Ammonium (mg/l as NH₄)
 - Total Hardness (mg/l as CaCO₃)
 - Total Hardness (mg/l as CaCO₃)
 - Total Organic Carbon (mg/l)
 - Turbidity (Nephelometric Turbidity Unit - NTU)
 - Zinc - Total (µg/l)

Table 15-10 - Portsmouth Water surface water quality locations

Study section	Portsmouth Water Sites	Site description (WFD Type used for comparison against standards)	Data Period	Number of samples (typical per parameter ²⁷)
Headwater Streams				
1	HT1	Western (Type 2)	2008-2010 2018-2020	18 5
	HT2	Middle (Type 2)	2008-2010 2018-2019	29 10
	HT3	Eastern (Type 2)	2008-2010 2018-2020	26 11
Watercourses underneath reservoir site footprint				
2	HT4	Winterslow Drive (Type 3)	2008-2010 2018-2020	28 17
Riders Lane Stream (RLS) & The Lake Stream (TLS)				
3	HT5	TLS -u/s of confluence with RLS (Type 3)	2008-2010 2018-2019	11 7
	HT9	RLS -u/s of confluence with TLS (Type 3)	2008-2010 2018-2019	12 9
	HT21	RLS -d/s of confluence with TLS (Type 5)	2008-2010 2018-2019	12 15
	HT7	RLS u/s of confluence with Hermitage Stream (Type 5)	2008-2010 2018-2020	12 19
Hermitage Stream upstream of RLS				
4	HT6	Hermitage Stream u/s of confluence with RLS (Type 5)	2008-2010 2018-2020	13 20
Hermitage Stream downstream of RLS				
5	HT8	Hermitage Stream d/s of confluence with RLS (Type 5)	2008-2010 2018-2020	23 17
	HT22	At Environment Agency sampling location (New Lane) (Type 5)	2008-2010 2018-2020	12 19
6	Langstone Harbour			
	-/-	-/-	-/-	-/-
7	Headwater Streams draining east towards River Lavant			
	-/-	-/-	-/-	-/-
8	Park Lane Stream			
	-/-	-/-	-/-	-/-

²⁷ Number of samples varies between parameters, the data presented presents the number of samples for the majority of parameters sampled.

Table 15-11 - Alkalinity data used to derive WFD Type for each watercourse

Study section	Portsmouth Water sites	Date range		Count	Alkalinity (annual average) (mg/l as CaCO ₃)	Altitude (m)
1	HT1	28/11/2018	28/01/2020	10	14.0	40
	HT2	18/05/2018	20/06/2019	20	21.1	41
	HT3	18/05/2018	17/03/2020	24	13.4	39
2	HT4	18/05/2018	17/03/2020	34	61.3	19
3	HT5	24/05/2018	10/12/2019	18	63.6	17
	HT9	24/05/2018	10/12/2019	22	83.0	16
	HT21	24/05/2018	10/12/2019	35	115.6	16
	HT7	24/05/2018	17/03/2020	38	146.9	9
4	HT6	24/05/2018	17/03/2020	40	169.4	9
5	HT8	24/05/2018	17/03/2020	34	154.2	9
	HT22	24/05/2018	17/03/2020	36	159.6	7

15.67 Sampling was initially undertaken between July 2008 and December 2010 and recommenced in 2018 with monitoring data made available up to April 2020. Data points for analysis vary for each determinand at each Portsmouth Water site as a result of intermittent flow in some reaches (which meant streams could be dry). The following determinands were compared to WFD standards with results presented in Table 15-12.

- BOD (90th percentile);
- Reactive phosphorus (average²⁸);
- Ammoniacal nitrogen (90th Percentile)²⁹;
- Temperature (98th percentile); and,
- Total iron (average).

15.68 Results from the Portsmouth Water sampling data can be summarised as follows:

- The BOD data presented indicated Good to High status within study section 1; this trend was generally observed on the downstream sections, with exception at study section 3, where BOD concentrations are indicative of Moderate status upstream of the confluence between Riders Lane Stream and The Lake Stream (HT9). This was a localised reduction in BOD as concentrations improved to High status downstream of the confluence of Riders Lane stream and Hermitage Stream (HT8) and remained so at the furthest downstream monitoring point (HT22).
- Reactive phosphorus concentrations were indicative of Moderate status at most sites, including the Headwater Streams (study section 1). There was an improvement at study section 2 (HT4) and the most upstream monitoring point at study section 3 (HT5), where Good status was attained. However, increases in reactive phosphorus were observed further downstream in the catchment, and reactive phosphorus concentrations were indicative of Moderate status at all remaining monitoring points.

²⁸ Reactive phosphorus standards have been calculated using the equations and methodology specified within the 2015 WFD Directions.

²⁹ It is noted that the Portsmouth Water data were for ammonium. As ammoniacal nitrogen is typically mainly composed of ammonium this was considered a representative comparison.

- The ammoniacal nitrogen data presented indicated localised issues at the Middle headwater stream (HT2), where concentrations were indicative of Bad status. This was not observed in the two other streams, where water quality was indicative of at least Good status. Ammoniacal concentrations were indicative of High status at all other study sections, with the exception of localised poor water quality upstream of the confluence between Riders Lane Stream and The Lake Stream.
- Temperature was indicative of High status at all monitoring points, when comparing against Cyprinid standards.
- The pH recorded at the all three headwaters streams in study section 1 did not attain High/Good status standards, with the Middle Stream indicative of Poor status. Overall, this is considered indicative of natural variation, for example as a result of low buffering capacity (in context of these streams being groundwater and rainwater fed) and/or upstream coniferous plantation. All other monitoring points were indicative of High status.
- The only Specific Pollution/Priority (Hazardous) Substance with a relevant WFD standard sampled by Portsmouth Water was total iron. Concentrations of iron were elevated and thus did not attain relevant WFD standards within study sections 1 and 2. General improvements in water quality were observed further downstream as observed concentrations pass WFD standards downstream of the confluence between Riders Lane Stream and The Lake Stream.

Table 15-12 - Comparison of Portsmouth Water data against freshwater WFD standards

Study section	Portsmouth Water Sites	Determinand (Statistic used for assessment against WFD standard)					
		BOD (90 th percentile) (mg/l)	Reactive phosphorus (annual average) (µg/l)	Ammoniacal nitrogen (90 th percentile) (mg/l)	Temperature (98 th percentile) ¹ (°C)	pH (5-95 th Percentile) (10 th Percentile) ² pH units	Total Iron (annual average) (µg/l)
1	HT1	2.24	39.0	0.02	14.4	5.0 - 6.5 (5.1)	4515
	HT2	3.37	43.8	1.60	16.1	4.4 - 7.2 (4.4)	3463
	HT3	2.80	40.7	0.26	20.1	4.9 - 6.5 (5.0)	7295
2	HT4	2.30	33.9	0.06	16.4	6.3 - 7.9	1570
3	HT5	3.25	32.2	0.12	15.2	6.2 - 7.9	1842
	HT9	5.91	78.4	0.77	17.7	6.8 - 7.8	1090
	HT21	3.70	88.7	0.23	17.1	6.9 - 7.8	930
	HT7	3.52	90.0	0.08	17.3	7.4 - 8.2	1108
4	HT6	3.54	120.9	0.12	18.7	7.7 - 8.5	664
5	HT8	3.12	91.7	0.19	19.7	7.7 - 8.9	661
	HT22	3.00	111.6	0.07	22.1	7.9 - 9.3 (8.0)	436
6	-/-	-/-	-/-	-/-	-/-	-/-	-/-
7	-/-	-/-	-/-	-/-	-/-	-/-	-/-
8	-/-	-/-	-/-	-/-	-/-	-/-	-/-

Table notes:

1 - Electrofishing undertaken in the Hermitage Stream in 2012 (3 sites) and 2014 (1 site) recorded the presence of European eel, bullhead and 3-spined stickleback and therefore temperature data has been compared against Cyprinid Standards.

2 – Where High-Good status is not met using the 5-95th percentile, the 10th percentile value has been used to determine Moderate/ Poor status.

- 15.69 As stated above, the analysis was extended to include further determinands including some of the total metal data, which have been compared against the dissolved WFD fraction standards for cadmium³⁰ and nickel. Total chromium data has been assessed against the chromium (vi) standard for indicative purposes, in Table 15-13. It should be noted that this assessment has been provided to provide water quality context and does not strictly provide a pass/ fail status against the standards.
- 15.70 Assessment of total metals (cadmium, nickel and chromium) against dissolved standards, indicated poorer water in study section 1, particularly for cadmium and nickel. With the exception of nickel within study section 2, all other parameters indicated standards would Pass throughout the study area. As the analysis was for total metals, the results are not directly comparable with the standards for dissolved and it is likely that they are an overestimate of the dissolved concentrations at these locations.

Table 15-13 - Metal determinand analysis (indicative against WFD standards)

Study section	Portsmouth Water sites	Determinand (Statistic used for assessment against dissolved WFD standard)		
		Total Cadmium (annual average (µg/l))	Total Nickel (annual average) (µg/l)	Total Chromium (annual average) (µg/l)
1	HT1	0.25	9.62	4.16
	HT2	0.25	7.42	2.53
	HT3	0.16	9.04	2.12
2	HT4	0.13	4.83	1.18
	HT5	0.07	4.34	1.72
3	HT9	0.08	3.61	1.12
	HT21	0.09	3.52	1.08
	HT7	0.07	3.27	1.86
4	HT6	0.06	3.30	1.12
5	HT8	0.08	3.22	1.26
	HT22	0.07	2.36	1.02
6	-/-	-/-	-/-	-/-
7	-/-	-/-	-/-	-/-
8	-/-	-/-	-/-	-/-

It should be noted that the Total fraction concentration has been compared against a Dissolved fraction standard for indicative purposes only.

³⁰ the EQS values vary depending on the hardness of the water as specified in five class categories (Class 1: < 40 mg CaCO₃/l, Class 2: 40 to < 50 mg CaCO₃/l, Class 3: 50 to < 100 mg CaCO₃/l, Class 4: 100 to < 200 mg CaCO₃/l and Class 5: ≥ 200 mg CaCO₃/l)

- 15.71 Nutrient data, including nitrates, nitrites and total phosphorus (presented in Table 15-14) showed a general trend of a reduction/deterioration in water quality, from upstream to downstream of the study sections.

Table 15-14 - Nutrient data (as average)

Study section	Portsmouth Water sites	Determinand		
		Nitrate (mg/l as NO ₃)	Nitrite (mg/l as NO ₂)	Phosphorous – Total (µg/l as P)
1	HT1	0.96	0.00	19.8
	HT2	0.78	0.00	29.4
	HT3	1.48	0.00	21.4
2	HT4	0.72	0.00	27.7
	HT5	1.26	0.01	63.8
3	HT9	1.91	0.06	140
	HT21	2.52	0.07	117
	HT7	7.43	0.08	149
4	HT6	9.92	0.14	143
5	HT8	9.16	0.07	129
	HT22	12.70	0.09	142
6	-/-	-/-	-/-	-/-
7	-/-	-/-	-/-	-/-
8	-/-	-/-	-/-	-/-

- 15.72 Sanitary determinands, shown in Table 15-15 included suspended solids, conductivity and turbidity. The trends varied, with turbidity and suspended solids decreasing between study section 1 and 4, whilst conductivity increased.

Table 15-15 - Sanitary determinands (as average)

Study section	Portsmouth Water sites	Determinand		
		Electrical Conductivity (µS/cm)	Suspended Solids (mg/l)	Turbidity (NTU)
1	HT1	308.50	50.32	359.85
	HT2	266.07	109.77	87.73
	HT3	229.93	364.39	59.99
2	HT4	386.73	15.24	33.42
	HT5	291.18	32.93	33.66
3	HT9	341.27	14.30	11.72
	HT21	356.78	11.31	11.34
	HT7	459.94	19.83	11.84
4	HT6	582.39	10.12	7.22
5	HT8	541.60	10.34	8.78
	HT22	504.77	12.92	7.10
6	-/-	-/-	-/-	-/-
7	-/-	-/-	-/-	-/-
8	-/-	-/-	-/-	-/-

15.73 In summary, the sample data reviewed indicated differences in water quality between the five sections. There were localised areas of poorer water quality, notably Headwater Stream 2 within study section 1 (sample site HT2) and Riders Lane Stream upstream of the confluence with The Lake Stream within study section 3 (sample site HT9).

Bedhampton and Havant Spring Water data

15.74 Spring water quality data, sampled between January 2008 and March 2020 is summarised in Table 15-16. The data is presented for information only and no assessment against (WFD) standards has been undertaken.

Table 15-16 - Data summary for Bedhampton and Havant Springs

Parameter	Average	Min	Max	Count
Temperature (Celsius)	11.1	9.80	15.10	592
22C Plate Count (72hr) (No / 1 ml)	802	0.00	34000	586
37C Plate Count (48hr) (No / 1 ml)	111	0.00	8000	587
Presumptive <i>Clostridia</i> (Number / 100ml)	11.0	0.00	740	484
Presumptive <i>E.Coli</i> (Number / 100ml)	73.5	0.00	5700	590
Presumptive Enterococci (Number / 100ml)	65.1	0.00	5800	585
Presumptive Total Coliforms (Number / 100ml)	402	0.00	72000	589
Colour (mg/l Pt/Co)	1.30	0.30	35.2	266
Electrical Conductivity (µS/cm)	525	396	623	586
Hydrogen Ion Content (pH Units)	7.22	6.94	7.92	586
Turbidity (NTU)	0.60	0.05	9.77	477
Ammonium as N (mg/l as N)	0.02	0.01	0.05	176
Chloride (mg/l as Cl)	21.7	18.3	26.1	178
Nitrate (mg/l as NO ₃)	33.3	21.4	53.5	487
Nitrite (mg/l as NO ₂)	0.00	0.00	0.04	487
Phosphate (µg/l as P)	36.4	2.00	251	144
Sulphate (mg/l as SO ₄)	16.8	12.2	26.8	160
Total Alkalinity as CaCO ₃ (mg/l as CaCO ₃)	239	221	258	69
Total Alkalinity as HCO ₃ (mg/l as HCO ₃)	297	233	379	165
Total Ammonium (mg/l as NH ₄)	0.02	0.01	0.07	176
Total Hardness (mg/l as CaCO ₃)	300	229	345	160
Total Hardness as mg/l Ca (mg/l as Ca)	120	91.60	138	160
Total Oxidised Nitrogen (mg/l as NO ₃)	33.6	27.9	41.9	186
Aluminium - Total (µg/l)	35.5	1.90	236	24
Boron - Total (mg/l)	0.03	0.01	0.05	59
Cadmium - Total (µg/l)	0.05	0.01	0.10	74
Calcium - Total (mg/l as Ca)	112	105	121	21
Chromium - Total (µg/l)	0.21	0.05	0.70	73
Copper - Total (mg/l)	0.04	0.00	0.20	75
Iron - Total (µg/l)	36.9	0.01	799	151

Lead - Total (µg/l)	2.69	0.05	46.8	78
Magnesium - Total (mg/l)	2.16	0.20	2.40	22
Manganese - Total (µg/l)	0.47	0.05	3.60	150
Nickel - Total (µg/l)	1.04	0.30	2.80	75
Phosphorous - Total (µg/l as P)	20.5	0.90	32.0	22
Potassium - Total (mg/l)	1.19	1.10	1.30	21
Sodium - Total (mg/l)	10.2	9.30	11.6	21
Zinc - Total (µg/l)	6.60	1.40	17.4	22
Total Organic Carbon (mg/l)	0.99	0.05	7.10	343
Temperature (Celsius)	11.1	9.80	15.10	592
22°C Plate Count (72hr) (No / 1 ml)	802	0.00	34000	586

Environment Agency water quality data

- 15.75 The Environment Agency Water Quality Archive³¹ contained data for study sections 5, 6 and 7 (see Table 15-17). These data have been compared against WFD standards in Table 15-18 and Table 15-19.
- 15.76 Available data for study section 5 reflects the official Environment Agency WFD classifications, in that Good status was generally met, with the exception of reactive phosphorus (Moderate). The reported pH value also corresponded to less than Good status (Moderate; note that the reported value was close to the Good status threshold). Data for the River Lavant indicated High status for physico-chemical parameters with the exception of reactive phosphorus.
- 15.77 Water quality of transitional waterbodies is based on turbidity using suspended particulate matter (mg/l), however as this data was not available the turbidity data (as ftu) has been used for indicative purposes and an "Intermediate" type has used for all sample locations due to the generally low turbidity values. Data presented for transitional waterbodies also reflects the official Environment Agency WFD classifications.

³¹ Environment Agency, 2020g, Water Quality Archive [online] Available at: <https://environment.data.gov.uk/water-quality/view/landing>

Table 15-17 - Environment Agency sample locations

Study section	Environment Agency Sample location	Average turbidity (FTU) used to assess Type for transitional waterbodies	Sampling point ID	Sampling date range	
	(WFD Type for assessment against standards- where applicable)				
1	-/-	-/-	-/-	-/-	-/-
2	-/-	-/-	-/-	-/-	-/-
3	-/-	-/-	-/-	-/-	-/-
4	-/-	-/-	-/-	-/-	-/-
5	Hermitage Stream – New Road (Type 5)	-/-	SO-G0003625	04/02/2008	13/02/2020
6	Entrance to Chaldock Lake (Clear)	8.8	SO-G0016921	04/02/2008	13/02/2020
	Langstone Channel – Southmoor Point (Clear)	8.7	SO-G0003468	04/02/2008	13/02/2020
	Alpha Buoy Langstone (Intermediate)	10.4	SO-G0015927	04/02/2008	13/02/2020
	NW Sinah Buoy (Intermediate)	11.3	SO-G0016920	04/02/2008	13/02/2020
	Langstone Harbour Mouth (Intermediate)	11.2	SO-G0003493	04/02/2008	13/02/2020
7	River Lavant at IBM Havant (Type 7)	-/-	SO-G0016921	04/02/2008	13/02/2020
8	-/-	-/-	-/-	-/-	-/-

Table 15-18 - Comparison of Environment Agency data for Hermitage Stream and River Lavant against freshwater WFD standards

Determinand (Unit)	Statistic used for assessment	Hermitage Stream – New Road SO-G0003625 (Count of data points)	River Lavant at IBM Havant SO-G0016921 (Count of data points)
Physicochemical			
Ammoniacal Nitrogen as N (mg N/l)	90th percentile	0.05 (104)	0.02 (77)
BOD (mg/l)	90th percentile	3.27 (134)	-
Reactive phosphorus (µg/l)	Average	89.2 (96)	17.62 (77)
Dissolved oxygen (% Saturation)	10th Percentile	89.5 (104)	84 (77)
pH	5th-95th percentile (10th percentile)	7.5 - 9.14 (7.8) (104)	7.4-7.9 (7.4) (77)
Temperature ¹	98th percentile	20.6	13.7 (77)
Priority Substances			
4-Nonylphenol (µg/l)	Average	0.04 (12)	-
4-tert-Octylphenol (µg/l)	Average	0.01 (12)	-
Benzo(a)pyrene (µg/l)	Average	0.0007 (24)	-
Fluoranthene (µg/l)	Average	0.002 (20)	-
Specific Pollutants			-
Triclosan (µg/l)	Average	0.01 (12)	-

1 - Data have been compared against Cyprinid Standards.

Table 15-19 - Comparison of Environment Agency data for Langstone Harbour against transitional WFD standards

Determinand (Unit)	Statistic used for assessment	Entrance to Chaldock Lake	Langstone Channel – Southmoor Point	Alpha Buoy Langstone	NW Sinah Buoy	Langstone Harbour Mouth
Dissolved inorganic nitrogen (micromoles/l)	99 th Percentile	60.0	54.4	49.1	42.2	41.8
Dissolved Oxygen (mg/l)	5 th Percentile	6.9	6.8	6.9	7.1	7.1

Comparison of baseline data against SSSI Conservation Objectives

- 15.78 Langstone Harbour SSSI has six units within the harbour area (see Chapter 9 Biodiversity in ES Volume 2):
- Unit 1 – 113.3ha of neutral grassland assessed as ‘favourable’ in 2009
 - Unit 3 – 498.0ha of littoral sediment assessed as ‘unfavourable – recovering’ in 2018
 - Unit 6 – 430.0ha of littoral sediment assessed as ‘unfavourable – recovering’ in 2018
 - Unit 9 – 371.4ha of littoral sediment assessed as ‘unfavourable – recovering’ in 2018
 - Unit 13 – 205.1ha of littoral sediment assessed as ‘unfavourable – recovering’ in 2018
 - Unit 14 – 356.4ha of littoral sediment assessed as ‘unfavourable – recovering’ in 2018
- 15.79 There was no reference to water quality or inundation issues for Unit 1, although agriculture and fertiliser use were mentioned as pressures. This unit is, therefore, not further considered as part of the water baseline or assessment. All other units (i.e. Units 3, 6, 9, 13, 14) are inundated at high tide and thus influenced by water quality.
- 15.80 The SSSI condition assessment³² referred to WFD standards as a benchmark for Units 3, 6, 9, 13 and 14 and highlights that the ‘unfavourable - recovering’ status was in context of “*weight of evidence on inorganic nitrogen and biological indication of eutrophication shown by the abundance of macroalgae, but recovering on the basis of a large reduction in nutrient inputs through the diversion of wastewater*”. It further noted that “*there remains a significant nitrogen load input from the Solent and less so by minor rivers into the head of the harbour*”.
- 15.81 The findings of the SSSI condition assessment for Units 3, 6, 9, 13 and 14 are broadly corroborated by the Environment Agency data reviewed for study section 6.
- ### Water Quality Modelling
- 15.82 The Havant Thicket Storage Reservoir Early Start Studies Water Quality Modelling report (Appendix A15.3 Water Quality Report in ES Volume 4) was agreed with the Environment Agency as a suitable basis for modelling water quality impacts to support the EIA for the Scheme. With relevance to the baseline, it presents available data and a literature review of treatment risk associated with the development of the reservoir as well as details of the revised reservoir water quality spreadsheet model (originally developed by R.M. Walls in 2011³³). It also contains an assessment of potential impacts of operation of the Scheme on downstream water quality, which has been used in this ES.
- 15.83 The baseline reservoir conditions established using the model identified:
- The trophic status of the reservoir is likely to be between oligotrophic to mesotrophic which represents a low to moderate risk from algae. Compared to other surface water reservoirs in southern England, the trophic status will be low.
 - Importance of reservoir drawdown and refill on water quality especially on concentrations of nutrients and algal risk.
 - Bird droppings make up a large proportion of the phosphorus inputs and prediction of future numbers is difficult.
 - Nitrogen inputs were dominantly from Bedhampton and Havant Springs but remained well below the Drinking Water standard even during and after drought events.
 - Exchange of phosphorus from the sediment remains a key area of uncertainty, however the average depth is predicted to be 10 m and therefore likely to be less than more typical shallow reservoirs.
 - Historical short term increases in total phosphorus recorded in Bedhampton and Havant Springs are less significant in terms of treatment risk.
 - Future sensitivity testing will be possible during the outline design stage using the reservoir spreadsheet model.

³² NE, 2020. Langstone Harbour SSSI. [online] Available at: <https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S1001182&ReportTitle=Langstone%20Harbour%20SSSI>

³³ Walls, R.M. 2011. Havant Thicket Winter Storage Reservoir: Assessment of the Impact on Water Quality of the Proposed Reservoir.

- A separate report addressed the implications for water treatment including mitigation options to reduce treatment risks associated with reservoir water³⁴.

Anthropogenic Influences

- 15.84 The Scoping opinion required that the EIA consider (other) abstraction and impoundment licences as well as environmental (discharge) permits.

Surface water abstractions

- 15.85 Information provided by the Environment Agency confirmed that there were no surface water abstractions within a 500 m radius of the reservoir's central point (OSNGR SU 71435 10028). Surface water abstractions at a radius greater than 500 m were reported in the Scoping Report and detailed in Table 15-20 below. The location of this abstraction has been shown in Volume 3, Figure 15.3.
- 15.86 There are no Catchment Abstraction Management Strategy Assessment Points in the Hermitage Stream catchment, but the catchment is considered to have 'water available for licencing' at Q30, Q50, Q70 and Q95³⁵.

Table 15-20 - Surface water abstractions in the Hermitage Stream catchment

License No.	Operator	Source Type	Distance from reservoir (m)	Abstraction Use	Max Daily Quantity (ML/d)	Annual Quantity (ML/d)	Average Daily Quantity (ML/d)
11/42/36.1/3ca	Borrow Investments Ltd.	Surface water	824	Spray Irrigation	Not given	Not given	-/-

Surface water discharges

- 15.87 Information provided by the Environment Agency confirmed that there were no surface water discharges within a 500 m radius of the reservoir's central point (OSNGR SU 71435 10028). Surface water discharges at a radius greater than 500 m from the study area were reported in the Atkins Scoping Report and detailed in Table 15-21 below. The location of these discharges has been shown in Figure 15.3 in ES Volume 3.

Table 15-21 - Surface water discharges in the Hermitage Stream catchment

Permit Reference	Discharge Type	Receiving Environment	Issue Date	Easting	Northing	Estimated Distance from Site (m)	Status
PO4452	Trade Effluent Discharge – Site Drainage	Freshwater River	10 th April 2001	471380	108240	782	Pre National Rivers Authority Legislation where issue date < 01/09/1989
PO4452	Discharge of Other Matter – Surface Water	Freshwater Stream/River	20 th August 1992	471380	108240	782	Post National Rivers Authority Legislation where issue date > 31/08/1989

³⁴ Atkins, 2019b, Havant Thicket Early Start Studies: Study 4 Water Quality Report. Atkins - for Portsmouth Water.

³⁵ Environment Agency. 2020a. Environment Agency - Catchment Data Explorer. [online] Available at: <https://environment.data.gov.uk/catchment-planning/search?type=placename&k=HAVANT&q=http://environment.data.gov.uk/catchment-planning/so/Town/havant>

Permit Reference	Discharge Type	Receiving Environment	Issue Date	Easting	Northing	Estimated Distance from Site (m)	Status
H01943	Sewage Discharges – Final/Treated Effluent - Not Water Company	Saline Estuary	23rd October 1964	473000	109100	809	Pre National Rivers Authority Legislation where issue date < 01/09/1989
NPSWQD0 02110	Sewage Discharges – Final/Treated Effluent - Not Water Company	Freshwater Stream/River	19 th September 2008	472297	110899	653	New consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by the Environment act 1995)
A01276	Public Sewage: Storm Sewage Overflow	Freshwater Stream/River	28 th May 2007	470060	110030	729	New consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by the Environment act 1995)

Hydromorphology

- 15.88 The Scoping Report required, for the hydromorphology baseline section, the inclusion of all available Environment Agency flow data.
- 15.89 For the assessment, the Scoping Report highlighted that further flow monitoring was likely to be required. This has been undertaken by Portsmouth Water with data presented below.
- 15.90 The Scoping Report also highlighted that there is the potential to create a variable flow regime downstream of the reservoir, with the aim of enhancing the aquatic ecology of the watercourse. The current baseline flow conditions for each section has been described below and will be used to inform the development of environmental flows.

WFD status - hydromorphology

- 15.91 Hydromorphology and Hydrological Regime are supporting conditions unless a water body is classified as being of High ecological status. In these cases, hydromorphological elements contribute towards status classification.
- 15.92 As mentioned above, Hermitage Stream and Langstone Harbour have been designated as HMWB under the WFD. The reasons for designation were flood risk and urbanisation for Hermitage Stream and navigation for Langstone Harbour³⁶. It is understood that Hermitage Stream was modified as part of the Hermitage Stream FAS undertaken in 1971-1975 in which the watercourse was straightened, concreted and the bed was lowered³⁷.

³⁶ Environment Agency, 2009. River Basin Management Plan South East River Basin District. Annex B: Water body status objectives. [online] Available at: < <https://www.gov.uk/government/publications/south-east-river-basin-management-plan> >

³⁷ River Restoration Centre (RRC), 2000. River restoration news. Issue 6, July 2000. [online] Available at: <<https://www.therrc.co.uk/newsletters/issue6.pdf>>

- 15.93 Hydromorphology was considered to 'support good' WFD status in the Hermitage Stream, River Lavant and Langstone Harbour in 2016³⁸. In terms of flows supporting the aquatic ecology (environmental flows or Environmental Flow Indicators), the hydrological regime was also considered to 'support good' WFD status in the Hermitage Stream, River Lavant and Langstone Harbour in 2016.
- Hydromorphology baseline description**
- 15.94 The Water Framework Directive Assessment (Appendix A15.1 WFD Assessment in ES Volume 4) provides a detailed description of the hydromorphology for each of the key study sections, including photographs taken during a site visit on 20 November 2019. A short summary for each study section has been provided below.
- 15.95 Study section 1: The three Headwater Streams that flow into the reservoir footprint (HS1-HS3) are ephemeral; two of which were flowing on the day of a site visit in November 2019, the third, in the east, was not. The first two (HS1, HS2) were around 1-1.5 m wide and water depth was around 0.3 m on the day. The third tributary (HS3) was smaller with an average width of around 0.5 m.
- 15.96 Study section 2: The three Headwater Streams do not change in nature from study section 1. Watercourses underneath the reservoir site footprint - the middle tributary (HS2) flowed into an online pond which is also within the reservoir site footprint and is approximately 100 m by 80 m. The three Headwater Streams (HS1-3) are joined by HS4 and HS5 to form Riders Lane Stream, again an ephemeral stream, within the reservoir site footprint.
- 15.97 Study section 3: Riders Lane Stream has largely natural features (although in many places it has been historically straightened, it is showing signs of recovery), particularly in Great Copse where it is highly sinuous; some other sections remain concrete lined. Outside Great Copse, Riders Lane stream was moderately sinuous and had an average width of 2 m. On the day of the site visit the water depth was around 0.3 m. In parts, the stream was heavily incised and shaded by trees.
- 15.98 Study section 4: The section of Hermitage Stream immediately above the Riders Lane Stream i.e. between Middle Park Lane up to its confluence with Riders Lane Stream has been restored in the past with the concrete banks removed and woody features placed along the banks and perpendicular to the flow within the channel to replicate riffles at low flow. The concrete bed, however, has been left in place reducing the overall diversity of habitats.
- 15.99 Study section 5: Hermitage Stream flows south from its confluence with Riders Lane Stream and is a perennial watercourse within the study area. The concrete channel is present on Hermitage Stream until it reaches the NTL. For most of its length the stream is lined with concrete on both the bed and banks, and due to this modification is largely straight and lacking both hydraulic and habitat diversity.
- 15.100 Study section 6: Downstream of the NTL the river is more natural. There were two overflow outflows from Havant and Bedhampton Springs. However, the furthest downstream outflow flows into a millpond owned by a private a landowner who controls the amount of flow released from the millpond into Hermitage Stream.
- 15.101 Study section 7: The Headwater Streams draining east towards River Lavant are mainly straightened ditches, with natural edges.
- 15.102 Study section 8: In absence of a site visit, map data indicates Park Lane Stream appears to be ephemeral in nature, flowing through a wooded valley with some sinuosity.
- Portsmouth Water hydrology data**
- 15.103 Between 2008 and 2018, Portsmouth Water undertook flow monitoring at 10 sites throughout the catchment (Figure 15-2 in ES Volume 3). A description of sites monitored has been provided in Table 15-22 and a summary of the flow data made available has been provided in Table 15-23. The flow monitoring method was based on a qualitative 'flow score' from 0 – 10. Through interpretation of the flow scores and discussions with Portsmouth Water, it was determined that a score of 0 – 3 indicated low/negligible flow, 4-8 some flow and 8-10 upper flow such as at or close to bank full. No Portsmouth Water flow gauging data were available for Langstone Harbour or the Headwater Streams of the River Lavant.

³⁸ Environment Agency. 2020a. Environment Agency - Catchment Data Explorer. [online] Available at: <https://environment.data.gov.uk/catchment-planning/search?type=placename&k=HAVANT&q=http://environment.data.gov.uk/catchment-planning/so/Town/havant>

Table 15-22 - Portsmouth Water hydrology monitoring locations

Study section	Portsmouth Water sites	Site description
1	Headwater Streams	
	HT1	Western
	HT2	Middle
	HT 3	Eastern
2	Watercourses underneath reservoir site footprint	
	HT4	Winterslow Drive
3	Riders Lane Stream (RLS) & The Lake Stream (TLS)	
	HT5	TLS -u/s of confluence with RLS
	HT 9	RLS -u/s of confluence with TLS
	HT21	RLS -d/s of confluence with TLS
	HT7	RLS u/s of confluence with Hermitage Stream
4	Hermitage Stream upstream of RLS	
	HT6	Hermitage Stream u/s of confluence with RLS
5	Hermitage Stream downstream of RLS	
	HT8	Hermitage Stream d/s of confluence with RLS
	HT22	At Environment Agency sampling location (New Lane)
6	Langstone Harbour	
	-/-	-/-
7	Headwater Streams draining east towards River Lavant	
	-/-	-/-
8	Park Lane Stream	
	-/-	-/-

Table 15-23 - Summary of Portsmouth Water hydrology data

Study section	Portsmouth Water sites	Start date	End date	No. of Readings	Low / Negligible flow (scores 0-3)	Some flow (scores 4-8)	Upper flow (scores 8-10)
1	HT1, HT2, HT3	14/08/2008	20/06/2019	89	61	22	6
2	HT4	22/08/2008	20/06/2019	40	25	13	2
3	HT5, 9*, 21, 7	22/08/2008	29/07/2019	132	54	8	4
4	HT6	22/08/2008	30/08/2019	29	22	3	2
5	HT8, 22	11/12/2008	29/07/2019	63	41	18	4
6	-/-	-/-	-/-	-/-	-/-	-/-	-/-
7	-/-	-/-	-/-	-/-	-/-	-/-	-/-
8	-/-	-/-	-/-	-/-	-/-	-/-	-/-

*The Lake Stream tributary

- 15.104 Portsmouth Water spot flow monitoring data were used to inform the conceptualisation of the Hermitage stream catchment indicating a change in intermittency of flows from reach to reach. The variability in behaviour of the system can be observed in Table 15-24. The hydrological behaviour appears to progress from ephemeral/intermittent flow in the upper reaches (study section 1), towards some flow/a perennial flow regime in study sections 2-5.

Table 15-24 - Summary of Portsmouth Water hydrology data for each study section

Study section	Average rating for flow at monitoring points	Comment
1	2.6	Indicative of intermittent flows
2	3.3	Indicative of some flow - more perennial regime
3	3.0	
4	3.3	
5	3.5	
6	-/-	-/-
7	-/-	-/-
8	-/-	-/-

Environment Agency hydrology data

- 15.105 The Environment Agency operates a flow gauging station on the Hermitage Stream in study section 5, noting that the station will measure flow from Hermitage Stream and Riders Lane Stream as well as their (headwater) tributaries. Data were available for the period between 1979 and 2018 through the National Rivers Flood Archive³⁹. The gauging station is a velocity area station designed to measure up to 14 cubic metre per second (cumecs - m³/s) of flow. Although high rainfall events are summarised in paragraph 15.116, the hydrograph suggests the maximum flow has been exceeded very rarely since the FAS works undertaken in 1971-1975 (i.e. prior to the gauge being installed). The gauging station is described as being sensitive to low flow (anomalies) as well as anomalous obstructions downstream causing back up. The data available exhibits intermittent readings between 1970 and 1990 with more regular readings from 1990 onwards.
- 15.106 Daily and annual flow data showed a typical flashy hydrograph which is responsive to rainfall, with NRFA highlighting that the gauge measured flows from a “*mainly impervious area*”. Median flow (Q50) was reported to be 0.117 m³/s with high flow (Q10) and low flow (Q95) 0.568 m³/s and 0.025 m³/s respectively. Hydrographic data shows there to be an occurrence of almost no flow during July 2008 for approximately one week demonstrating the catchment variability in a section of the watercourse that is considered mostly perennial.
- 15.107 In addition to the Hermitage stream, attention must be given to small ditches located in the upper catchment near Gipsies Plain that drain east into the River Lavant. No flow data were available for these watercourses, but the River Lavant has previously had a gauging station which stopped recording in 2003. The gauging station was described by NRFA⁴⁰ as having a poorly defined rating at low flows and as being bypassed by flood flows >3 m³/s. The flow regime was also described by NRFA as “*responsive with an evident urban influence*”. It should be noted that in lower flows were up to a factor of 10 less than the Hermitage Stream. This is rather unusual and due to the reported larger size of this catchment compared to Hermitage Stream (Table 15-25).
- 15.108 It is understood that since 2003, River Lavant flows >0.28 m³/s would have been diverted into the Hermitage Stream through a connecting pipeline. The Environment Agency Main Rivers map suggests this pipeline connects into the Hermitage Stream above the Environment Agency gauging station. The pipeline has a storage effect and allows 6 hours of natural stream runoff from the nearby Warren housing estate to be attenuated before it is released into Hermitage stream. This was designed with the intention that inflow from the River Lavant would enter the Hermitage on its receding limb. Figure 15-1 shows time series data from the Hermitage and Lavant Gauging station. It can be observed that the difference between pre and post 2003 Hermitage Stream flow data was minimal with the addition of flow from River Lavant not demonstrating any changes to the peak flows observed; this is likely as a result of the fact that pipeline design meant that post 2003 the recovery

³⁹ NRFA. 2020a. National River Flow Archive. Station 42017 – Hermitage Stream at Lavant. [online] Available at: <<https://nrfa.ceh.ac.uk/data/station/info/42017>>

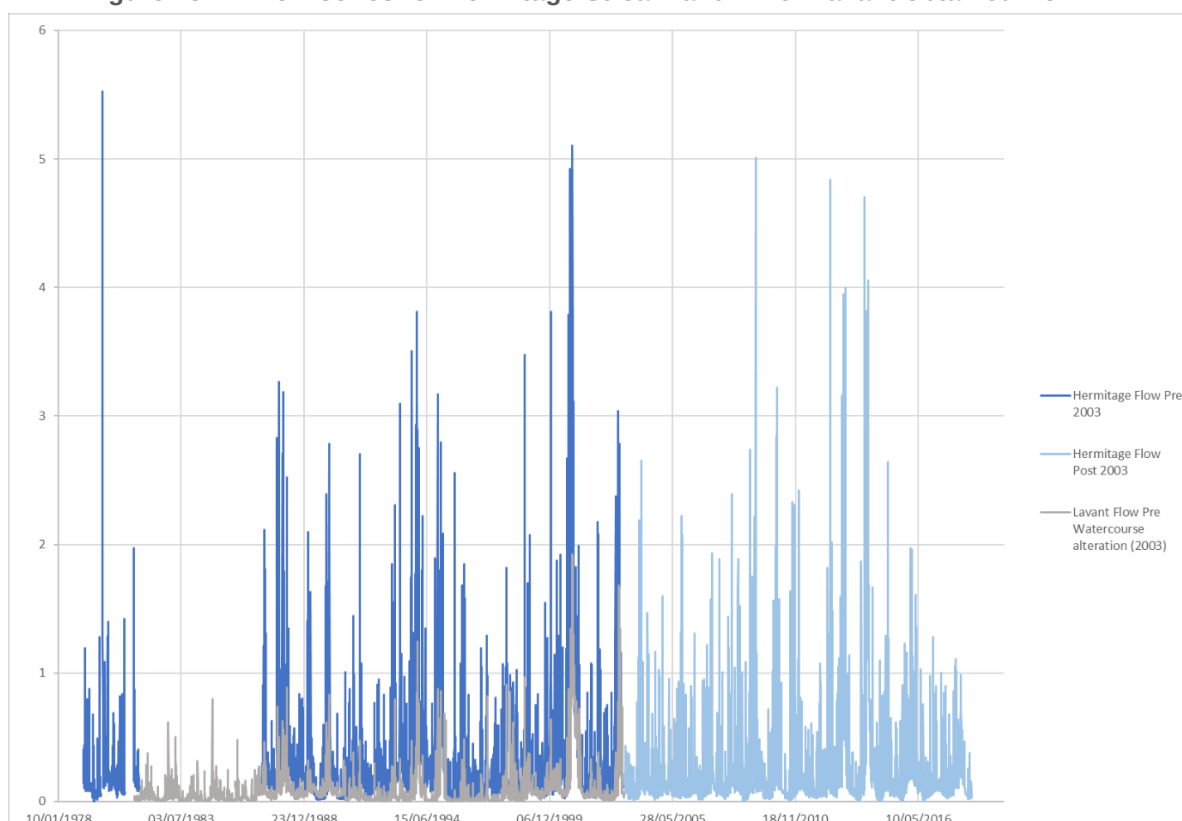
⁴⁰ NRFA. 2020b. National River Flow Archive. Station 42025 – Lavant Stream at Leigh Park. [online] Available at: <<https://nrfa.ceh.ac.uk/data/station/info/42025>>

of Hermitage stream's response to rainfall events would have been slower due to the delayed injection of runoff from the River Lavant.

Table 15-25 - Environment Agency Hermitage Stream and River Lavant Flow Gauge Statistics (NRFA, 2020a and 2020b)

	Hermitage Gauge	Lavant Gauge
Catchment area according to NRFA (km ²)	18.64	54.5
Operation period	02/1953 - present	01/1981 - 03/2003
Percent complete	85%	98%
Mean flow	0.24	0.83
Q95 (m ³ /s)	0.025	0.002
Q70 (m ³ /s)	0.071	0.015
Q50 (m ³ /s)	0.117	0.036
Q10 (m ³ /s)	0.568	0.168
Q5 (m ³ /s)	0.883	0.315

Figure 15-1 - Flow series for Hermitage Stream and River Lavant obtained from NRFA.



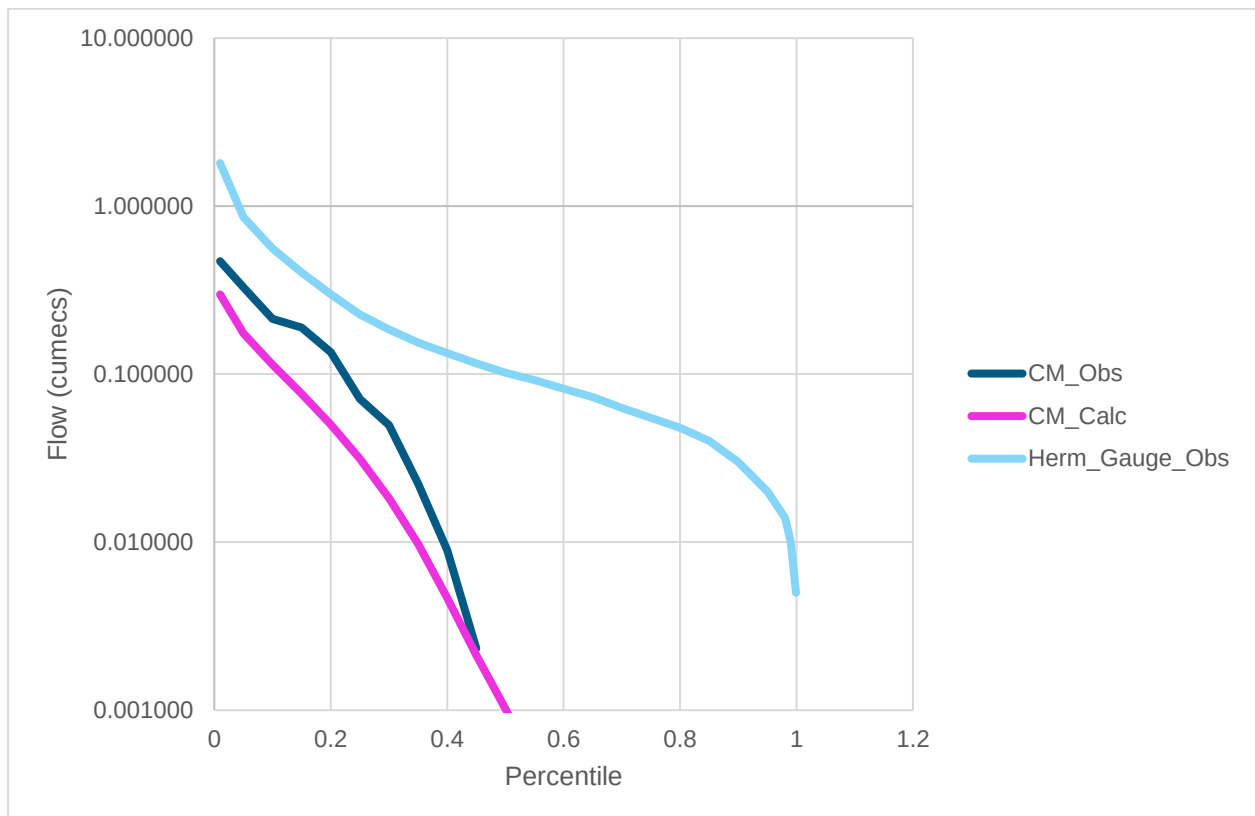
Catchment modelling

- 15.109 As described above, the Environment Agency gauge on Hermitage Stream is located further down in the catchment, measuring flows from all of the catchment including Riders Lane Stream, Park Lane Stream and the Hermitage Stream along with unknown flow contributions from the River Lavant (after 2003). As a result, this gauge could not be used to determine the flow regime for the Riders Lane Stream. In agreement with the Environment Agency, to inform the conceptualisation of the catchment, Portsmouth Water and Environment Agency flow data were used to develop a

catchment model (CATCHMOD or CM) which was used to characterise flows, notably in the upper catchment. The CATCHMOD data will be used for the impact assessment.

- 15.110 The CATCHMOD results have been presented as Flow Duration Curve in Figure 15-2 below. The CM_Calc represents CATCHMOD outputs whilst CM_Obs represent Portsmouth Water site 4 in the catchment, which is located roughly at the outlet of the reservoir and the bottom of study section 2. The Herm_Gauge_Obs line represents the Environment Agency gauging station data in study section 5.
- 15.111 The comparison between the two Flow Duration Curves confirms the change from ephemeral/intermittent flow in study section 2 compared a perennial flow in study section 5.

Figure 15-2 - Flood Duration Curve providing a comparison for CATCHMOD predicted flows for study section 2 (CM_Calc), compared to Portsmouth Water flow data for study section 2 (CM_Obs) and Environment Agency gauging station data (Herm_Gauge_Obs) for study section 5.



- 15.112 Downstream of the tidal limit, Langstone harbour is tidally dominated with approximately 70% of the harbour being exposed during ebb tide. The Hermitage stream and River Lavant provide freshwater inputs to the harbour at a rate of 0.1-0.2 m³/s (mean) and 7 m³/s (peak) (Lymington Technical Services, 2017).

Flood risk

- 15.113 The flood risk baseline included:
- A review of planning policy changes that will affect this project (which have been picked up in the Legislative and policy framework section); and,
 - An update of the InfoWorks CS/RS model to Infoworks ICM, which meant that topographic surveys at key locations were required.
- 15.114 The baseline for flood risk describes three main sources: fluvial & tidal, surface water and artificial sources (in this case, a reservoir). Groundwater levels are covered in the Groundwater section (Paragraph 15.130 onwards). Fluvial flooding occurs when there is an exceedance of the flow capacity of river channels, leading to overtopping of the riverbanks and inundation of the surrounding land. Tidal flood risk occurs as a result of high tide levels and / or wave action. Alternatively, it can be a result of the propagation of high tides and storm surges up tidal river channels, leading to overtopping of the riverbanks and inundation of the surrounding land. Surface water flooding occurs when rainfall intensities exceed the infiltration capacity such that water collects on the ground surface. Therefore, there is a greater risk of flooding from this source within urbanised areas where there is a higher proportion of impermeable surface. Flooding from artificial sources, in this case reservoirs, occurs when the design standard of a reservoir is exceeded and / or there is a failure of the asset causing downstream flooding.
- 15.115 To inform the baseline assessment of flood risk, the following available information has been used:
- Environment Agency Flood Zones (Figure 15.4 in ES Volume 3);
 - Environment Agency Surface Water Mapping (Figure 15.5 in ES Volume 3);
 - Environment Agency statutory Main River and reservoir mapping⁴¹; and,
 - Hydraulic river modelling undertaken as part of the Havant Thicket Surface Water Reservoir Flood Risk Assessment (Appendix A15.2 Flood Risk Assessment in ES Volume 4).

Historical flood risk

- 15.116 Historically, within the catchment there have been a series of large rainfall events recorded in: Winter 2002-2003; Autumn/Winter 2000 (September and December 2000); Summer 1997; Autumn 1995; Autumn 1993; Winter 1966 and 1955 (season unknown). In 1966 a severe flood event with an estimated peak flow of 22 m³/s caused considerable local flooding and prompted the Hermitage Stream FAS of 1971-75, in which the Hermitage Stream was straightened, concreted and the bed was lowered, to accommodate a flow of 22-24 m³/s. In September 2000, 20.7 m³/s was recorded at the Hermitage Stream gauging station which was estimated to have a 1.5% (1 in 65) Annual Probability (AP). The event caused damage throughout the catchment compounded by blockages caused by fly-tipping and debris within the channel reach.
- 15.117 At the River Lavant gauge the December 2000 storm was estimated to have a 1.2% (1 in 83) AP, however this was estimated as a 33% (1 in 3) AP storm for the Hermitage Stream. This shows that the two catchments flood in different storm event types. A flood occurring on one of the two streams will not usually result in a flood of similar magnitude on the other stream. This is caused by the varying catchment response times caused in part by characteristics such as the surface type, geology and topography. In general, the catchment has relatively high annual probabilities (i.e. low return periods) for the observed storm events, with events other than the September 2000 event estimated at higher than 8% (i.e. lower than 1 in 12) AP. There is, therefore no significant risk of flooding within the Hermitage Stream Catchment. The large capacity of the watercourse as a result of the Hermitage FAS, also contributes to the reduced frequency of flooding in the catchment since the early 1970s.

Baseline - Fluvial/Tidal Flood Risk

- 15.118 As shown on Figure 15.4 in ES Volume 3, for the Riders Lane Stream, the fluvial flooding occurs mostly in bank, or within areas of open land. There is limited property flooding despite the fact the watercourse flows through a highly urbanised area. This same trend is seen downstream of the confluence with the Hermitage Stream. The large area of Flood Zone 3 upstream on the Hermitage Stream indicates an area of property flooding, however, this is likely to be related to an historic flood event prior to the 1970s Hermitage FAS. The risk of fluvial flooding for the Hermitage Stream has

⁴¹ Environment Agency, 2020h, Environment Agency Main River Map [online] Available at: <https://environment.maps.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386>

been refined through the development of a detailed hydraulic model for this ES and the extent of flooding predicted by this modelling is shown in Figure 15.6 in ES Volume 3.

- 15.119 The NTL is located at a series of weirs at OSNGR SU 70511 06237. Upstream of this point the flood risk is fluvial, however below this point the flood zones shown in Figure 15.4 and Figure 15.6 in ES Volume 3 also include tidal influences. There is no significant tidal flood risk, with flows staying largely in bank, or within areas of open land. There is an increased flood risk at the NTL location. The cascade of weirs has a top crest level of 4.3 mAOD and this current level restricts a 0.1% (1 in 1,000) AP event tide, however once a climate change scenario is added to predicted levels, the tide exceeds the crest of the top weir. Therefore, it is expected that under a changing climate the NTL will migrate upstream to between the bridges located at Meyrick Road and West Street.
- 15.120 To further refine the baseline flood risk in the catchment, an InfoWorks ICM model was built, to allow for an updated assessment of baseline fluvial and tidal risk and to quantify the impacts on flood risk of the reservoir and associated infrastructure. The model's upstream boundaries are located at the bridge on Middle Park Way over the Hermitage Stream and at the site of the reservoir on the Riders Lane Stream. The downstream boundary of the model is the point of outflow of the Hermitage Stream into Langstone Harbour. This area covers the full extent of the channels and floodplain potentially affected by the reservoir. For more information on the model development refer to the Flood Risk Assessment (Appendix A15.2 Flood Risk Assessment in ES Volume 4).
- 15.121 The catchment is gauged at the downstream extent of the study reach⁴². A ReFH2.3 hydrological model at the gauge was calibrated using four high flow events, resulting in a significant shortening of the time to peak from the software suggested default. Design flows at the gauge were estimated, ranging from the 50% (1 in 2) AP event to the 0.1% (1 in 1000) AP event. In all cases, the design ReFH flows routed through the hydraulic model give very good agreement with those estimated from the Flood Estimation Handbook (FEH) statistical method and with the calibration event of September 2000. Table 15-26 below shows the estimated peak flows from the ReFH2.3 method at the gauge location. For full details on the hydrological derivation, the reader is referred to the Flood Risk Assessment (Appendix A15.2 Flood Risk Assessment in ES Volume 4).

Table 15-26 - Estimated peak flows at the 'Hermitage Stream at Havant' Gauge

Annual Probability	Peak Flow (m ³ /s)		
	Total	Hermitage Stream	Riders Lane Stream
50% (1 in 2) AP	10.7	7.8	2.9
20% (1 in 5) AP	13.9	10.1	3.8
10% (1 in 10) AP	16.2	11.8	4.4
3.33% (1 in 30) AP	19.9	14.5	5.5

- 15.122 Climate change scenarios were created following Environment Agency guidance⁴³. Uplift values were taken from the South East River Basin guidance for the 2080s epoch, and two scenarios were used as shown in Table 15-27, as agreed in consultation with the Environment Agency.

Table 15-27 - Uplift values specified in Environment Agency (2016) climate change guidance

South East River Basin	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	105%
Central	35%

- 15.123 Tide curves for the 50% (1 in 2) AP, 0.5% (1 in 200) AP and 0.1% (1 in 1000) AP events were derived for both the present day (2020) and one future epoch (2125). The design tide curves have been generated in accordance with guidance provided in Coastal Flood Boundary Conditions for the

⁴² NRFA. 2020a. National River Flow Archive. Station 42017 – Hermitage Stream at Lavant. [online] Available at: <<https://nrfa.ceh.ac.uk/data/station/info/42017>>

⁴³ Environment Agency, 2016. Flood risk assessments: climate change allowances [online] Available at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

UK: update 2018⁴⁴. Table 15-28 shows the peak tidal levels for each of the return periods and climate change scenarios. For full details on the tidal boundary derivation, the reader is referred to the Flood Risk Assessment (Appendix A15.2 Flood Risk Assessment in ES Volume 4).

Table 15-28 - Peak tidal levels

Epoch	Peak tidal levels (m)		
	50% (1 in 2) AP	0.5% (1 in 200) AP	0.1% (1 in 1000) AP
2020	2.72	3.19	3.35
2125 (Higher Central)	3.81	4.28	4.44
2125 (Upper)	4.18	4.65	4.81

- 15.124 As discussed above, the surface waterbodies have been divided into study sections. Eight sections have been identified and these will be used to identify baseline fluvial flood risk. The model outputs in Table 15-29 will be used as a baseline for comparison with the 'with Scheme' scenario results.

Table 15-29 - Model outputs used as a Baseline (climate change values used are the central estimate).

Study section	Annual Probability	u/s peak level (m AOD)	d/s peak level (m AOD)	u/s peak flow (m ³ /2)	d/s peak flow (m ³ /2)	Floodplain extent (km ²)
1	No river data available, assessment will be qualitative.					
2	3.33% (1 in 30)	-	20.80	-	3.09	-
	1% (1 in 100)	-	20.86	-	3.84	-
	1% (1 in 100) + CC	-	20.94	-	5.18	-
	0.1% (1 in 1000)	-	21.02	-	6.38	-
3	3.33% (1 in 30)	20.80	7.86	3.09	5.45	0.02
	1% (1 in 100)	20.86	8.06	3.84	6.62	0.03
	1% (1 in 100) + CC	20.94	8.37	5.18	8.23	0.04
	0.1% (1 in 1000)	21.01	8.52	6.38	8.25	0.05
4	3.33% (1 in 30)	9.99	7.86	11.77	13.52	0.01
	1% (1 in 100)	10.10	8.06	14.53	16.68	0.01
	1% (1 in 100) + CC	10.28	8.37	19.62	22.51	0.01
	0.1% (1 in 1000)	10.42	8.52	23.90	27.31	0.01
5	3.33% (1 in 30)	7.86	2.95	18.93	18.15	0.03
	1% (1 in 100)	8.06	3.04	23.26	22.70	0.04
	1% (1 in 100) + CC	8.37	3.22	30.74	31.45*	0.06
	0.1% (1 in 1000)	8.51	3.31	37.02	36.52	0.08

⁴⁴ Environment Agency, 2016. Flood risk assessments: climate change allowances [online] Available at: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Study section	Annual Probability	u/s peak level (m AOD)	d/s peak level (m AOD)	u/s peak flow (m ³ /2)	d/s peak flow (m ³ /2)	Floodplain extent (km ²)
6	3.33% (1 in 30)	2.95	2.72	18.15	25.83	0.04
	1% (1 in 100)	3.04	2.72	22.70	29.91	0.04
	1% (1 in 100) + CC	3.22	2.72	31.45	39.13	0.04
	0.1% (1 in 1000)	3.31	2.72	36.52	44.28	0.04
7	No river data available, assessment will be qualitative.					

8 No river data available, assessment will be qualitative.

** This follows a different pattern as seen within other AP events for this section. This is due to an increased flow from the Lavant Link Pipe within a climate change scenario.*

Baseline – Surface water

- 15.125 When comparing Figures 15.3 and 15.4 in ES Volume 3, surface water flood risk generally follows the same path and trend as the fluvial flood zones, remaining in bank, or within areas of open space. However, there are also localised flow routes through the surfaced roads in the area and localised areas of surface water ponding caused by variations in topography. Within the study area there is varying risk with some areas at High Risk which means that there is a chance of flooding each year of greater than 3.3%. However, some areas have Low Risk correlating to an annual risk between 0.1% and 1%.
- 15.126 The reservoir will not impact on the volume or rate of surface water flows throughout the majority of the study area (study section 1) or downstream (study sections 3-8), so quantitative baseline data for each of these study sections has not been derived. The changing flows in the river channel have the potential to impact on the discharge of the surface water drainage network and this will be described qualitatively in the assessment section as agreed through discussions with Hampshire County Council (see paragraph 15.41).
- 15.127 There will be increased surface water flows from the infrastructure that supports the new reservoir, i.e. the visitor centre and car park, located in study section 2. A separate drainage assessment to support the scheme design will be undertaken at detailed design stage.

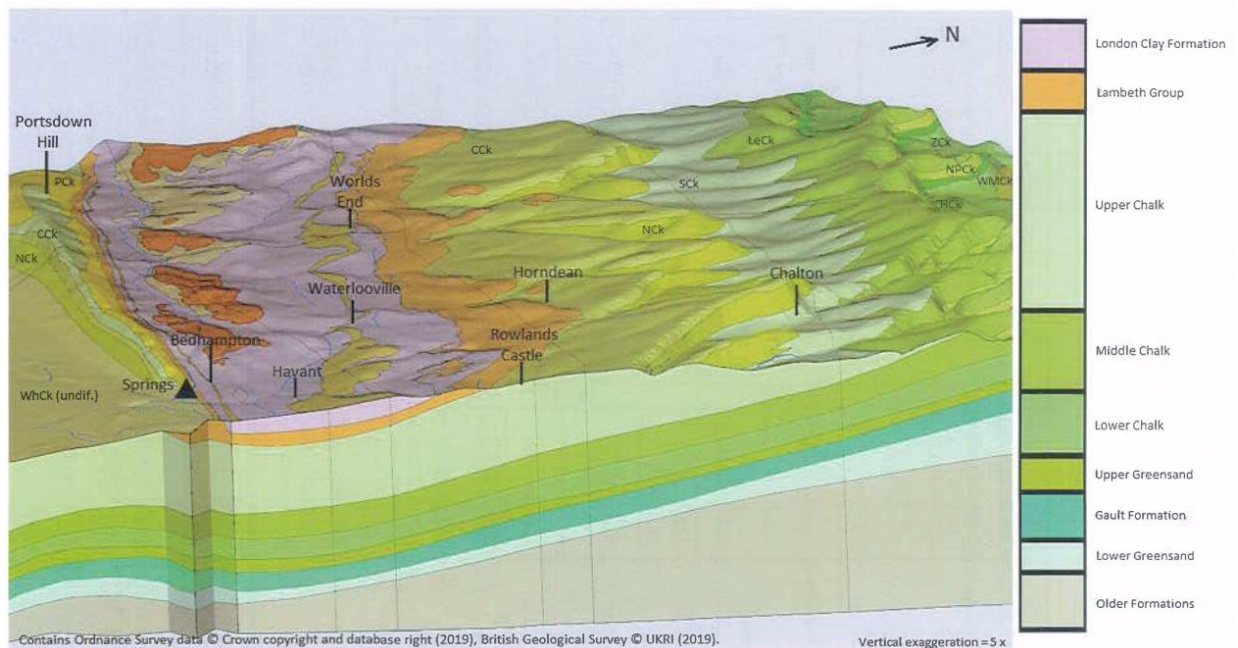
Groundwater

- 15.128 The groundwater baseline section has been informed by:
- Hydrogeological desk studies including all currently available information, an Envirocheck report and results from ground investigation reports ;
 - information collated from different data sources for the hydrogeological assessment itself and for the groundwater component of the WFD assessment.
- 15.129 Information was obtained via an Environment Agency data request, Portsmouth Water data request along with the Envirocheck report⁴⁵.

Geology and hydrogeology

- 15.130 A summary of the geology within the context of the groundwater environment is provided here. Further detail, particularly regarding made ground, soils and local geology can be found in Chapter 10 Ground Conditions in ES Volume 2.
- 15.131 The study area lies within the Wessex Basin which covers most of Southern England. The regional basin structure causes the oldest rocks to outcrop in the north and dip to the south. In the northern part of the Havant Thicket study area, the Chalk is at outcrop and then dips towards the coast beneath the younger Palaeogene formations (including the Lambeth Group and the London Clay). The geological structure of the area is significant; the Chalk has been subject to folding and faulting, resulting in the presence of the Portsdown Anticline and associated Chichester Syncline which stretches along the entire coastal margin. These geological features are key to understanding the groundwater flow in this area. As the Chalk dips south, it forms a basin filled with the Palaeogene formations (in this case, Lambeth Group and London Clay) and then outcrops again on the other edge of the basin as the Chalk is tilted upwards. This structure channels flow in the Chalk beneath the Chichester Syncline towards major springflows which occur as the Chalk nears the surface closer to the coast. These major springflows include the Havant and Bedhampton Springs. The geological structure is illustrated in the cross-section shown in Figure 15-3.

Figure 15-3 - Geological cross-section across the Havant and Bedhampton springs catchment⁴⁶



⁴⁵ Landmark, 2019. Envirocheck Report for 1000m radius around OSNGR 471510, 109770. Dated 29 April 2019.

⁴⁶ BGS, 2019. A review of the hydrogeology of the Bedhampton and Havant springs source protection zones. Groundwater Programme. Commissioned Report CR/19/046

- 15.132 Based on 1:50,000 scale BGS mapping⁴⁷, the solid (bedrock) geology in the reservoir area comprises the Tarrant Chalk Member (part of the Culver Chalk Formation), overlain by the Lambeth Group, Harwich Formation (shown on the BGS mapping as London Clay Formation Sand) and the London Clay Formation. The Chalk is at outcrop on the scarp slope to the north-east of the red line boundary. The bedrock geology dips to the south-west following the topography. Within the red line boundary, the Lambeth Group Reading Formation and the Harwich Formation outcrop in the north-east (Figure 15-10 in ES Volume 3). Within the reservoir site footprint itself, the Harwich Formation is at outcrop in the north east (with small windows through to the underlying Lambeth Group in places) and whilst the London Clay Formation and Bognor Sand Member outcrop to the south-west (Figure 15-11 in ES Volume 3). The red line boundary around the pipeline corridor is underlain by the London Clay Formation until its southern tip, where the Chalk outcrops once more on the Portsdown Anticline. This is in the vicinity of St. Chad's spring (Figure 15-10 in ES Volume 3).
- 15.133 In terms of superficial geology, the BGS mapping⁴⁸ shows Head Deposits overlying the bedrock geology in many locations within the reservoir site footprint, particularly in the central part (Figure 15-11 in ES Volume 3). Information from borehole logs⁴⁹ show the Head Deposits to consist of silty clay and fine sand with small gypsum crystals as well as sporadic flint pebbles and shells. The Head Deposits are not laterally extensive.
- 15.134 Along the pipeline corridor, there are few mapped superficial deposits (Figure 15-10 in ES Volume 3). There are some patches of Head Deposits and Aeolian Deposits ('Brickearth'). The pipeline corridor crosses into Alluvium at the southern end. The Head Deposits are as previously described: the Aeolian Deposits comprise mainly fine sandy silt, locally contaminated with gravel and the Alluvium comprises clay, silt and sand, locally organic with gravel. It should be noted that there is some discrepancy between the mapping and classification of superficial deposits at different scales, but this is not considered to affect the assessment undertaken.
- 15.135 Table 15-30 summarises the generalised geological sequence in the study area⁵⁰ and the Environment Agency aquifer designation⁵¹ of each geological formation.

⁴⁷ BGS. 1998. Fareham. England and Wales Sheet 316. Solid and Drift Geology. 1:50 000. (Keyworth, Nottingham: British Geological Survey). [online] Available at:

<http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001806>

⁴⁸ BGS. 1998. Fareham. England and Wales Sheet 316. Solid and Drift Geology. 1:50 000. (Keyworth, Nottingham: British Geological Survey). [online] Available at:

<http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001806>

⁴⁹ BGS, 2020b. Geoindex - British Geological Survey. [online] Available at:

<https://mapapps2.bgs.ac.uk/geoindex/home.html>

⁵⁰ BGS, 2020a. British Geological Survey Lexicon Of Named Rock Units. [online] Available at:

<https://www.bgs.ac.uk/Lexicon/>

⁵¹ Defra, 2020. Magic. [online] Available at: <https://magic.defra.gov.uk/MagicMap.aspx>

Table 15-30 - Generalised geological sequence underneath reservoir site

Period	Epoch	Formation	Sub-unit	Lithology Description	Environment Agency Aquifer Designation
Quaternary	Holocene	Head	-	Poorly sorted and poorly stratified angular rock debris. Matrix is generally silty, clayey and/or fine sand. Debris such as flint fragments are common.	Secondary (undifferentiated)
		Aeolian Deposits	-	Aeolian sand (Brickearth) incised by undifferentiated river terrace deposits – sand silt and clay.	Secondary A
		Alluvium	-	Unconsolidated clay silt sand and gravel deposited by a river or stream	Secondary A
Palaeogene	Eocene	London Clay (Thames Group)	-	Bioturbated and poorly laminated silty to very silty clay. Thin beds of shells and pockets of fine sand present at the vertical extremities of the formation.	Unproductive
			Bognor Sand Member	Glauconitic bioturbated or cross-bedded fine- and medium-grained sands, partially cemented.	Secondary A
			Harwich Formation	Glauconitic silty or sandy clays. Fine to coarse grained. Commonly includes shelly marine fauna and bioturbated silty and sandy clays.	Secondary A
	Palaeocene	Reading Formation (Lambeth Group)	-	Vertically and laterally variable sequences mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and occasional sandstone/conglomerate.	Secondary A
Cretaceous	Late Cretaceous	Upper Chalk (White Chalk Sub- Group)	Tarrant Chalk	Cretaceous	Late Cretaceous

15.136 Borehole data are available from GeoIndex⁵² with details confirming the lithology of the area. A Ground Investigation study was undertaken between November 2019 and January 2020 by

⁵² BGS, 2020b. Geoindex - British Geological Survey. [online] Available at: <https://mapapps2.bgs.ac.uk/geoindex/home.html>

Socotech⁵³ which gathered more detailed information across the reservoir site. The data have been interpreted in a subsequent geotechnical report (Atkins, 2020a), also referred to in Chapter 10 Ground Conditions in ES Volume 2.

WFD and groundwater bodies

- 15.137 The East Hants Chalk groundwater body lies to the north and south of the red line boundary. The reservoir site footprint is not mapped as being within the East Hants Chalk groundwater body as at the location of the reservoir, the Chalk is not at outcrop. The East Hants Lambeth Group groundwater body and the South Hants Lambeth Group groundwater body are mapped at the far north and the far south (respectively) of the red line boundary, where the Lambeth Group is at outcrop (Figure 15-12 in ES Volume 3).
- 15.138 When considering the mapped groundwater body boundaries, it should be recognised that these have been determined nationally at a small scale (i.e. looking at a large area with relatively little detail). When looking at more detailed geological mapping of the study area, it is apparent that there are some isolated patches of Lambeth Group outcrop which are not included within either of the defined Lambeth Group groundwater bodies (Figure 15-10 in ES Volume 3). In addition, it should be noted that both the Chalk and the Lambeth Group are present at depth over the section of the red line boundary for which no WFD groundwater body is shown (Figure 15-12 in ES Volume 3).
- 15.139 The Chichester Chalk groundwater body lies immediately to the east of the East Hants Chalk groundwater body. The works associated with the reservoir do not extend into the Chichester Chalk groundwater body and it is not anticipated that any impact will extend into the Chichester Chalk groundwater body. It was therefore screened out of the WFD compliance assessment (Appendix A15.1 WFD Assessment in ES Volume 4).
- 15.140 The groundwater body WFD status for the East Hants Chalk groundwater body and the two associated Lambeth Group groundwater bodies⁵⁴ is summarised in Table 15-31:

Table 15-31 - Groundwater Body WFD status

Receptor	Groundwater Body ID	2016 Cycle 2 Overall Status	Quantitative status element	Chemical status element	Overall objective (2021)	Reasons
East Hants Chalk Groundwater body	GB40701G502700	Poor	Poor	Poor	Poor	Disproportionate burdens, groundwater recovery time
South Hants Lambeth Group groundwater body	GB40702G503700	Good	Good	Good	Good	N/a
East Hants Lambeth Group groundwater body	GB40702G500800	Poor	Poor	Good	Good	N/a

- 15.141 As shown in Table 15-30, the Chalk groundwater body underlying the reservoir site is designated as a Principal Aquifer by the Environment Agency, whilst the Lambeth Group groundwater bodies are designated as Secondary A Aquifers. These designations indicate high groundwater sensitivity.
- 15.142 As noted above, the reservoir site footprint and the majority of the pipeline corridor is not located on the Chalk outcrop, instead the Chalk is present at depth beneath the Lambeth Group, Harwich Formation and London Clay Formations. At the reservoir site the Ground Investigation (GI) results

⁵³ Socotech, 2020. Havant Thicket Winter Storage Reservoir Factual Report on Ground Investigation. Report No. A9031-19

⁵⁴ Environment Agency. 2020a. Environment Agency - Catchment Data Explorer. [online] Available at: <https://environment.data.gov.uk/catchment-planning/search?type=placename&k=HAVANT&q=http://environment.data.gov.uk/catchment-planning/so/Town/havant>

indicate that the Chalk is approximately 30 m to 70 m below the ground surface (depth varies with location across the site).

- 15.143 The northern part of the red line boundary (to the north of the reservoir footprint) falls within the East Hants Lambeth Group WFD groundwater body. Three headwater streams arise in this area. These intermittent headwater streams are thought to be fed by shallow groundwater within the Palaeogene deposits, fed by rainfall-recharge.
- 15.144 The southern part of the red line boundary (associated with the pipeline corridor), falls within the South Hants Lambeth Group groundwater body. The Chalk groundwater is under artesian pressure from the confined ground conditions in this area and comes to the surface at many locations as part of the Havant and Bedhampton springs (Figure 15-10 in ES Volume 3).

Hydrogeological characteristics

- 15.145 The Chalk is major aquifer, typically characterised by a dual permeability system with fracture flow dominating and the matrix providing additional storage in the aquifer. The regional groundwater flow direction in the study area is predominantly NNE to SSW, towards the coast. The Chalk at outcrop is highly fissured; a hydrogeological review of the South Downs⁵⁵, identified that high permeabilities are typically associated with solution fissures within a few tens of metres of the Chalk water table. The review also identified that fissures above the general seasonal zone of water table fluctuation could be activated during extreme recharge events. Fissuring is present even at depth within the saturated Chalk. The local hydrogeology is dominated by karstic flow in the Chalk, with many karstic conditions associated with the presence of swallow holes close to the Chalk-Palaeogene contact. The Chichester syncline and Portsdown anticline provide a means of channelling underflow beneath the Palaeogene deposits through enhanced Chalk permeability⁵⁶.
- 15.146 The Chalk supports a number of outflows, including the major springs at Havant and Bedhampton. Historic tracer tests (such as those carried out by Atkinson and Smith in 1974) have demonstrated rapid travel times demonstrating fissure flow to both sets of springs. It is probable that the two springs drain different areas of the Chalk but are connected by fissures close to the point where the water reaches the surface⁵⁷. The karstic channels provide a year-round outlet to groundwater flow and therefore reduce groundwater levels on the Chalk outcrop to the north of reservoir site. In addition to the spring flows, there may also be some coastal and submarine discharges from the Chalk⁵⁸.
- 15.147 Chalk groundwater levels are monitored by the Environment Agency at five observation boreholes within 5 km of the site⁵⁹. Portsmouth Water also monitor Chalk groundwater levels at Idsworth Well. The locations of the observation boreholes are shown in Figure 15-10 in ES Volume 3. The data provided by the Environment Agency have been summarised in Table 15-32.

⁵⁵ BGS, 1999. The Chalk Aquifer of the South Downs. Hydrogeological Report Series of the British Geological Survey

⁵⁶ Entec, 2006. East Hampshire and Chichester Chalk Groundwater Conceptualisation Project. Phase 1 Data Synthesis, Conceptual Model and Water Balance Final Report, Environment Agency Southern Region, July 2006

⁵⁷ Entec, 2006. East Hampshire and Chichester Chalk Groundwater Conceptualisation Project. Phase 1 Data Synthesis, Conceptual Model and Water Balance Final Report, Environment Agency Southern Region, July 2006

⁵⁸ BGS, 2019. A review of the hydrogeology of the Bedhampton and Havant springs source protection zones. Groundwater Programme. Commissioned Report CR/19/046

⁵⁹ Environment Agency, 2020c, Data request on behalf of Portsmouth Water [received on 02/03/2020] Reference 200302 SSD160159

Table 15-32 - Groundwater level data provided by Environment Agency

					Groundwater levels metres Above Ordnance Datum (mAOD)		
Borehole	Ground level (mAOD)	Full length of record (years)	Location relative to reservoir central point	Recent data (Sept/ Oct 2019)	Min water level (2009 to 2019)	Max water level (2009 to 2019)	Approx. depth of groundwater below ground (in metres)
Catherington*	80.32	15	~5.0 NNW	30.36	27.84	59.69	21 to 53 m
Wood Copse Forest*	115.64	51	~4.5 km NE	31.26	30.8	45.27	70 to 85 m
Pyle Farm Cottages*	56.36	53	~2.7 km N	22.95	21.66	43.48	13 to 25 m
Carpenters Finchdean*	43.1	34	~4.0 km NNE	22.92	22.25	42.4	1 to 21 m
Day Lane Lovedean**	87.42	56	~4.6 km NW	-/-	28.22*	50.07*	37 to 59 m

*min and max from 2009-2019

**limited data therefore min max from 2005-2010

- 15.148 The Lambeth Group Harwich Formation are classed as Secondary A Aquifers these are defined as having permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers⁶⁰. There are no Environment Agency observation boreholes monitoring these formations in the study area. There is some site-specific groundwater level information available from the ground investigation study⁶¹, however groundwater monitoring is at an early stage. The ground investigation recorded seepages and groundwater strikes within the Harwich Formation and seepages in the Reading Formation.
- 15.149 The London Clay is not considered to be productive strata, being predominantly clay and having generally low permeability and negligible significance for water supply or river baseflow. However, the London Clay Formation does contain sand beds within it, such as the Bognor Sand Member which is classed as a Secondary A Aquifer. Site-specific groundwater level information is being collected, following the ground investigation, however limited data have been collected to date⁶².
- 15.150 The Quaternary drift deposits have the potential to be very variable but may contain pockets of shallow groundwater at a localised scale.

Groundwater quality

- 15.151 No groundwater quality monitoring data were available from the Environment Agency within 5 km of the reservoir⁶³. On a regional basis, groundwater quality is assessed as part of the WFD classification (Tables 3-4, 3-5, 3-6 and 3-7 in Appendix A15.1 WFD Assessment in ES Volume 4). The chemical status element had two components: the general chemical test which relates to general water quality such as nitrates and pesticides and the Chemical GDWTE component

⁶⁰ Environment Agency, 2017a. Protect groundwater and prevent groundwater pollution guidance, published 14 March 2017. Available [online] at: <https://www.gov.uk/government/publications/protect-groundwater-and-prevent-groundwater-pollution/protect-groundwater-and-prevent-groundwater-pollution>

⁶¹ Atkins, 2020a. Havant Thicket Reservoir Project. Ground Investigation Report. Atkins Doc No. HTR-ATK-RZ-RE-RP-C-0001. April 2020.

⁶² Atkins, 2020a. Havant Thicket Reservoir Project. Ground Investigation Report. Atkins Doc No. HTR-ATK-RZ-RE-RP-C-0001. April 2020.

⁶³ Environment Agency, 2020c, Data request on behalf of Portsmouth Water [received on 02/03/2020] Reference 200302 SSD160159

(Groundwater Dependant Terrestrial Ecosystems). Both South Hants Lambeth and East Hants Lambeth Group achieved a 'good' status for the general chemical test. East Hants Chalk was given a 'poor' classification, citing poor nutrient management from agricultural land use⁶⁴. Regarding Chemical GDWTE (Groundwater Dependant Terrestrial Ecosystems) all three groundwater bodies achieved 'good' status.

- 15.152 Groundwater chemistry data was available on a regional basis from various BGS reports, including the regional hydrogeological map⁶⁵ and the baseline chemistry of groundwater in UK aquifer series^{66,67}. Unconfined Chalk groundwater was typically of calcium hydrogen carbonate (Ca-HCO₃) type. Variations in the natural chemistry take place with increasing residence time as water moved down gradient beneath the Palaeogene cover. Across the Chichester syncline, roughly equal and low levels of magnesium (Mg²⁺), chloride (Cl⁻), sulphate (SO₄²⁻), sodium (Na⁺) and potassium (K⁺) were reported in the Chalk. High levels of calcium (Ca²⁺) and bicarbonate (HCO₃⁻) were reported with a pH of 7.2. Nitrate (NO₃⁻) levels were reported to be lower in confined sections of the aquifer and comparably higher in unconfined sections.
- 15.153 Groundwater chemistry in the Palaeogene groundwater was typically of calcium hydrogen carbonate (Ca-HCO₃) type, although compared to the Chalk, the overall carbonate content is low (BGS, 2004). This means that there was limited capability to neutralise acidic infiltrating recharge water, often leading to slightly acidic conditions. Oxidation of pyrite generates additional acidity and led to waters which are rich in iron (Fe²⁺) and sulphate (SO₄²⁻). It is considered that some Ca-HCO₃ waters in the Wessex Basin area could become modified towards a sodium hydrogen carbonate (Na-HCO₃) type composition as a result of ion exchange, with water derived through recharge from the underlying Chalk (BGS, 2004).

Groundwater discharges

- 15.154 The Environment Agency has confirmed there were no groundwater discharges within a 500 m radius of the reservoir's central point (OSNGR SU 71435 10028). No groundwater discharges were identified within a 1km radius⁶⁸.

Groundwater abstractions

- 15.155 The Environment Agency confirmed that there were no groundwater abstractions within a 500 m radius of the reservoir's central point (OSNGR SU 71435 10028). With the exception of the Portsmouth Water Havant and Bedhampton springs licence, the only other known groundwater abstraction is a spray irrigation licence located 1.2 km from the reservoir (Figure 15-10 in ES Volume 3).

Source Protection Zones

- 15.156 The study area lies within one large source protection zone (SPZ). This is shown in Figure 15-13 in ES Volume 3. The reservoir footprint and the majority of the pipeline corridor lie within a SPZ1c (inner protection zone subsurface activity area). The southern tip of the pipeline corridor lies within a SPZ1 (inner protection zone) which has been defined to cover the area immediately around the Havant and Bedhampton springs where the Chalk aquifer discharges. To the north of the red line boundary, the SPZ transitions from a SPZ1c into a SPZ1 which represents the recharge area to the springs. The SPZ2 (outer protection zone) lies further to the north and the total catchment zone extend beyond this.
- 15.157 SPZs show the risk of contamination from any activities that may cause pollution in the area and are defined around large and potable abstractions. SPZ1 is considered the highest risk SPZ with progression into SPZ2 and SPZ3 showing a decrease in risk. The SPZ1 is defined as the area where groundwater in the aquifer has a 50-day or less travel time to the source/abstraction. The

⁶⁴ Environment Agency. 2020a. Environment Agency - Catchment Data Explorer. [online] Available at: <https://environment.data.gov.uk/catchment-planning/search?type=placename&k=HAVANT&q=http://environment.data.gov.uk/catchment-planning/so/Town/havant>

⁶⁵ BGS. 1979. Sheet 9 Hydrogeological map of Hampshire and the Isle of Wight 1:100,000 Available at: <http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1003979>

⁶⁶ BGS, 2004. Baseline Report Series. The Palaeogene of the Wessex Basin. Groundwater Systems and Water Quality. Commissioned Report CR/04/254N.

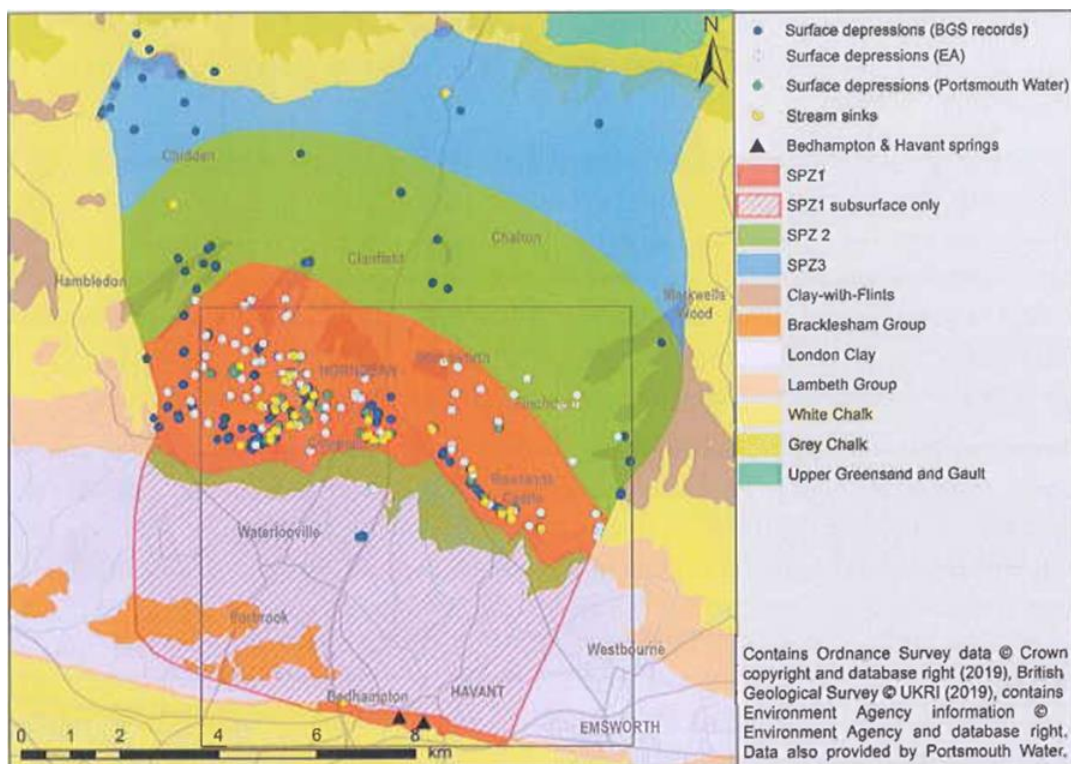
⁶⁷ BGS, 2009. Baseline groundwater chemistry: the Chalk aquifer of Hampshire. British Geological Survey Open Report, OR/09/052.

⁶⁸ Atkins, 2019a. Havant Thicket Reservoir Project. EIA Scoping Report – Addendum. 22 November 2019.

SPZ1c extends where the aquifer is confined and unlikely to be affected by surface activities but may be impacted activities at depth, such as deep drilling. As the reservoir site is largely confined by London Clay the SPZ1c category applies⁶⁹.

- 15.158 Figure 15-13 in ES Volume 3 shows that a large area to the north of the red line boundary is covered by the high risk SPZ1 classification. Beyond this, the SPZ2 (outer protection zone) which extends northwards represents a theoretical 400-day travel time from a point below or at the water table. The SPZ3 (Total Catchment) represents the total catchment area for groundwater recharge to the source/abstraction.
- 15.159 A review of the Havant and Bedhampton springs SPZ has recently been undertaken by BGS in 2019⁷⁰. This study was commissioned by the Environment Agency to assess the significance of karst features in the area and identify whether there were new lines of evidence (that indicated a redefinition of the SPZs was required).
- 15.160 The groundwater source protection zones for the springs were defined in 1998 and since then additional data have been collected and interpreted. The BGS study reviewed information regarding the occurrence and extent of the karst network. Karst features include stream sinks, dolines (also known as sink holes), dissolution pipes, caves and large springs. The study also reviewed evidence from borehole data, spring data and tracer tests. The mapped known karstic features are shown in Figure 15-4 below.

Figure 15-4 - Mapped surface karst features in the Bedhampton and Havant Springs SPZ catchment⁷¹



⁶⁹ Environment Agency. 2020b. Environment Agency - Groundwater Source Protection Zones. [online] Available at: <http://apps.environment-agency.gov.uk/wiyby/37833.aspx>

⁷⁰ BGS, 2019. A review of the hydrogeology of the Bedhampton and Havant springs source protection zones. Groundwater Programme. Commissioned Report CR/19/046

⁷¹ BGS, 2019. A review of the hydrogeology of the Bedhampton and Havant springs source protection zones. Groundwater Programme. Commissioned Report CR/19/046

- 15.161 Referring to Figure 15-4, it can be seen that there are no mapped surface karst features in the SPZ1c (i.e. none within the red line boundary for the reservoir). In addition, the Ground Investigation Report did not find any evidence of karst features within the study area (reservoir site footprint) investigated for the reservoir⁷².
- 15.162 The BGS study noted that the southern limit of the large SPZ1 area (to the north of the reservoir) was originally defined by the point at which the Palaeogene cover overlying the Chalk was approximately 6 m thick. This area was previously designated as SPZ4 (Special interest). SPZ4 can present a surface water catchment which drains into the aquifer, feeding the groundwater supply (this could be by overland flow and/or catchment draining into a doline). The area is currently designated as SPZ2 as well as being SPZ1c. The BGS 2019 study stated that the Environment Agency intends to revert to the SPZ4 classification in 2020 for the Havant and Bedhampton springs catchment⁷³. A further re-evaluation of the current SPZ delineation for the Havant and Bedhampton springs was also recommended, using a bespoke method and drawing together additional evidence, based on the guidance in the SPZ manual.

Designated sites

- 15.163 A full description for all designated sites has been provided in Chapter 9 Biodiversity in ES Volume 2. In the context of the water environment, the only site designations apply to Langstone Harbour (study section 6):
- Langstone Harbour SSSI
 - Chichester and Langstone Harbour SPA
 - Solent Maritime SAC
 - Chichester and Langstone Harbour Ramsar
 - Farlington Marshes LNR⁷⁴
- 15.164 The designations for Langstone Harbour SSSI and the Chichester and Langstone Harbour SPA and Ramsar are primarily in context of large populations of migrant and overwintering waders and wildfowl, which are dependent on extensive beds of seagrass/eelgrass (*i*) species as well as nearby high tide roosting areas including saltmarshes and reedbeds (e.g. Farlington Marshes LNR). Although eelgrass requires clear water with relatively low nutrient levels, the harbour is considered to be meso- to eutrophic⁷⁵.
- 15.165 Langstone Harbour is also a shellfish water protected area under the WFD, as it contains edible oyster (*Ostrea edulis*) beds.
- 15.166 With regard to groundwater, the reservoir and access roads is located in a Nitrate Vulnerable Zone (2017 designation). Nitrate Vulnerable Zones (NVZ's) are areas designated under the Nitrate Regulations as being at risk from agricultural nitrate pollution. NVZ's extend to approximately 55% of land in England⁷⁶
- 15.167 The reservoir and access roads is also in a drinking water safeguard zone (groundwater). Drinking Water Groundwater Safeguard Zones (SgZs) are established around public water supplies where additional pollution control measures are needed. The WFD requires that Drinking Water Protected Areas are identified (WFD Article 7.1) and that they are given the necessary protection (WFD Article 7.3) with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water. The geometry of Groundwater Safeguard Zones is based on Groundwater Source Protection Zones (SPZs) and use additional assessment to identify areas, which may or may not coincide with the SPZ, where additional measures are required to ensure that abstraction waters meet Article 7.3 of the WFD.

⁷² Atkins, 2020a. Havant Thicket Reservoir Project. Ground Investigation Report. Atkins Doc No. HTR-ATK-RZ-RE-RP-C-0001. April 2020.

⁷³ BGS, 2019. A review of the hydrogeology of the Bedhampton and Havant springs source protection zones. Groundwater Programme. Commissioned Report CR/19/046

⁷⁴ The following sites are outside the 2 km radius: West Hayling LNR, Hayling Billy LNR and The Kench, Hayling Island LNR

⁷⁵ JNCC, 2008. Information Sheet on Ramsar Wetlands (RIS). Chichester and Langstone Harbours. 13 June 2008. [online] Available at: <<https://jncc.gov.uk/jncc-assets/RIS/UK11013.pdf>> [Accessed 10 May 2020]

⁷⁶ Gov.uk. 2020. Nitrate Vulnerable Zones. [online] Available at: <https://www.gov.uk/government/collections/nitrate-vulnerable-zones>

Receptor importance

- 15.168 Using criteria set out in Table 15-5, the baseline sections have been used to determine the importance of features within each study section, which will be used in the impact assessment. The overall importance for each study section has also been provided for context. See Table 15-33 on the next page.
- 15.169 In summary, the overall importance assigned to each study section is as follows:
- study section 1 – overall High importance, mainly based on groundwater baseline
 - study section 2 – overall Medium importance, mainly based on water quality and hydromorphology baseline
 - study section 3 – overall High importance, mainly based on hydromorphology baseline
 - study section 4 – overall Medium importance, mainly based on water quality and hydromorphology baseline
 - study section 5 – overall Very High importance, mainly based on groundwater baseline
 - study section 6 – overall Very High importance, mainly based on water quality and groundwater baseline
 - study section 7 – overall High importance, mainly based on groundwater baseline
 - study section 8 – overall High importance, mainly based on groundwater baseline

Table 15-33 - Receptor importance

Study section	Descriptor				Importance				
	Water quality	Hydromorphology	Flood risk	Groundwater	Water quality	Hydro-morphology	Flood risk	Ground water	Overall
1. Headwater Streams 1, 2 and 3 up to reservoir site footprint	Portsmouth Water data indicative of <'good' WFD status, which included 'bad' status for ammonia in HS2, 'poor' for pH in HS2; and 'moderate' for pH in HS1 and HS3; and 'moderate' for reactive phosphorus in HS1, 2 and 3. Total iron levels were also above the EQS. This is however a function of the ephemeral nature of the waterbody, rather than an indicator of pollution: the lower pH levels suggested poor buffering capacity typical of headwaters whilst elevated iron levels are indicative of a strong groundwater influence. Despite <'good' WFD status, the groundwater is of sufficient quality to support a number of Near Threatened, nationally notable and scarce macroinvertebrate species (see species lists	Three straightened streams within wood but with natural boundaries. Ephemeral hydrology, no designations.	Ordinary Watercourse (not Main River). Rural wooded area with no vulnerable receptors.	East Hants Lambeth Group groundwater body. Secondary A Aquifer. SPZ zone 1 subsurface (according to MAGIC merged SPZ zones), relating to the Chalk aquifer. Shown as zone 2 on current Environment Agency SPZs (1998 methodology). Groundwater in hydraulic continuity with headwater streams.	Medium	Medium	Low	High	High

Study section	Descriptor				Importance				
	Water quality	Hydromorphology	Flood risk	Groundwater	Water quality	Hydro-morphology	Flood risk	Ground water	Overall
	in Appendix A9.3 Aquatic ecology in ES Volume 4). No (public) water supply abstractions.								
2. Headwater Streams 1, 2, 3, 4, 5, Upper Lake and short section of Riders Lane Stream all under reservoir site footprint	Portsmouth Water data indicative of <'good' WFD status for total iron only. No (public) water supply abstractions.	Three straightened streams within footprint but with natural boundaries. Ephemeral hydrology, no designations but habitats support some Near Threatened, nationally notable and scarce aquatic macroinvertebrate species.	Ordinary Watercourse (not Main River). Rural area with no vulnerable receptors.	Not officially included in the East Hants Chalk groundwater waterbody (confined Chalk). SPZ zone 1 subsurface (according to MAGIC). Does not support river ecosystem (hydraulically separate).	Medium	Medium	Low	Low	Medium
3. Riders Lane Stream between reservoir site footprint up to Hermitage Stream confluence.	Portsmouth Water data indicative of <'good' status, including 'moderate' status for reactive phosphorus, BOD and ammonia at Riders Lane Stream upstream of The Lake Stream. Reactive phosphorus was also indicative of 'moderate' at	Mix of channel morphology with near reference conditions in Great Copse which is however, suffering from severe recreational pressures.	Designated Main River up to confluence with The Lake Stream. Urban area with flooding predominantly kept within	As per study section 1.	Medium	High	Medium	High	High

Study section	Descriptor				Importance				
	Water quality	Hydromorphology	Flood risk	Groundwater	Water quality	Hydro-morphology	Flood risk	Ground water	Overall
The Lake Stream joining Riders Lane Stream from Leigh Lake.	the other two Riders Lane Stream sites (downstream The Lake Stream, upstream of Hermitage Stream). Total iron <'good' status at all sites except Riders Lane Stream downstream of The Lake Stream. No (public) water supply abstractions.	Riders Lane Stream has been historically modified, via channel straightening, but is actively recovering through channel adjustment. This has been prevented, in places, as it frequently flows at the back of gardens. Intermittent hydrology, no designation.	channel or within open areas. Fewer than 10 less vulnerable buildings (outbuildings/sheds) within the 1% floodplain Non main river. Rural area with no vulnerable receptors						
4. Hermitage Stream – between A3(M) and confluence with Riders Lane Stream	Portsmouth Water data indicative of <'good' status as a result of 'moderate' status for reactive phosphorus only. No (public) water supply abstractions.	This reach has been historically improved through restoration of the channel banks and margins. However, the concrete bed of the channel has been retained. Intermittent hydrology, no designation.	Designated Main River. Urban area with flooding predominantly kept within channel or within open areas.	As per study section 2	Medium	Medium	Low	Low	Medium

Study section	Descriptor				Importance				
	Water quality	Hydromorphology	Flood risk	Groundwater	Water quality	Hydro-morphology	Flood risk	Ground water	Overall
			No vulnerable receptors within the floodplain						
5. Hermitage Stream – between confluence with Riders Lane Stream and Nominal Tidal Limit (NTL)	This section contains the Environment Agency WFD compliance sampling location. Portsmouth Water and Environment Agency data indicative of <'good' WFD status as a result of 'moderate' status for reactive phosphorus and pH. This is in context of this waterbody's objective to attain 'good' status by 2027. No (public) water supply abstractions.	This reach of the Hermitage Stream has been historically channelised and possesses concrete bed and banks. Intermittent hydrology, no designation.	Designated Main River. Urban areas with fewer than 10 residential and commercial properties within the 1% floodplain.	This is in a combination of GWBs. Initially the stream flows over confined Chalk as per study reach section 2, then the stream flows over the South Hants Lambeth Group groundwater body and also interacts with the East Hants Chalk aquifer groundwater body. It is SPZ zone 1 (for part of area)	Medium	High	High	Very High	Very high
6. Langstone Harbour	Waterbody at 'good' WFD status, which is (generally) corroborated by Environment Agency data. Langstone Harbour has been designated SAC/SPA/SSSI/Ramsar/L	Downstream of the large weir the channel is more natural and tidally influenced. There remain some modifications, but a variety of morphological forms and	Designated Main River. Rural area with no vulnerable receptors in the floodplain	On the geological mapping it is difficult to distinguish between the Chalk and Lambeth Group formations in this area. This area is included in the East Hants Chalk aquifer	Very High	High	Low	High	Very high

Study section	Descriptor				Importance				
	Water quality	Hydromorphology	Flood risk	Groundwater	Water quality	Hydro-morphology	Flood risk	Ground water	Overall
	NR with water quality supporting some of the designated features. No (public) water supply abstractions.	features were present within in this reach. Hydrology is tidally dominated with only relatively minor contributions from Hermitage Stream and River Lavant.		groundwater body. This is a Principal Aquifer. It is not part of the mapped SPZ.					
7. Headwater Streams of River Lavant	No Portsmouth Water or Environment Agency water quality data available for waterbodies in this study section. Environment Agency data further downstream in the River Lavant catchment was indicative of 'high' WFD status, except for reactive phosphorus, which was at 'moderate' to 'good' WFD status. No (public) water supply abstractions.	Short reach of designated Main River. Assumed ephemeral hydrology, no designation.	Partially designated main river at the downstream end near Durrants Road. Predominantly rural along reach. Fewer than 10 residential buildings within the 1% floodplain at the very downstream end.	See study section 2.	Medium (uncertain)	Medium	High	Low	High
8. Park Lane Stream	No Portsmouth Water or Environment Agency water quality data	Mainly natural boundaries.	Ordinary Watercourse.	This is in a combination of groundwater	Medium (uncertain)	Medium (uncertain)	Low	High	High

Study section	Descriptor				Importance				
	Water quality	Hydromorphology	Flood risk	Groundwater	Water quality	Hydro-morphology	Flood risk	Ground water	Overall
	available for waterbodies in this study section. The overall WFD status of Hermitage Stream catchment is indicative of 'moderate' WFD status although waterbody objective is to attain 'good' by 2027. It has been assumed that this extends upstream into the Park Lane Stream. No (public) water supply abstractions.	Assumed ephemeral hydrology, no designation.		bodies. Initially the stream flows over the East Hants Lambeth Group groundwater body as per study section 1 but further downstream it flows over the London Clay as per study section 2.					

Potential impacts

Impact types

- 15.170 The potential impacts of the reservoir site and access roads and pipeline corridor will be considered separately, but they are expected to include the same potential impact types:

Water quality:

- Changes to water quality – direct and indirect
- Pollution (habitat degradation – WQ degradation – injury to species)
- Impacts on abstraction

Hydromorphology:

- Habitat loss (both temporary and permanent)
- Habitat connectivity (both temporary and permanent)
- Changes to hydrology (locally and downstream)
- Changes to geomorphology (fluvial processes, sediment regime, channel stability)

Flood risk:

- Changes to fluvial/tidal flood risk
- Changes to surface water flood risk
- Changes to artificial flood risk

Groundwater:

- Changes to groundwater quantity (level / flow)
- Changes to groundwater quality

Changes to water quality

- 15.171 Changes to water quality exclude pollution events (which are discussed in paragraphs 15.174-15.178) and refer to short-, medium- or longer-term changes to the overall water quality in the waterbody as a result of construction and operation of the pipeline and reservoir.
- 15.172 Changes in water quality can include changes to oxygen balance, pH, temperature as well as sediment loads, organic and inorganic pollutants (metals, nutrients). Water quality changes can benefit, or harm organisms based on their individual preferences.
- 15.173 In the context of the pipeline corridor, reservoir site and access roads, general changes to water quality can occur as a result of dewatering activities during construction, especially if this is a large volume. Once constructed, during operation, changes in water quality can occur as a result of the reservoir compensation flow being composed of water originating from different a groundwater source, i.e. Havant and Bedhampton Springs compared to ephemeral flows from springs that feed Headwater Streams 1 to 5.

Pollution

- 15.174 Pollution involves the introduction of a substance to the environment which causes direct or indirect harm to water quality and aquatic organisms. This is most relevant to the construction stage and can include the introduction of new substances which were not present already (for example fuels, lubricants, solvents, cleaning products, heavy metals, concrete and cement) or an increase in the levels of existing substances (for example silt/sediment and associated nutrients).
- 15.175 With regard to aquatic organisms, the effects of pollution are generally seen through mortality, reduced reproductive success and/or habitat degradation. Mortality can occur as a result of toxic properties (e.g. ammonia or organic pollutants can affect fish or macroinvertebrates) or reductions in oxygen levels (e.g. as a result of chemical or biochemical oxygen demand exerted by the breakdown of pollutants). Reproductive success can be affected, for example through the smothering of spawning habitats by silt or a reduction in an individual's fitness (e.g. as a result of disease or in case of plants, smothering) or through a reduction in the adult population.
- 15.176 Spillage of fuels could lead to pollution at any stage. Risk of a fuel spill is greatest during refuelling activities. Apart from refuelling, risk of chemical spillage can occur due to leaking valves, leaking pipework, corrosion, leaking pumps, bowsers and generators, mechanical failure and

vandalism. Contamination due to sediments, chemicals or hydrocarbons may not be obvious at first and is most likely to occur if run-off mobilises the pollutants.

- 15.177 Run-off rates can increase as a result of compacted soils (e.g. as a result of vehicle movements) or a loss of vegetation. Higher run-off rates can also increase overall soil erosion rates which increases the risk of pollution.
- 15.178 Pollution can arise from within or outside of the site; notably from upstream sources. Pollutants can also be washed downstream into more sensitive habitats. This does not have to be immediate but can occur following an increase in flow. For example, sediment pollution can initially settle at the point of ingress and is then mobilised following a period of heavy rainfall, affecting habitats and species further downstream of the source.
- 15.179 Habitat deterioration may occur as a result of the release of sediments into the watercourse as well as a result of water quality deterioration or pollution incidents.
- 15.180 In context of the pipeline corridor, reservoir site and access roads, works in and near the river associated with the construction of the three in-river pipeline crossings in study sections 3, 4 and 5 have the potential to cause pollution especially at watercourse crossings and where the red line boundary includes or is adjacent to the Riders Lane Stream/Hermitage Stream.
- 15.181 In context of the pipeline corridor, reservoir site and access roads, during the construction period, two main haulage roads are located within the woodland to the north of the reservoir footprint (study sections 1) and along the west of the reservoir site footprint (study section 8). These will use existing bridges and culverts, although two (i.e. over HS1 and HS2) will need upgrading to be above reservoir Top Water Level (TWL) meaning the culverts need to be extended. There are also access roads associated with the pipeline construction. All access roads have an increase risks of pollution as run-off from the road containing sediments and other pollutants could channel to the watercourses. Once constructed, access to the reservoir will be from the north (by upgrading a forestry track and a new junction on the B2149) and/or south (by using existing roads and the construction track).

Impacts on other abstractors

- 15.182 Changes to the water balance in a catchment (surface- or groundwater) have the potential to affect other abstractors.
- 15.183 In the context of the pipeline corridor, reservoir site and access roads, there were no surface water or groundwater abstractions within 500m. There were no groundwater abstractions in the wider catchment and there was one surface water abstraction to the north west of the proposed reservoir in the headwaters of Park Lane Stream. This was upstream of any study sections and outside the red line boundary. As such, potential impacts on other abstractors have not been considered further as part of the assessment.

Habitat loss

- 15.184 The loss of in-channel habitats can be a result of in-channel works and be both temporary or permanent and will directly affect the in-stream ecology at that location.
- 15.185 The type of habitat lost, its frequency of occurrence (waterbody as a whole) and its ecological function all determine the overall significance of the impact of the loss.
- 15.186 In the case of temporary loss, there is the potential for longer term habitat improvement if reinstatement is accompanied by further improvement works. The loss of habitats in a river system can also result in habitat connectivity impacts
- 15.187 In the context of the pipeline corridor, reservoir site and access roads, there will be temporary in-channel habitat loss associated with the three in-river pipeline crossings in study sections 3 and 4 and a permanent loss of headwater streams associated with the reservoir itself in study section 2; the loss would occur when coffer dams are installed and site water management starts.

Habitat connectivity

- 15.188 Habitat fragmentation, when considered separately from habitat loss, generally affects more mobile species which may become isolated within smaller fragments of habitat with limited species carrying-capacity. They may become separated from key resources necessary for long term species survival, such as spawning grounds, food or other members of their population.
- 15.189 Fragmentation can occur through the introduction of a physical barrier, or the removal of habitat which then creates an inhospitable gap between two retained areas of habitat on either side or in some cases by frequent and sustained disturbance.

- 15.190 Habitat gaps and other barriers not only restrict movement, but can also cause an animal to be at risk of injury or mortality if it does attempt to cross areas more exposed to predators, or if it is more exposed to predation in the area of the river it cannot move away from.
- 15.191 Fragmentation through habitat removal can become ecologically significant when species associated with that habitat type are then unable or unwilling to cross this gap, thus creating a barrier effect.
- 15.192 Fragmentation can also sever a habitat's connection with the physical processes necessary to sustain that habitat. Examples include high flows that move sediments in a catchment; remove sediments from spawning grounds and/or the ingress of water providing oxygen and removing waste materials (e.g. ammonia).
- 15.193 In the context of the pipeline corridor, reservoir site and access roads, there would be temporary habitat fragmentation associated with the three in-river pipeline crossings and a permanent loss in connectivity between the upper sections of the headwater streams (study section 1) and the Riders Lane Stream (study section 3) associated with the construction and operation of the reservoir. This loss of connectivity would start when coffer dams are installed and site water management starts.

Changes to hydrology

- 15.194 Changes in water levels and flow regimes can be a result of a temporary measure (e.g. coffer dam during in-channel works) or a more permanent feature (e.g. reservoir dam). Changes can affect the quality and quantity of water-dependant habitats such as riffles and runs as well as wetted perimeters. Effects can occur upstream of a structure, e.g. as a result of impoundment or downstream e.g. as a result of an increase or reduction in flow.
- 15.195 The effects are normally manifested as some form of habitat degradation/damage or habitat loss. If flow is transferred incorrectly, this can lead to local acceleration or deceleration of flows, which can in turn result in increased erosion/deposition risk. Erosion around structures and riverbanks can result in destabilisation of key infrastructure.
- 15.196 Sufficient flow is also required within pipes and culverts in order to maintain hydrological continuity between upstream and downstream sections and reduce fragmentation effects described above.
- 15.197 In the context of the pipeline corridor, reservoir site and access roads, the reservoir itself would change water levels for watercourses within the reservoir footprint permanently from ephemeral/wet grassland to standing water. Downstream of the reservoir, the compensation flow may provide opportunity for a different flow regime. Temporary changes to flow regime would result from the three in-river pipeline crossings.

Changes to geomorphology

- 15.198 Changes in flow regime, channel width and depth and/or in-channel obstructions can all cause a change in river processes such as sediment transport including erosion and deposition. This can, in turn, change the channel's shape and form.
- 15.199 In context of the pipeline corridor, reservoir site and access roads, the reservoir itself would change sediment transport between the headwater streams, Riders Lane and Hermitage Stream. A change in flow regime may have benefits for geomorphology, especially if this is more variable.

Changes to fluvial flood risk

- 15.200 Impacts to fluvial flood risk occur as a result of changes to river flows, levels and volumes during high flow events. In the context of the pipeline corridor this may be as a result of temporary damming of the watercourse in order to lay the pipeline.
- 15.201 In the context of the reservoir site and access roads, changes to fluvial flood risk may be caused by the construction works to build the embankment which would temporarily alter the rivers' existing downstream conveyance capacity and during operation by the permanent placement of a new dam and spillway to impound water and create storage.

Changes to surface water flood risk

- 15.202 Impacts to surface water flood risk can be both direct as a consequence of increase runoff rates and/ or volumes due to introducing new impermeable surfaces or indirect as a consequence of changes to the capacity in the drainage network as result of changes to the river flow regimes.
- 15.203 In the context of the pipeline corridor, reservoir site and access roads, changes to surface water flood risk may be caused by the construction methodology, temporary site drainage works and/or

the temporary obstruction of surface water flow paths. In the context of the reservoir, changes to surface water flood risk relate to how the embankment, visitor centre and car park will be drained.

Changes to artificial flood risk

- 15.204 There are currently no potential sources of artificial flood risk. Changes to artificial flood risk downstream of the reservoir will occur as a consequence the reservoir's moderated flow regime. This is due to the nature of the Scheme, which impounds water above ground level, meaning that there is a very small, but residual risk that failure of the structure could result in flooding downstream of the reservoir. The reservoir has been designed in accordance with relevant legislation and policy and will be owned and maintained by Portsmouth Water following the requirements set out in the Reservoirs Act 1975. The probability of reservoir failure is therefore highly unlikely. Reservoir failure (through embankment breach or emergency drawdown) is a residual risk and not considered as part of the Scheme in construction or operation; a detailed assessment of changes to artificial flood risk are described in the Flood Risk Assessment (Appendix A15.2 Flood Risk Assessment in ES Volume 4).

Groundwater quantity

- 15.205 Changes to groundwater quantity can include changes to groundwater levels or changes to the volume of groundwater available.
- 15.206 In the context of pipeline corridor, reservoir site and access roads, changes to groundwater quantity can occur as a result of works extending below the water table such as dewatering or placement of impermeable barriers that might obstruct groundwater flow and result in a rise in groundwater levels. Changes in groundwater quantity might cause alterations to groundwater levels and groundwater flow paths and/or impact on the water available to support the ecological status of surface water bodies, wetlands and licensed abstractions

Groundwater quality

- 15.207 Changes to groundwater quality can include intrusions of poor-quality water or pollution, for example from contaminated runoff or spills. These might affect the water quality of abstractions and/or impact on the chemical and ecological status of surface water bodies or wetlands.
- 15.208 In the context of the pipeline corridor, reservoir site and access roads, changes to groundwater quality could result from increased construction traffic, operation of construction machinery, creation of impermeable surfaces or any activities which could result in contaminated runoff and infiltration. Earthworks in particular may create new pathways for potentially contaminated runoff to pass into groundwater or stop existing pathways, for example the use of clay bunds.

Reservoir site and access road construction work

- 15.209 See Figure 15-1 in ES Volume 3 for the Scheme's red line boundary. Reservoir construction is expected to be between Spring 2021 and Autumn 2024, with reservoir filling scheduled to start in Autumn 2024 and expected to be complete five years later, i.e. around Autumn 2029. The construction impacts cover the period up to Autumn 2029, whilst reservoir operation (see section below) covers the period after this.
- 15.210 This section contains the properties and dimensions of the reservoir construction work which have been used as assumptions for the impact assessment. Any changes to these dimensions or assumptions may change the assessment findings and/or trigger additional assessment requirements.
- 15.211 Activities undertaken as part of reservoir construction work (which may affect the water environment) have been summarised in Table 15-34. **Error! Reference source not found.** This list of activities has been reviewed to identify potential impact types in relation to the water environment.

Pipeline corridor construction work

- 15.212 See Figure 15-1 in ES Volume 3 for the Scheme red line boundary. The 4.4 km pipeline corridor from Bedhampton to the reservoir site follows a fairly sinuous course along the bank of the Hermitage Stream following several residential roads with a key aim, to wherever possible, avoid major thoroughfares and minimise impacts to residents and the travelling public.
- 15.213 This section contains the properties and dimensions of the construction work within the pipeline corridor, which have been used as assumptions for the impact assessment. Any changes to these dimensions or assumptions may change the assessment findings and/or trigger additional assessment requirements.
- 15.214 Activities undertaken as part of pipeline corridor construction work (which may affect the water environment) have been summarised in Table 15-35. This list of activities has been reviewed to identify potential impact types in relation to the water environment.

Reservoir and pipeline operation

- 15.215 Activities undertaken as part of reservoir and pipeline operation (which may affect the water environment) have been summarised in Table 15-36, and include:
- Transfer of spring water pumping from the Bedhampton and Havant Springs system to fill and replenish the Havant Thicket reservoir. This will include controls based on limitations of Bedhampton spring yield, spring water abstraction licence and levels within the reservoir;
 - Monitoring and management of water availability and quality within the reservoir to minimise risk of adverse effects on drinking water quality and to maintain environmental water quality in the Hermitage Stream catchment;
 - Transfer of reservoir water to treatment. This is expected to include abstraction limitations based upon reservoir water quality, levels within the reservoir, prevention of flooding risk at Farlington, and abstraction limits imposed by the Environment Agency within the reservoir abstraction licence. The proposed reservoir level and drawdown regime is as follows:
 - Normal year (absence of drought or operation): Reservoir water level will be normally at TWL of 39.5m from November to April, and typically around 39.0m in summer months
 - Drought event (1 in 5 years): water level will likely to fall below 39.0m during the summer months after which it will be topped up during the winter period until TWL is recovered. It is expected that this recovery is relatively rapid, i.e. within a winter period.
 - Prolonged drought (1 in 10 years, water abstracted for potable supply): significant reduction in water level during the summer months. Water levels would be drawn down by 4-5m below TWL to around 35m after which they would be topped up during the winter period until TWL is recovered. It is expected that this recovery time would extend over the course of a winter period.
 - In an extreme drought (1 in 200 years) the water level would be as low as the minimum level of 27m – 28m for extended periods over multiple seasons (i.e. around the top of the bottom 20% emergency storage which would take around 320 days). Although the water quality model has covered this event within the 1000-year model sequence, as this is an extremely rare occurrence, it has not been assessed as part of the impact assessment presented below.

- Emergency draw down of the reservoir is as required by the Reservoirs Act (1975) over a 3 m long weir and through a 700 mm diameter pipe with 1.5 m³/s capacity, noting this is a very rare event and will only take place in case of suspected dam failure; this scenario has not been assessed further;
- Non-emergency draw downs (e.g. for maintenance and repairs) may also be needed. It will be acceptable to test the system at a reservoir water level lower than the TWL. A testing programme will be developed to measure head and discharges at various openings, and at various stages of filling, and these will be compared with the manufacturer's performance data. It is likely that the testing would occur twice per year, following Environment Agency guidance⁷⁷. It is assumed that submerged valves would be tested to an opening corresponding to 10% of the emergency discharge flow. This would be around 0.7 m³/s for Riders Lane Stream (via the emergency spill weir and/or the compensation flow channel) and 0.38 m³/s for Hermitage Stream (at Emergency Discharge Valve location). The arrangement of maintenance/control valves upstream would still allow the valves to be tested under full head but giving only a partial discharge. The valves could be tested individually, for example, testing the Hermitage Emergency Discharge, and then after closing the valves, testing the Riders Lane Stream Emergency Discharge. Careful planning would be required to test at the correct time, e.g. the system would not be tested if the additional discharge could cause flooding, or if the river was unusually low. It would also be unreasonable to expect a test to be run over a long period as this would waste water which had been pumped into the reservoir with associated pumping costs;
- There will be a controlled compensation flow from the reservoir as required by the Environment Agency to maintain the health of the ecology and wider environment in and downstream of the Riders Lane stream;
- Treatment suitable for reservoir water and monitoring and control of treatment objectives in line with the water quality standards imposed by the Drinking Water Inspectorate (DWI) under the Water Supply (Water Quality) Regulations (2016); and
- Transfer of treated water to the Portsmouth Water network to enable bulk supply to Southern Water.

⁷⁷ Environment Agency 2017b. Guide to drawdown capacity for reservoir safety and emergency planning, published 11 August 2017. Available [online] at: <https://www.gov.uk/government/publications/guide-to-drawdown-capacity-for-reservoir-safety-and-emergency-planning>

Table 15-34 - Reservoir site and access road scheme components

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
AA.	Enabling works	2021	Prior to starting work onsite, activities include detailed topographical surveys, ecological surveys and ecological habitat enhancements (Chapter 9 Biodiversity in ES Volume 2). Ephemeral animal communities recorded at distinct locations in Headwater Streams 1-5 will be translocated to appropriate receptor areas, as informed by a baseline ecology survey/Ecological Clerk of Works.	-	-	-	-
BB.	Construction Support Site (CSS)	2021 to 2024	The CSS will be set up in the north western corner of the red line boundary for the duration of the work. This will include: • Welfare facilities • Car parking • Storage of pipeline • Access control • Laboratories • Crushing and screening plant • Maintenance yard for vehicles • Contractors compound There will be run-off associated with CSS hardstanding areas which will contain pollutants. There will also be stockpiling of (raw) materials within the footprint of the CSS, originating from within the site but also outside (i.e. pipeline construction).	2	2	2	2
CC.	Access Roads (construction)	2021 to 2024	Two main access roads will be set up: • Running south to north along the western end of the reservoir • Running east to west along the northern end of the reservoir The access road to the north of the reservoir will need to be raised to 40 mAOD to be above the reservoir's operational TWL of 39.5 mAOD. This will affect culverts over Headwater	1, 2	1, 2	1, 2	1,2, 3

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			Streams 1 and 2, but not Headwater Stream 3 (which is outside of the reservoir flooded area at TWL). This will mean that the existing culverts over Headwater Streams 1 and 2 will need to be replaced or extended to accommodate a raised access road. It is estimated that this will result in up to 3 metres of watercourse being lost at Headwater Stream 1 and up to 6 metres at Headwater Stream 2. This watercourse loss is within the ultimate reservoir footprint and thus not in addition to the area specified below under item KK (site water management). For the purpose of the EIA, it has been assumed there will be no additional watercourse crossings in study section 1, including for the construction access roads and the northern access road (see item AAA, Table 15-36).				
DD.	Haul Routes	2022 to 2024	Onsite haul routes will be used for construction activities such as tree felling, topsoil removal, earthworks and reservoir construction. They are within the reservoir site footprint. Haul routes will take into consideration constraints such as buffer zones to (historic) woodland and watercourses, as informed by ecology surveys/Ecological Clerk of Works. Within the approximate centre of the reservoir footprint, a haul route will run along north to south along The Avenue on Q3 Q4 2021. For the purpose of the EIA, it has been assumed these are unpaved and have hard core or gravel as a base and that any surface water run-off will be collected as part of the site water management systems.	2, 3	2,3	2	2,3
EE.	Habitat enhancements	2021 - 2022	There will be habitat enhancements in Havant Thicket woodland to the north of the reservoir (to include selected tree felling and watercourse improvements) and Bells Copse to the west of the reservoir (mainly terrestrial habitats work in addition to enhancement of two onsite ponds).	1	1	-	-

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
FF.	Tree felling	2021 (Southern Avenue) - 2022	Tree felling will be undertaken at the southern section of the site (The Avenue) and three other areas of the site (Middle Clearing, Round Wood and Corsican Pine Plantation), all within the footprint of the reservoir.	-	-	-	-
GG.	Stump removal	2023	Once the tree felling has been completed in the Corsican Pine Plantation (North East of the site) the remaining stumps are to be removed as part of the development of the wetland area. The stumps will need to be ground out using a rotor like system, or similar.	-	-	-	-
HH.	Topsoil stripping (initial, where required)	2022	Topsoil removal will be required along haul road route and clay blanket locations (currently expected around the south west of the reservoir site). Removed topsoil will be stored within the footprint of the reservoir. Stripping will occur as and when required to suit the activities on site and will not be carried out as a blanket activity across the whole site at the start of the programme to prevent site run-off and avoid clashing with ecological works which may still be on going. Run-off generated by the topsoil stripping is picked up by the site water management system (see item KK below).	2, 3	2, 3	-	3
II.	Coffer dams for Headwater Streams 1-3	2022	Three cofferdams will be constructed on Headwater Streams 1-3 to prevent water flow on site during construction. The coffer dams will be replaced by the wetland bund over time (see item JJ below). Site water management will be started (see item KK below).	2, 3	2, 3	1, 2	1, 2
JJ.	Construction of wetland bund	2022 - 2024	A wetland bund will be constructed in the northern part of the site at an early stage to assist in site water management during construction. The bund will be made from material excavated from the borrow pits, but without the need for conveyors.	1, 2, 3	1, 2, 3	1, 2	1, 2, 3

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			The bund is constructed in sections, aligning with the compartment design, in order to facilitate a more efficient construction sequence. The bund will replace the initial coffer dams. When constructing the bund care will be taken to avoid disturbing environmental features such as the grassland to the east which is of ecological value to the overall scheme. When construction is completed, the wetland bund will be retained and function as a retention structure to keep water in the wetland areas as reservoir levels fluctuate.				
KK.	Site water management	2022 - 2024	Water management will be started in Q1 2022 to manage incoming water from Headwater Streams 1-3; and rainwater falling on hard standing; exposed soils; as well as any groundwater arisings (notably as a result of Bognor Sands and Harwich Formation). The water management will use the coffer dams / wetland bund to manage water originating from Headwater Streams 1-3 along with three coffer dams towards the south of the site to manage the remainder of the site. These will be located on the lowermost parts of Headwater Stream 1, Headwater Stream 2 (which captures flow from Upper Pond, Headwater Streams 3 and 4 at that point) and Headwater Stream 5. Water entering the site water management system will be discharged into the Riders Lane Stream downstream of the reservoir. There will be no discharges into the Park Lane Stream towards the west of the reservoir. Further detail on these measures (to be included in the REAC as part of the OEMP Appendix A2.1 in ES Volume 4) has been provided in the "Design, mitigation and enhancement measures" section below (see paragraph 15.218 onwards). Once coffer dams are installed, and site water management is started in Q1 2022, the approx. 3.7 km of watercourse	1, 2, 3	1, 2, 3	1, 2, 3, 5, 6	1, 2, 3

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			within the footprint will no longer contain regularly flowing water. Any discharge into Riders Lane Stream will be subject to environmental permits, to be obtained from the Environment Agency.				
LL.	Site material imports	2022 - 2024	Movement of materials to and from site will use the designated construction access roads, with the washing of vehicles, where required, to minimise the amount of dust occurring on the public highway. Any arisings from vehicle washing will be managed by the site water management system.	1, 2, 3	1, 2, 3	-	-
MM.	Earthworks borrow pits, material movement and embankment construction	2022 - 2024	Three borrow pits are to be dug within reservoir compound and the first step is to remove topsoil. These borrow pits will supply material to the embankment and the wetland bund and would be dug according to when the material is required. Movement of materials from the borrow pits to the embankment would be either via conveyors or large earth moving vehicles. A conveyor system is currently preferred to reduce vehicle movement on site. After the topsoil has been stripped the conveyors will be installed. Articulated dump trucks (ADTs) would be used to feed the conveyors taking the material up the dam. Before the material can be transported there may be a pre-process involved, to meet specification requirements, where the material may need to be sized or water may need to be added to allow transportation. Material placed onto the conveyor will travel to the embankment where it will be dropped at the required drop off point to be then graded out using either a bulldozer, D9 or similar, or a motor grader into its final location. Once graded three gangs of sheepsfoot rollers or dynamic compaction equipment will compact the material to	1, 2, 3	1, 2, 3	-	1, 2, 3

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			specification. During the lifting of the embankment, each layer will be coordinated using GPS and onboard technology so that each section is placed and compacted to the designed profile. The final trim will not commence until the finished profile plus compaction tolerance is complete. Once the final trim is complete the front face and landscaping finish will be applied including observation platforms and access arrangements. Embankment construction is estimated to last 18 months, however assessment work on the effects of excess pore pressure may require programme extension and/or further foundation treatment.				
NN.	Bognor Sand Clay Blanket	2022	This is to be located to the south west corner of the embankment with the purpose of stopping exchange of water between the reservoir and Bognor Sands Member. Material for this blanket will be supplied from borrow pit.	-	-	-	2
OO.	Harwich formation clay seal	2023 - 2024	This clay seal formation is required within the borrow pits upon completion of digs.	-	-	-	2, 3
PP.	Dam Culvert	2022 - 2023	A Dam Culvert will be constructed to the south of the reservoir, north of the location for the Control House. The Dam Culvert will be used to pipe water from the reservoir into Riders Lane Stream when the reservoir is in operation. The flow of water will be controlled by the Control House along with reservoir water level. The Dam Culvert is designed to house two pipelines (scour and mid-level intake). As stated under item II-KK above, construction of two cofferdams will be required upstream of the Dam Culvert for site water management purposes, these will converge near the northern/ upstream end of the Dam Culvert. The culvert would be cast in-situ with reinforced concrete and the embankment constructed over the top .	2, 3, 5	2, 3, 5	2, 3, 5, 6	-

Item	Reservoir site and access roads construction Scheme component	Timing and duration	Reservoir site and access roads construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
QQ.	Control House	2023	The Control House is to be located to the south of the reservoir and the culvert. This is designed is to be embedded within the embankment and thus the design includes thick reinforced concrete base and walls. Internal and front compound walls would be formed of steel columns with blockwork infill panels, with composite steel decking and reinforced concrete slab roofs allowing turf coverage for living roofs, which will remove any (downstream) flood risks as a result of attenuation.	3	-	-	-
RR.	Visitor Centre and associated facilities	2024 onwards	Will be footprint of CSS as long as this does not interfere with the main contracts works for the reservoir. Services would include: • Bus parking • Car park • Play area • Picnic area • Wildflower meadow • Education hide All water generated onsite will go to foul, resulting in no impacts on the water environment.	-	-	-	-
SS.	Access Roads (post-construction)	2024 onwards	Two visitor access roads to the reservoir have been identified: a south and north option. There are no watercourse crossings for either the northern or southern access road options.	-	-	-	-

Table 15-35 - Potential pipeline corridor construction impacts

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
A.	Bankside enabling works	Mar-Sep in 2021, 2022 or 2023	• Bankside enabling works are required for all pipeline corridor crossings, culvert improvement works as well as work in close proximity to Hermitage Stream in study section 5. • Activities are expected to include vegetation clearance as well as ecological checks in advance of the works – Chapter 9 Biodiversity in ES Volume 2. • Work alongside (but not within) Hermitage Stream in study section 5 will use sheet piling to protect the bank and provide a safe working area. It has been assumed there will be no in-river works within this study section. • A Ground Investigation is proposed to confirm the presence of contaminated land along the pipeline corridor. • In addition, the following locations have (supporting) activities in close proximity to watercourses therefore the works may impact the water environment. Noting these are not linear features, construction areas are located adjacent to: • Hermitage Stream between approx. CH 1150 – CH 1600 (study section 5); and, • Riders Lane Stream between approx. CH 2400 and CH 2500; around CH 2900; around approx. CH 3150; between CH 3420 and CH 3460 (study section 3). • There is an extended working area when the pipeline corridor crosses the Riders Lane Stream. This is at the location CH 2510 to CH 2530. This is to facilitate access from the main road to the stream from Purbrook Way. • A construction compound is also planned adjacent to the Riders Lane Stream around CH 3750 – 3900 (study section 3). Each individual pipe section will have a secured (fenced) area and welfare office for the duration of the works within that section. For the purpose of the EIA, it has	3, 4, 5	3, 4, 5	3, 4, 5	-

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			been assumed that there is no stockpiling of any materials at this construction compound or within any of the pipeline corridor and that this is contained within the footprint of the reservoir construction area. A section of the pipeline corridor (between CH 840 and CH 2000) runs very close to Hermitage Stream, which is within study section 4 and 5. For this section, the red line boundary includes the Hermitage Stream. Importantly, for the purpose of the EIA, it has been assumed that where the red line boundary includes a main watercourse e.g. CH 840 to CH 2000 along Hermitage Stream, that there will be no in-river work in these sections.				
B.	In-channel enabling works	Mar-Sep in 2021, 2022 or 2023	- There are three sections of the pipeline corridor which cross a watercourse. These include: - Hermitage Stream (study section 4) – Chainage (CH) 2000 to CH 2020; - Riders Lane Stream (study section 3) – CH 2510 to 2530; and, - The Lake Stream (study section 3) – CH 4000 to 4050. - A dry open cut trench methodology is selected at this stage. It is assumed the in-river working area is up to 20 m. It is also assumed that up to 10 m of bank and bankside vegetation is stripped as part of these works. - Any works in the vicinity of the watercourses (i.e. the three stream crossings, installation of pipe closer to Hermitage Stream and work on the three culverts) is to be carried out within the drier season of March – September, to avoid groundwater issues and instability of excavations, as well as high flows at stream crossings. - All three watercourses (Hermitage Stream, Riders Lane Stream, the Lake Stream) are relatively narrow at pipeline corridor crossing points. River flow will be maintained through coffer damming and either using temporary “flume” pipes (installed in the bed of watercourse to pass flows across the watercourse) and/or suitably sized pumps.	3, 4, 5	3, 4, 5	3, 4, 5	-

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			Any culverts dewatered (see item E below) will put measures in place to mitigate effects on European eel likely to be present in softer sediments and culverts.				
C.	Excavation of pipeline trench	Not specified, Mar-Sep in 2021, 2022 or 2023 for any watercourse crossings	- A light excavator will be used around utilities and a tyre excavator for areas where no utilities are present. - Trench shutters are to be installed once excavation is complete. - The majority of shallow excavation is expected in Head Deposit material, which is highly variable, and alluvial deposits. Trench boxes are assumed to be suitable for excavation in the Head but there is high risk of running sands in the alluvial deposits, therefore sheet piles are required if this geology is encountered. - Depending on the depth of excavation and any tunnelling, there is the potential to impact on groundwater and flows within adjacent watercourses, noting that a deeper excavation is more likely to impact on groundwater. - A Ground Investigation is proposed to confirm actual geology at critical locations and along the pipeline corridor. - As set out under element B above, the assumed working area is 20 m within watercourse crossings, with up to 10 m of riverbank affected by vegetation clearance. - There will be no open cut pipeline or directional drilling through Great Copse (CH 2900 to CH 3750). As a result, there is no interaction with the Riders Lane Stream in this section.	3, 4, 5	3, 4, 5	4, 5, 7	5, 7
D.	Pipeline installation	Not specified, Mar-Sep in 2021, 2022 or 2023 for any watercourse crossings	Following excavation, the following steps will be undertaken: - Pipeline bedding, likely composed of finer materials, will be installed to support the pipe. - Once bedding is in place, pipe sections will be lowered and placed into position before being secured. - Pipe support will be provided adjacent to the pipe sections and well compacted.	3, 4, 5	3, 4, 5	3, 4, 5	5, 7

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			- The trench will be filled with material. Once filling is complete, the trench will be compacted. - In case of roads, once the pipeline is completed, sub-base, base course and wearing course will be installed along with road tie-ins. Concrete will be placed around utilities and normal road laying for asphalt pavements using a mini paver. - For watercourses, the pipeline will be 1.5 m depth under river and a concrete slab will be placed on top followed by finer materials (gravel/pebbles/cobbles).				
E.	Culvert improvement works	Mar-Sep in 2021, 2022 or 2023	- There will be culvert improvements works on three sections of the Riders Lane Stream (all within study section 3). These are located at key pinch points to increase capacity in case emergency drawdown of the reservoir is required. These include: - Culvert no. 1 at Middle Park Way (OSNGR SU 71761 08669), where a 1x 1200 mm circular culvert will be added to the existing 1x 1540 mm circular culvert; - Culvert no. 3 at Dunsbury Way (OSNGR SU 71302 08168), where a 1x 1200 mm circular culvert will be added to the existing 1x 1540 mm circular culvert; and - Culvert no. 4 at Purbrook Way (OSNGR SU 71179 07781), where 2x 900 mm circular culverts are will be added to the existing 3x 900 mm circular culverts. - The culvert construction methodology needs further detail as part of the detailed design stage. For the purpose of the EIA, it has been assumed that the enabling and demobilisation works reflect items A, B and H. and that the works themselves include items F and G. - It is assumed that there would be no loss of in-channel habitat during the works, other than a temporary dewatering of the existing culvert footprint.	3, 4	3, 4	3, 4	-

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
F.	Dewatering before and during	Expected to be continual requirement 2021-2023	- It is assumed that the watercourse pipeline corridor crossings will require dewatering once the (upstream) coffer dam has been put in place. - There will also be a requirement for dewatering and management of groundwater and surface water along the pipeline corridor where free groundwater is encountered. - Free groundwater is expected within the Harwich Formation, and may be encountered in the Bognor Formation Member, in claystone bands within the London Clay Formation, and through seepages in sand horizons within the Reading Formation. - Higher groundwater level can be expected in deep excavations in proximity of St Chads Well Spring, i.e. Under Track Crossing (UTX) shafts, at Bedhampton. - It is expected any dewatering during in-channel works will be discharged immediately downstream of pipeline corridor crossing points in the Riders Lane Stream or Hermitage Stream. - There is currently no detail on discharge locations for any groundwater for other pipeline sections. These will be discussed and agreed with the Environment Agency prior to dewatering starting. It is noted many road gullies/drains will drain to local watercourses and that use of these gullies/drains will be subject to the same measures as if the discharge was directly to a surface watercourse. - Any dewatering into surface watercourses will be subject to environmental permits, which will be obtained from the Environment Agency.	3, 4, 5	3, 4, 5	3, 4, 5	5, 7
G.	Soil/material use and storage	Expected to be continual requirement 2021-2023	- There is not enough space to store the material within the pipeline corridor meaning that all materials will be loaded and taken away to the main compound area. - Material which will have to be taken off site includes- asphalt, road-base and subbase. - For the purpose of the EIA, it is therefore assumed that all soils etc. excavated are placed immediately into another	3, 4, 5	3, 4, 5	-	-

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			vehicle and taken away, removing the risk of exposed material (storage) adjacent to watercourses. • Pipeline bedding and cover will be backfilled using gravel, re-used recycled planings or concrete (self-compacting with early strength mix design). Once placed or pumped the final finish can be applied (see below). It has been assumed materials are purchased on demand or stored centrally before being delivered straight to site. • When the material is backfilled, if it is taken away from site is it a risk that the material will be different/ of a worse quality posing risks for water quality and groundwater storage.				
H.	Demobilisation	Expected to be continual requirement 2021-2023	• Topsoil vegetation will be replaced, ideally by careful removal of topsoils in the first instance, keeping these well-conditioned (wet) before reinstatement. • In case of watercourses, channel banks will be reprofiled akin to existing profile and replanted. • Any channel bank improvements will be undertaken in line with the outline Biodiversity Ecological Mitigation and Compensation Strategy included with the planning applications. • All plant and equipment will be taken to the next pipeline section.	3, 4, 5	3, 4, 5	3, 4, 5	5, 7
I.	Emergency Discharge Valve	As above	• The pipeline includes a 700 mm diameter pipe (approx. 1,650 m in length) for normal pump-and-return flows with this increased to 1,200 mm diameter pipe (approx. 2,750 m in length) for the section where it is to accommodate the emergency drawdown flow from the reservoir site to the Emergency Discharge Valve. • The location of the Emergency Discharge Valve is not (yet) fixed but will be located on the Hermitage Stream upstream of the Riders Lane Stream confluence and Purbrook Way (CH 1800 – CH 2050, study section 4) subject to geomorphology modelling, flood modelling and aquatic/ecological assessment.	-	4	4	-

Item	Pipeline corridor construction Scheme component	Timing and duration	Pipeline corridor construction activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			It is expected that the Emergency Discharge Valve is housed in a concrete structure which has a footprint of 10x15 m. The exact construction method is unknown at this stage, but it has been assumed that this will only result in limited in-channel works around the location of the Valve itself. The smaller diameter also allows for a smaller construction footprint, notably for a section of pipeline running adjacent to the Hermitage Stream in study section 5.				

Table 15-36 - Potential reservoir and pipeline operational features and associated impacts

Item	Reservoir and pipeline operational scheme component	Timing and duration	Operational activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
AAA.	Reservoir (and visitor centre) access roads	Following completion (Q3 or Q4 2024)	For the purpose of the EIA, the main environmental impacts will be associated with the construction of these roads (which are considered in Table 15-34 above), with residual pollution, flood and groundwater risks as part of use of the roads when the site becomes operational. Operational surface water run-off risks will be mitigated through the use of Sustainable Drainage systems (SuDS) which make provision to retain hydrocarbons and other potential contaminants (through interceptors), before the water is transferred into the reservoir. There will be no discharge route into Park Lane Stream (for the southern access road or the main car park) or Headwater Streams 1-3 (for the northern access road).	1	-	1	1
BBB.	Visitor area and educational hide	See AAA.	A visitor area and educational hide will be constructed to the north west of the reservoir, providing a range of facilities and activities for a wide range of users and the local community. The visitor centre and educational hide are with the footprint of the CSS. It is assumed that the construction of the visitor area does not require any dewatering of the wetland area/reservoir; access is via the historic CSS land and that sewage from toilets and wash basins will go to foul rather than the reservoir. With regard to the water environment, the Visitor Centre will inform visitors about water resource management and the protection of wetland environments.	-	-	-	-
CCC.	Car park	See AAA.	For the purpose of the EIA, the main environmental impacts will be associated with the construction of the car park (which are considered in Table 15-34 above), with residual surface water run-off risks (flooding, pollution) as part of use of the car park and roads when the site becomes operational. It has been assumed that operational surface water run-off risks will be mitigated through the use of Sustainable Drainage systems (SuDS) which make provision to retain	2	-	2	2

Item	Reservoir and pipeline operational scheme component	Timing and duration	Operational activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			hydrocarbons and other potential contaminants (through interceptors), which will soak into the ground locally or are transferred into the reservoir. It has been assumed there will be no discharge route into Park Lane Stream (for the southern access road or the main car park) or Headwater Streams 1-3 (for the northern access road).				
DDD.	Wetland and wetland retaining structures	See AAA.	There will be 4 no. wetland areas around the north west of the reservoir, plus provision of an area for wet grassland habitat creation to the east of the retained wetland. Further detail is in Chapter 9 Biodiversity in ES Volume 2. The wetland will be fed by Headwater Streams 1, 2 and 3, but will also be in continuity with the reservoir water level under normal operation conditions (water levels at 39.0 – 39.5 mAOD). The wetland retaining structures will retain the wetland during lower (drought) levels in the main reservoir (i.e. 38.8 mAOD and below). They will be built during the very first earthworks season, initially to retain flows from Headwater Streams 1-3, allowing these to be diverted away from the reservoir construction area. The retained wetland area will be approx. 6.8 ha at 38.8 mAOD. The wetland area will be approx. 10.2 ha at TWL (39.5 mAOD). The creation of a wetland habitat is a key benefits which will attract a range of different wildlife and bird species to the site.	-	-	-	-
EEE.	Reservoir outlet channel	See AAA.	There will be a 250 m long reservoir outlet channel between the Control House location and Riders Lane Stream. This will be an open channel and designed to have meanders and carry the reservoir's compensation flow.	3	3	3	-
FFF.	Reservoir compensation flow	See AAA.	Exact details on the reservoir's compensation flow will be subject to agreement with the Environment Agency. Conceptually, this could be several different options:	3	3	3	-

Item	Reservoir and pipeline operational scheme component	Timing and duration	Operational activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			- Applying a continual flow, using median (Q50) gauged flow from the Hermitage Stream Gauging Station factored by area to the catchment upstream of the reservoir embankment using the CATCHMOD model - Continuation of the current intermittent nature of the catchment (mimic natural wetting and drying) - A hybrid regime based on 1 and 2.				
GGG.	Spillway / overflow pipe	Very rare: Annual Probability is 0.01% / 1 in 10,000 AP	The spillway/overflow pipe will also discharge into the top of Riders Lane Stream (study section 3). The spillway will be designed to pass Design Flood (DF, 0.01% / 1 in 10,000 AP) and Safety Check Flood (SCF, Probable Maximum Flood (PMF)) with minimum flood freeboard to prevent/limit overtopping due to waves.	-	-	3, 5, 6	-
HHH.	Reservoir quality management	Variable, most likely summer periods	There will be aeration equipment, controlled from the Control House, to prevent adverse effects to water quality as a result of thermal stratification. This could have downstream benefits for dissolved oxygen levels. Stratification can pose risks to drinking water safety (e.g. solubilisation of metals compromising treatment) as well as environmental water quality deterioration (e.g. increased algal blooms). Mixing will be undertaken using air released from a system of low-level perforated pipes within the reservoir.	2, 3	-	-	-
III.	Reservoir draw down as part of normal operations	Throughout the year, with four main scenarios	There are four main operational scenarios (see paragraph 15.215): - Normal year - Drought event (1 in 5 years) - Prolonged drought (1 in 10 years) - Extreme drought (1 in 200 years) A reduction in water level has the potential to affect reservoir water quality, which in turn affects water quality in the compensation flow entering Riders Lane Stream. The duration of effects is expected to be over summer and autumn with refill taking place over winter (October to March).	2, 3	-	-	-

Item	Reservoir and pipeline operational scheme component	Timing and duration	Operational activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
JJJ.	Emergency draw down	See AAA.	This type of draw down is highly unlikely, i.e. emergency only, the reservoir can be lowered by 0.85 m (5% of depth) in 24 hours and then 1/3 of its full water depth in 6 days using two outlets: - A 1.4 m diameter scour pipe and submerged discharge valve discharging into Riders Lane Stream via the reservoir outlet channel. Discharging 7.05 m³/s. - A 1200 mm diameter inlet/outlet pipe, which can discharge into the Hermitage Stream at the Emergency Discharge Valve. Discharging 3.85 m³/s The total discharge capacity of these outlet pipes is 10.9 m³/s.	-	-	3, 4, 5, 6	-
KKK.	Routine inspection and maintenance draw downs	Twice annually	Routine draw downs will be undertaken for inspection and maintenance purposes. Assumed to be 10% of the emergency draw down flow and twice a year. Flows in receiving waterbodies will be: - Riders Lane Stream (from reservoir dam) – 0.70m³/s - Hermitage Stream (from Emergency Discharge Valve located in study section 4) – 0.38m³/s	-	3, 5	3, 4, 5, 6	-
LLL.	Control House and Ancillary Structures	See AAA.	The Control House is required to house operating equipment for the control of potential emergency discharge of the reservoir, and the routine operation equipment required for day-to-day running of the reservoir, including: - Motor Control Centre (MCC) room - Electronic security room - Compressor room - Transformer area and metering room - Sampling instrumentation (to mitigate hydrocarbon and nitrate risks) - Mixing equipment Equipment in the Control House will be used to implement to undertake mixing of the reservoir to prevent stratification For the purpose of the EIA, the main environmental impacts will be associated with the construction of the Control House	3	-	-	-

Item	Reservoir and pipeline operational scheme component	Timing and duration	Operational activities	Potential impacts within study sections			
				Water quality	Hydro morph	Flood	Ground water
			(which are considered in Table 15-34 above), with the risk of local pollution (e.g. fuels, oils, chemicals) as part of use when the site becomes operational.				
MMM.	Public Realm	See AAA.	There are no features within the public realm that are considered likely to give rise to effects on the water environment during operation of the reservoir, other than the potential risk of vandalism and/or littering of the water environment.	-	-	-	-
NNN.	Filling of reservoir	2024 onwards	Filling of the reservoir would commence following the construction of the embankment, wetland and other features within reservoir footprint. Filling is planned to take three winter seasons (October to March) over five years to avoid adverse effects due to pore water pressure. From this point onwards, spring water will be diverted into the reservoirs.	6	-	-	-

Assessment of effects

- 15.216 The potential scheme impacts set out in Table 15-34, Table 15-35 and Table 15-36 above have been used to assess the effects of the reservoir, access roads and pipeline construction and operation on receptors described in the baseline section and summarised in Table 15-33.
- 15.217 The results of the assessment are provided in Table 15-37 to Table 15-44 below. For each receptor, the nature of effect is described using criteria set out in paragraph 15.33. Where an effect is identified, the magnitude and if this is adverse or beneficial has been established using the assessment criteria set out in Table 15-5. The overall significance of effect is established using the matrix in Table 15-6.

Table 15-37 - Assessment of effects (before mitigation) for study section 1 (Headwater Streams 1, 2 and 3 up to reservoir site footprint)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> No construction activities have been identified in study section 1 that would cause a change to water quality.	No Change	None
			<u>Operation</u> Assuming there are connections from the northern access road into study section 1, all operational activities are downstream of study section 1 and no changes to water quality are expected.	No Change	None
		Pollution	<u>Construction</u> Temporary direct impacts to study section 1 may result from the construction of Access roads around the northern edge of the reservoir in Q3 2021, including extension of access road culverts over HS2 and HS3, and the construction of coffer dams across HS1-HS3 (Q1 2022 – Q3 2024). Effects will be on the lowermost section of study section 1 only and up to reservoir construction completion (Q3 2024).	Low Adverse	Minor
			<u>Operation</u> Assuming there are connections from the northern access road into study section 1, all operational activities are downstream of this point, resulting in no operational pollution risks.	No Change	None
Hydro morphology	Medium	Habitat loss	<u>Construction</u> No habitat loss upstream of reservoir site footprint. The habitat will change slightly as the lower sections of the various watercourses will back up from the wetland at the top end of the reservoir. Siltation of these lower reaches is likely. These reaches are likely to become more still water habitats. The changes are likely to occur as construction starts and the wetland bunds are constructed in Q1 2022.	Low Adverse	Minor
			<u>Operation</u>	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			Following construction, there will be no further changes to or loss of habitat in this study section.		
		Habitat connectivity	<u>Construction</u> The construction of the reservoir will create a permanent discontinuity in the system as the embankment will create a barrier to any habitat connectivity. The changes are likely to occur as construction starts and the wetland is constructed. The loss of habitat connectivity could result in potential waterbody deterioration and, as such, has been considered in further detail in Appendix A15.1 WFD Assessment in ES Volume 4.	High Adverse	Moderate
			<u>Operation</u> Following construction, there will be no further changes to habitat connectivity in this study section.	No Change	None
		Changes to hydrology	<u>Construction</u> The upper and middle reaches of these systems will remain unaltered by the reservoir site footprint, but the lower sections will be influenced by backwaters caused by the reservoir construction. The changes are likely to occur as construction starts and the wetland is constructed.	Low Adverse	Minor
			<u>Operation</u> Following construction, there will be no further changes to hydrology in this study section.	No Change	None
		Changes to river geomorphology	<u>Construction</u> The construction of the reservoir will create a permanent discontinuity in the system and will trap any sediment that is coming from the headwater systems. Sediment is likely to drop out within the lower sections of the headwater streams or in the wetland itself. The changes are likely to occur as construction starts and the wetland is constructed. The changes to river geomorphology could result in potential waterbody deterioration and, as such, has been considered	High Adverse	Moderate

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			in further detail in Appendix A15.1 WFD Assessment in ES Volume 4.		
			<u>Operation</u> Following construction, there will be no further changes to geomorphology in this study section.	No Change	None
Flood risk	Low	Fluvial/tidal flood risk	<u>Construction</u> The construction of cofferdams at the downstream end of Headwater Streams 1-3 will have a temporary, direct impact on fluvial flood risk due to obstructing downstream flows as these will prevent water flowing on site during construction. The direct impact will increase water levels locally, upstream of the cofferdams, possibly by more than 100mm, however there are currently no properties/receptors at risk. It has been assumed that these flows and volumes will be conveyed downstream to the reservoir embankment as described in study section 2. The details will be confirmed during detailed design. However, for the purpose of the EIA it has been assumed the predicted increase in levels will not increase flow or flood risk to study section 1 or other downstream watercourses. The replacement of two culverts to accommodate the construction access road (across HS1 and HS2) are not expected to have any impacts on fluvial flood risk. The culverts will be sized appropriately for the anticipated flood flows and include a trash screen to allow vegetation clearance from the track.	No Change	None
			<u>Operation</u> The operation of the pipeline or reservoir will have no impact on fluvial flood risk in study section 1.	No Change	None
		Surface water flood risk	<u>Construction</u> In study section 1, surface water flow paths are the same as fluvial flow paths and so the predicted impact is the same. In addition, the construction of the access roads around the northern edge of the reservoir will introduce increased hard	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			standing that will increase surface water runoff rates and volumes. This will be attenuated by the site water management system.		
			<u>Operation</u> In study section 1, surface water flow paths are the same as fluvial flow paths and so the predicted impact is the same. The northern access road will increase surface water runoff rates and volumes. The predicted increase is expected to be less than 25% of the catchment surface water runoff. The operation of the pipeline will have no impact on surface water flood risk in study section 1.	Very Low Adverse	Negligible
Groundwater	Low	Changes to groundwater quantity	<u>Construction</u> Construction of cofferdams will remove water in the headwater streams which run across the Harwich Formation and Lambeth Group. This will have a temporary indirect adverse effect, reducing shallow groundwater locally due to the effects of dewatering pumping and groundwater-surface water interaction. However, the creation of a wetland bund will eventually increase shallow groundwater in the Harwich Formation and Lambeth Group (and create a wetland). The eastern part of the wetland bund is close to the edge of the mapped East Hants Lambeth Group groundwater body. There is no identified impact on the confined Chalk aquifer.	Low Adverse	Minor
			<u>Operation</u> The permanent wetland bund installation can be expected to cause a permanent change to shallow groundwater i.e. raising the levels and changing flow pathways. There is no identified impact on the confined Chalk aquifer.	Low Adverse	Minor
		Changes to groundwater quality	The access roads around the reservoir have the potential to directly adversely affect groundwater quality within the Harwich Formation and Lambeth Group (classed as Secondary A aquifers) through infiltration of contaminated run-off. The access roads also have the potential to indirectly	Moderate Adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			affect the Chalk (Principal aquifer) as the start of the access road from the north is within SPZ1 and in the vicinity of mapped surface karst features. This means that any potential spills could travel rapidly through the Chalk aquifer and impact outlet springs including the Havant and Bedhampton springs. The remainder of the access road from the north is mapped to run close to the mapped outcrop of the East Hants Chalk, as is the north western part of the road around the reservoir. In general, the access roads will pose an increased risk to groundwater contamination. Contaminated runoff and infiltration into the Chalk has the potential to cause deterioration to the groundwater body. Earthworks associated with the construction of the wetland bund and embankment has the potential to create contamination pathways and have a direct adverse effect on shallow groundwater quality within the Harwich Formation and Lambeth Group (Secondary A aquifers). Any contaminated runoff could potentially pollute the shallow groundwater. The risk of groundwater contamination from earthworks will cease on completion of construction activities.		
			<u>Operation</u> When the reservoir is established, increased traffic on access roads leading to the reservoir has the potential to directly adversely affect groundwater quality within the Harwich Formation and Lambeth Group and indirectly affect the Chalk if runoff is contaminated.	Low Adverse	Minor

Table 15-38 - Assessment of effects (before mitigation) for study section 2 (Headwater Streams 1, 2, 3, 4, 5, Upper Lake and short section of Riders Lane Stream all under reservoir site footprint)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> Placement of cofferdams at the bottom of Headwater Streams 1-3 in Q1 2022, will result in flow diversion to study section 3 (Riders Lane Stream). There will be no flow diversion to Park Lane Stream (study section 8). The coffer dams will be removed once the wetland retention bund is constructed in Q3 2022 and the wetland bund will be used to retain flows from Headwater Streams from this time onward. Another set of coffer dams will be placed at the very bottom of the reservoir site footprint on Headwater Streams 1, 2 and 5. Water collected behind these coffer dams will be stored in tanks prior to overpumping into Riders Lane Stream. Following construction of cofferdams in Q1 2022, there will no longer be any flowing or standing surface water features within study section 2. As such, water quality, for surface water features, is not considered further within this study section. Downstream effects are considered within study section 3 (Table 15-39).	No Change	None
			<u>Operation</u> Permanent and direct changes in water quality would result from mixing of Headwater streams 1-3 and groundwater piped from Bedhampton and Havant Springs in the new reservoir. Expected water quality from modelling and data analysis results suggest that there would be: Higher nitrate concentrations within the reservoir compared with baseline stream data.	Moderate Adverse (permanent) Temporary, Major Adverse during periods of extended drawdown in drought periods	Minor (permanent) Moderate (drought)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			• a potential reduction in ammonia concentrations within the reservoir compared against baseline stream data, but this is dependent on in-reservoir processes. • Variable reservoir reactive phosphorus concentrations based on local conditions due to variable groundwater inputs and potential wildfowl, amenity (angling) and sediment inputs compared against baseline stream data. • Potential for reduction in turbidity/ suspended solids compared to current surface water conditions. • Reduction in metal concentrations as groundwater quality is relatively good. • Potential for increases in hydrocarbon concentrations from fly tipping, accidental spills and amenity use. • Seasonally variable changes in surface water total organic carbon resulting from in-reservoir processes, with the potential to increase in late summer/ autumn. • No changes expected in micropollutant concentrations (e.g. priority hazardous substances and endocrine disruptors) although there is a risk of pesticides which have historically been used in the upstream catchment. This is, overall, judged to be a permanent, moderate adverse change in water quality in the reservoir itself compared to the current watercourse baseline, although there will be an improvement in BOD and dissolved oxygen as a result of aeration. The water quality model shows that as a result of extended draw down during periods of droughts, concentrations of nutrients and algal risk could increase substantially. This would occur for the duration of the draw down period and afterwards when the reservoir is refilled (which would be a matter of several months in case of a 1 in 5 years drought and over winter i.e. up to six months in case of a 1 in 10 years drought). During these refill periods there will be a temporary, up to major adverse change in water quality within the reservoir itself. In the context of WFD, the reservoir will, in future, become an artificial (lake) waterbody rather than a river waterbody.		

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			According to the modelling, the greatest source of phosphorus (a WFD parameter) is likely to be wildfowl and waders with the reservoir expected to be oligo- to mesotrophic which presents a moderate risk to algae. Aeration will control algal blooms, which will influence phytoplankton conditions (another WFD parameter).		
		Pollution	<u>Construction</u> Prior to the construction of cofferdams (Q1 2022) at Headwater Streams 1-3, temporary direct pollution risks to surface water features within study section 2 could result from the following activities: • Initial development of CSS (Q3, 2021) • Construction of access roads and initial route to southern section of The Avenue (Haul Route) (Q3 2021) • Tree felling at southern end of The Avenue (Q3 Q4 2021) • Construction of initial haul route around site, including topsoil stripping and storage within reservoir footprint (Q1 2022) • Construction of coffer dams (following which site water management is initiated) (Q1 2022). Pollution risks will include sediments, hydrocarbons, metals and nutrients and although the magnitude of impact can be high, they are easily mitigated through successful implementation of a CEMP (Construction Environmental Management Plan developed by the appointed contractor). Following construction of bunding/ cofferdams, there will no longer be any flowing or standing surface water features within study section 2 and the pollution risk transfers to study section 3 (see Table 15-39).	High Adverse	Moderate
			<u>Operation</u> Following construction, the new access roads and car parks will result in increased surface water runoff within the study section, which will be managed through SuDS and pollution prevention measures (e.g. interceptors).	Low Adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			There is a risk of dumping of rubbish/litter/fuels into the reservoir when it is operational. Culvert presence may result in localised leaching of alkaline substances from concrete pipes.		
Hydro morphology	Medium	Habitat loss	<u>Construction</u> The construction of the reservoir will result in a permanent, direct, loss of 3.7km of watercourses to the footprint of the new reservoir. This includes sections of Headwater Streams 1-3 (all Ordinary Watercourses); the entirety of Headwater Stream 4 and 5 (Ordinary Watercourse) and approximately 200m of the Riders Lane Stream (also Ordinary Watercourse at this location). The extent of this impact marks a loss of 18.5% of the whole length of the water bodies within the Hermitage Stream catchment, 44% of Riders Lane Stream and 42% of all headwater streams within the catchment. The type of habitats lost are 'headwaters' (as described by Furse, 1995). An ecological survey undertaken in March 2020 found that some of the Headwater Streams, notably Headwater Streams 1 and 2, supported a range of specialist taxa indicative of groundwater supply and ephemeral flow conditions, including some Near Threatened, nationally notable and scarce species (see species list in Volume 4, Appendix A9.3 Aquatic Ecology in ES Volume 4). A small pond (Upper Lake) will also be lost. The loss of headwater habitat could result in potential waterbody deterioration and, as such, has been considered in further detail in Appendix A15.1 WFD Assessment in ES Volume 4.	High Adverse	Moderate
			<u>Operation</u> Following construction, there will be 4 no. wetland areas (approx. 6.8 ha at a 38.8 mAOD water level) which will provide a new type of habitat for wildlife along with the reservoir itself. In the context of WFD, the reservoir will, in future, become an artificial (lake) waterbody rather than a contributing river	Moderate Beneficial	Minor Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			water body. As a result, this will need to be classified by the Environment Agency.		
		Habitat connectivity	<u>Construction</u> The construction of the reservoir will result in a permanent, direct, reduction in habitat connectivity as a result of the embankment and creation of the reservoir. There will be a direct loss of 3.7km of watercourses.	High Adverse	Moderate
			<u>Operation</u> Following construction, there will be no further changes to habitat connectivity in this study section.	No Change	None
		Changes to hydrology	<u>Construction</u> The construction of the reservoir will result in a permanent, direct, change in hydrology in this study section as the watercourses will go from open flowing watercourses (albeit ephemeral) to a reservoir which holds standing water.	High Adverse	Moderate
			<u>Operation</u> Following construction, there will be no further changes to hydrology in this study section.	No Change	None
		Changes to river geomorphology	<u>Construction</u> The construction of the reservoir will result in a permanent discontinuity in the system, with the waterbody trapping any sediment that comes from the headwater systems. This will also affect downstream communities.	High Adverse	Moderate
			<u>Operation</u> Following construction, there will be no further changes to geomorphology in this study section.	No Change	None
Flood risk	Medium	Fluvial/tidal flood risk	<u>Construction</u> During construction, the northern headwater streams (HS1-3) will be allowed to flow into the wetland area, once the retaining wall has been constructed. This will have a temporary, direct impact of removing the risk of fluvial flooding upstream of the reservoir embankment. There are no sensitive fluvial flood risk receptors within the wetland area or	Minor	Negligible

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			study section 2. The flow within the wetland will be managed by a series of culverts from and between each 'compartment'. These will have valve/sluiice controls. The mechanism of attenuating and transporting the stored flows into the Riders Lane Stream will be further investigated at detailed design. However, for the purpose of the EIA it has been assumed this will not increase flow or flood risk to areas adjacent to the reservoir or downstream watercourses. HS4-5 and the River Lavant headwaters (study section 7) will be diverted during the construction of the embankment to the spillway location where they will drain into the Riders Lane Stream via a culvert. This culvert has been sized to accommodate all of the headwaters within study section 2, including the Lavant headwaters. The capacity of the temporary diversion pipes in the embankment culvert will be sized to accommodate the peak flow of the 1 in 30 (3.33%) AP flood (4.6m³/s). Downstream of the embankment the existing flow regime should therefore be maintained for the duration of construction up to and including a 1 in 30 (3.33%) AP. Flood flows in excess of this will be attenuated within study section 2 and will not be passed downstream. There are no sensitive fluvial flood risk receptors in this location, meaning that the overall significance of the impact is negligible.		
			<u>Operational</u> Upstream of the embankment the presence of the reservoir will result in a permanent, direct, change to fluvial flood paths in this study section. The open, narrow watercourses will be replaced by a wide expanse of stored water. There are no sensitive fluvial flood risk receptors in this location, meaning that the overall significance of the impact is negligible.	Minor	Negligible
			<u>Construction</u>	Moderate Adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
		Surface water flood risk	In study section 2, surface water flow paths are the same as fluvial flow paths and so the predicted impact is the same. The construction of the access road, visitors centre, educational hides and car park will have a permanent direct impact to surface water flood risk by increasing runoff rates and volumes due to increased areas of hardstanding. These facilities are on the boundary between study sections 2 and 8. It is assumed that increase in surface water flows will discharge into study section 2. The temporary and permanent drainage design for these facilities is currently being developed. For the purpose of this EIA however, it has been assumed that without mitigation, they will result in a greater than 50% increase in surface water flows.		
			<u>Operation</u> In study section 2, surface water flow paths are the same as fluvial flow paths and so the predicted impact is the same. There is no further effect in the operational phase.	No Change	No Change
Groundwater	Low	Changes to groundwater quantity	<u>Construction</u> Construction of cofferdams will remove water in the headwater streams which run across the Harwich Formation and Lambeth Group. This will have an indirect effect, reducing shallow groundwater due to removal of groundwater-surface water interaction. However, excavation of the borrow pits will directly reduce shallow groundwater in the Harwich Formation and Lambeth Group as any shallow groundwater will be removed by dewatering and these geological deposits will be removed. After excavation of the borrow pits, the base will be lined with a clay seal making these changes permanent. Laying the clay blanket/cut-off in the south-west corner of the embankment will directly reduce shallow groundwater within the Bognor Sands as the intention is to dewater this section of the Bognor Sands during construction and lay a clay	Moderate Adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			blanket over the top so that there is no potential for leakage into this deposit after the reservoir is filled. There is no identified impact on the confined Chalk aquifer.		
			<u>Operation</u> There is no further effect in the operational phase.	No Change	No Change
		Changes to groundwater quality	<u>Construction</u> The access roads around the reservoir and the haulage roads have the potential to directly adversely affect groundwater quality within the Bognor Sands, Harwich Formation and Lambeth Group (all classed as Secondary A aquifers). They also have the potential to indirectly affect the Chalk (Principal aquifer). The development of the CSS has the potential to indirectly adversely affect groundwater quality in the Harwich Formation, Lambeth Group and Chalk through contaminated runoff. The earthworks (excavation of borrow pits, laying of clay blanket/cut off, embankment) have the potential to create contamination pathways and have a direct adverse effect on shallow groundwater quality within the Bognor Sands, Harwich Formation and Lambeth Group (all classed as Secondary A aquifers). There is also the potential for an indirect adverse impact on the confined Chalk. This is due to the presence of a small isolated outcrop of Lambeth Group which is shown on the geological mapping. The hydraulic continuity between Lambeth Group and the Chalk is unclear at this location. On completion of the earthworks, the base of the borrow pits will be lined with a clay seal, the Bognor Sands will be covered with a clay blanket and there will be a clay embankment, therefore ending the risk of groundwater contamination.	Moderate Adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> During reservoir operation, there are no anticipated changes to groundwater quality. The reservoir will be clay lined and therefore there will be no interaction with the surrounding geological deposits.	No Change	None

Table 15-39 - Assessment of effects (before mitigation) for study section 3 (Riders Lane Stream between Reservoir footprint down to Hermitage Stream confluence; and The Lake Stream joining Riders Lane Stream from Leigh Lake.)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> During reservoir construction, water in the top of study section 3 will be from the following sources: • Water captured from study section 1 (upper sections of Headwater Streams 1-3) through coffer dams / wetland retention bunds placed at the northern side of the reservoir site footprint. • Surface water captured from the very bottom of Headwater Streams 1-5 which can include surface water run-off that falls on hard standing as well as areas of ground where topsoil is removed. • Groundwater generated as a result of dewatering of borrow pits. • Reservoir dam toe drains. Total volumes can be large, which means that if the water quality characteristics are different from those currently in Riders Lane Stream there could be an effect. There were no groundwater quality data available for this section, but surface water quality in study section 1 was broadly comparable to that in study section 3, with the exception of very high ammoniacal nitrogen levels observed at HT2 (1.6 mg/l) compared to all other monitoring points within study section 3 (all <0.77 mg/l). In the absence of treatment, this may present a water quality risk to study section 3. As the pipeline work will pass any water downstream through over pumping, there are no anticipated changes to water quality as a result of pipeline construction work in this study section.	High Adverse	Moderate
			<u>Operation</u>	Low Benefit (permanent)	Minor Benefit (permanent)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			A permanent direct benefit to study section 3 is expected from operation of the reservoir. Water quality modelling undertaken by Atkins has shown that there is no risk of a deterioration in Water Framework Directive Status within the waterbody, with mass balance reductions in WFD physico-chemical modelled for parameters including reactive phosphorus (-85%), ammonium (-49%) and BOD (-15%) at the very top of study section 3 (HT4). The reservoir will provide a buffering effect, helping to smooth out peaks in iron and manganese which currently arise from the three small streams and helping to reduce magnesium concentrations. Changes in temperature downstream of the reservoir were also assessed; findings indicated that the mixing of the compensation water with the Riders Lane stream is extremely unlikely to result in a change of temperature immediately below the confluence of the streams greater than 3°C; the WFD threshold. Changes further downstream will be less because of increased dilution. The model predicts increases in some non-WFD determinants including alkalinity (429%), calcium (473%) and a decrease in aluminium (65%). Downstream nitrate concentrations within the streams will initially increase, reflecting the greater concentrations of nitrate in the Bedhampton and Havant Springs compared to the surface waters, but again these changes will diminish downstream and only be small in the Hermitage Stream. Some nitrate is lost in the reservoir after spring water has been transferred as a result of natural denitrification processes and transfer to supply meaning the overall nitrate load will decline (see study section 6). Overall, water discharged from the reservoir into the Riders Lane Stream will be of a more consistent quality. Water quality changes predicted are likely to result in an improvement in primary and secondary productivity (which is considered positive), with no negative effects on ecological functioning of the watercourse or WFD status anticipated.	Moderate Adverse during drought (temporary)	Minor Impact during drought (temporary)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			As part of the Scheme operations, there will be maintenance discharges from the spillway into Riders Lane Stream and there may also be emergency discharges (noting these are unlikely). These will be short lived and unlikely to change water quality. During extended draw down during periods of droughts, concentrations of nutrients and algal risk could increase substantially. This would occur over the draw down period and afterwards whilst the reservoir is refilled (which would be a matter of several months in case of a 1 in 5 years drought and over the course of a winter i.e. October-March up to six months in case of a 1 in 10 years drought). During the period of refill, there could be water quality effects in the Riders Lane Stream. Any water quality impacts downstream will be helped by the compensation flow coming from the upper level intake (approx. 4m below the TWL) when the water level is above that. Water quality effects will be temporary, resulting in an up to moderate adverse change in water quality.		
		Pollution	<u>Construction</u> As described above, water generated as a result of reservoir construction work is pumped into the top of Riders Lane Stream and, if untreated, will present a substantial pollution risk to study section 3. With regard to the pipeline construction, there is potential for short term direct pollution impacts as a result of dewatering activities associated with the upgrade of three culverts; and two pipeline corridor watercourse crossings (one on The Lake Stream, one on the Riders Lane Stream) using open cut crossing techniques. All river works are planned during the period March-September in either 2021, 2022, or 2023. There is also a potential for short term, direct surface water contamination from bankside (groundwater) dewatering requirements. Pipeline pollution risks are likely to include sediments, hydrocarbons, metals and nutrients (notably ammonia from the reservoir construction work).	High Adverse	Moderate

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> There will be an on-going pollution potential as a result of the storage and use of chemicals used at Control House. Dam culvert presence may result in localised leaching of alkaline substances from concrete pipes.	Low Adverse	Minor
Hydro morphology	High	Habitat loss	<u>Construction</u> There will be a short section of Riders Lane Stream which will be permanently lost downstream of the reservoir site footprint (approximately 100 m) to the point at which the compensation flow enters the channel at the confluence of the compensation channel. This will occur once the construction works start and the streams are diverted. At the same time, a new 250 m channel will be created between the reservoir outlet and the Riders Lane Stream, but this will be a significantly different habitat as it will be a much steeper channel compared to the existing. There will be temporary reduction in habitat during the construction of the pipeline corridor crossings on The Lake Stream and also Riders Lane Stream totaling a length of 40 m (2x20 m).	Low Adverse	Minor
			<u>Operation</u> Following construction, there will be no further changes to habitat loss in this study section.	No Change	None
		Habitat connectivity	<u>Construction</u> There will be temporary reduction in habitat connectivity during the construction of the pipeline corridor crossings on The Lake Stream and also Riders Lane Stream totaling a length of 40 m.	Low Adverse	Minor
			<u>Operation</u> Following construction, there will be no further changes to habitat connectivity in this study section. Adjustments to the culvert upgrade designs will provide an opportunity to provide habitat connectivity benefits.	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
		Changes to hydrology	<u>Construction</u> Without mitigation there could be changes in the downstream hydrology as a result of the dewatering and/or run-off from the reservoir site during construction. Negligible effects on hydrology are expected during pipeline corridor works provided flow is continued through a flume or overpumping.	Negligible	Negligible
			<u>Operation</u> Following construction of the reservoir, there will be a compensation flow maintained. Three options being explored for the compensation flow downstream of the reservoir site (see item FFF, Table 15-36). In addition, there will be operational discharges twice every year, which would be up to 0.7 m ³ /s for Riders Lane Stream. This is a flow which occurs approximately once a year at the moment whilst bank full flows are modelled to be 3 m ³ /s. At the very least there will be no change in the hydrology downstream of the reservoir and if more flow is added there could be a considerable benefit, especially as the gauging records indicate that the Riders Lane Stream and Hermitage Stream have periodically dried up in the past.	No Change or up to Moderate Beneficial for compensation flow Low Adverse for operational flows	None or up to Moderate Benefit for compensation flow Minor impact for operational flows
		Changes to river geomorphology	<u>Construction</u> The construction of the reservoir will lead to a direct permanent change to the river geomorphology of the Riders Lane Stream since no sediment from the headwaters will be able to enter this reach due to the reservoir. This will happen as soon as flow is diverted around the site in the construction phase. Without mitigation there may also be an increase in fine sediment entering the Riders Lane Stream downstream due to run-off originating from the reservoir site and Pipeline Corridor. The impact on geomorphology could result in potential waterbody deterioration and, as such, has been considered in further detail in Appendix A15.1 WFD Assessment in ES Volume 4.	High Adverse	Major

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> Following construction, there will be no further changes to habitat connectivity in this study section.	No Change	None
Flood risk	Medium	Fluvial/tidal flood risk	<u>Construction</u> During construction, study section 3 is likely to see a temporary reduction in flood risk for flood flows in excess of a 1 in 30 (3.33%) AP, due to flood attenuation in study section 2, and controlled flow through site water management. The pipeline corridor crosses the watercourses in study section 3 in two locations. • Riders Lane Stream– CH 2510 to 2530 • The Lake Stream– CH 4000 to 4050. The approach for construction is currently open trench, which will entail the temporary damming of the watercourses. The construction design has assumed installation of a flume to ensure the downstream conveyance of flood flows up to and including the 1 in 100 (1%) AP. No change in flood risk is therefore expected. Material from the trenches will not be stored on site (i.e. within the pipeline corridor red line boundary) and therefore there are no predicted impacts on flood flow paths. The pipeline corridor red line boundary crosses into both Flood Zone 2 and 3 within study section 3. The following are within Flood Zone 3 and therefore have a high probability of flooding. • Potential area for construction compound north of Middle Park Way • Area for construction use between Ellisfield Road and Riders Lane • All three culvert improvement work areas. The area of the construction compounds and their likely content are small in comparison to the wider floodplain and their duration of use is temporary. The potential management of flood risk for these compounds will be identified in the	Very Low Adverse	Negligible

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			Flood Risk Assessment and any impacts addressed in a Flood Risk Activity Permit. For the purpose of EIA, the impact is therefore considered to be very low adverse. The three culvert improvements are required within study section 3 to facilitate the safe drawdown of the reservoir. As with the construction compounds, the potential management of flood risk will be identified in the Flood Risk Assessment and any impacts addressed in a Flood Risk Activity Permit. For the purpose of the EIA, it is assumed there will be no impact.		
			<u>Operation</u> During operation of the reservoir, there will be a permanent, direct impact on fluvial flood risk. The reservoir will result in a reduction in peak flow, peak level and floodplain extent, for all AP including under climate change scenarios. During a 3.33% AP, there would be a reduction in peak flow of 2.93m³/s and a reduction in peak level of 0.6m at the upstream end of Riders Lane Stream, and 2.81 m³/s and 0.15 m at the downstream end (towards the Hermitage Stream confluence). Across the study section the floodplain extent would reduce by 0.02 km², which is an 85% reduction. During a 1% AP flood, there would be a reduction in peak flow of 3.64 m³/s and a reduction in peak level of 0.64 m at the upstream end, and 3.37 m³/s and 0.15 m at the downstream end. Across the study section the floodplain extent would reduce by 0.03 km², which is an 87% reduction. There is no predicted change in flood risk to The Lake stream. There are no operational impacts of the pipeline on fluvial flood risk in study section 3 as its operation is all below ground. However, it is expected that the routine drawdown system will be tested on commissioning up to the capacity of the watercourse. For routine testing, it is expected that there will be a small opening of the valves to allow 10% of the Emergency Discharge flow. This is expected to occur twice per year as per Environment Agency guidance. For study	High Beneficial	Moderate Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			section 3 this equates to a flow of about 0.7m ³ /s, which is far less than the reduction in peak flow as a result of the reservoir construction. Therefore, will not have any impact on flood risk.		
		Surface water flood risk	<u>Construction</u> There is no predicted change in surface water flood risk during construction of the reservoir as there are no works in study section 3. There would however be a temporary, indirect impact to the discharge of surface water flows from the urban drainage network into the Riders Lane stream. Due to the storage of flows upstream of the embankment, this will result in a reduction in both peak level and flow within the watercourse, providing more capacity for the surface water network to discharge into the channel and therefore a low benefit. Construction of the pipeline within study section 3, may have a temporary direct impact on increasing surface water flood risk, by localised increases in hard standing.	Very Low Adverse	Negligible
			<u>Operation</u> There is no predicted change in surface water flood risk during operation of the reservoir as there are no elements of the Scheme in study section 3. There is however a permanent, indirect impact to the discharge of surface water flows from the urban drainage network into the Riders Lane stream. Due to the storage of high flows within the reservoir, this will result in a reduction in both peak level and flow within the watercourse, providing more capacity for the surface water network to discharge into the channel. The surface water flows from the embankment would drain into a toe ditch at the bottom. A high-level assessment has assumed around half of this will be routed into the Riders Lane Stream. This increase in flow will be offset by storage in the reservoir and will be confirmed at detailed design.	Low Beneficial	Minor Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			There are no operational impacts of the pipeline on surface water flood risk in study section 3. There are no operational impacts of the pipeline on surface water flood risk in study section 3.		
Groundwater	High	Changes to groundwater quantity	<u>Construction</u> Excavation of the borrow pits will directly reduce shallow groundwater in the Harwich Formation and Lambeth Group, as any shallow groundwater will be removed by dewatering and these geological deposits will be removed. After excavation of the borrow pits, the base will be lined with a clay seal making these changes permanent. The construction of the wetland bund has the potential to indirectly impact shallow groundwater in the Harwich Formation and the Lambeth Group by providing a barrier to flow and altering flow pathways. On completion of the works, there will be a permanent barrier to groundwater flow. There is no identified impact on the confined Chalk aquifer. From a WFD perspective, it should be noted that the Harwich Formation is not included as part of any WFD groundwater body designation. The Lambeth Group largely underlies the Harwich Formation (except for a few isolated patches which are exposed) and is not included as part of either of the mapped WFD groundwater bodies in the study area. Although the eastern end of the wetland bund is located close to the edge of the mapped WFD East Hants Lambeth Group groundwater body, the topography and drainage is such that water levels in this groundwater body should not be affected.	Moderate Adverse	Moderate
			<u>Operation</u> Post-construction, the presence of the reservoir (with clay seal, permanent wetland bund and embankment and clay seal) will result in no shallow groundwater in the secondary A aquifers underlying this part of the reservoir footprint (Harwich Formation, Lambeth Group). This is a permanent change to part of the mapped outcrop of these deposits. There will be a permanent barrier to any shallow groundwater	Low Adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			flow. This may locally increase groundwater levels and alter shallow groundwater flow in the Harwich Formation and Lambeth Group. There is no identified impact on the confined Chalk aquifer. As noted above, although this affects the Secondary A aquifers, these are not part of the mapped WFD groundwater bodies in the study area.		
		Changes to groundwater quality	<u>Construction</u> The access roads around the reservoir and the haulage roads have the potential to directly adversely affect groundwater quality within Harwich Formation and Lambeth Group (classed as Secondary A aquifers) through infiltration of contaminated runoff. The earthworks (excavation of borrow pits, embankment) have the potential to create contamination pathways and have a direct adverse effect on shallow groundwater quality within the Harwich Formation and Lambeth Group (Secondary A aquifers). On completion of the earthworks, the base of the borrow pits will be lined with a clay seal and there will be a clay embankment, therefore ending the risk of groundwater contamination.	Moderate Adverse	Moderate
			<u>Operation</u> During reservoir operation, there are no anticipated changes to groundwater quality. The reservoir will be clay lined and therefore there will be no interaction with the surrounding geological deposits.	No Change	None

Table 15-40 - Assessment of effects (before mitigation) for study section 4 (Hermitage Stream – between A3(M) and confluence with Riders Lane Stream)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> Pipeline corridor construction discharges in this study section are unlikely to be sufficiently large to result in a change in water quality.	No Change	None
			<u>Operation</u> Other than the Emergency Discharge Valve, there will be no operational discharges in this study section. Due to short duration of operational testing of the Emergency Discharge Valve, there are no anticipated changes to water quality.	No Change	None
		Pollution	<u>Construction</u> With regard to the pipeline construction, there is potential for short term direct impacts as a result of dewatering activities associated with the pipeline corridor watercourse crossing to be installed using open cut technique. There is also the potential for short term direct impacts as a result of work on the Emergency Discharge Valve. All river works are planned during the period March-September in either 2021, 2022, or 2023. There is also a potential for short term, direct surface water contamination from bankside (groundwater) dewatering requirements. Pollution risks are likely to include sediments, hydrocarbons, metals and nutrients.	High Adverse	Moderate
			<u>Operation</u> Other than the Emergency Discharge Valve, there will be no operational discharges in this study section and, therefore, no pollution risks are anticipated.	No Change	None
Hydro morphology	Medium	Habitat loss	<u>Construction</u> Construction of the Emergency Discharge Valve in this study section will result in the permanent presence of a 15 x 10 m	Low adverse	Minor

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			concrete housing which will house the valve. This will result in local habitats lost during construction as well as a permanent loss of riparian and in-channel habitat associated with the Emergency Discharge Valve housing. This is in context of a reach which has been naturalised (restored) over time, but still has a concrete riverbed. There will be a small amount of habitat loss (around 20 m) during construction as a consequence of the pipeline corridor watercourse crossing.		
			<u>Operation</u> There will be limited change to this study section as it is above the confluence of Riders Lane Stream which is impacted by the reservoir construction. Any disturbance to the channel from the pipeline corridor crossing will be local and temporary. There are no changes to habitat loss following construction of the Emergency Discharge Valve housing. There is also the potential to improve the channel form on re-instatement leading to a localised, permanent, improvement.	No Change	None
		Habitat connectivity	<u>Construction</u> There would be temporary loss of habitat connectivity in this study section during pipeline corridor crossing construction work. This is in context of a concrete riverbed in this study section.	Very Low	Negligible
			<u>Operation</u> Following construction, there will be no further changes to habitat connectivity in this study section.	No Change	None
		Changes to hydrology	<u>Construction</u> Assuming there will be no dewatering into the Park Lane Stream catchment, there is a temporary change to hydrology in this study section during pipeline corridor crossing construction work.	Very Low	Negligible

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> There will be operational discharges from the Emergency Discharge Valve. These will occur for a short duration, twice a year for flow rates up to 0.38 m ³ /s which will affect in-stream hydrology.	Low adverse	Minor
		Changes to river geomorphology	<u>Construction</u> There will be no anticipated change to this study section as it is above the confluence of Riders Lane Stream. Provision has been made to take the Emergency Discharge Valve in this reach (approx. 15x10 m diameter) but as the base is concrete there will be very little difference.	Low adverse	Minor
			<u>Operation</u> Provision has been made to take the Emergency Discharge Valve in this reach but as the base is already composed of concrete this is unlikely to change geomorphology.	No Change	None
Flood risk	Low	Fluvial/tidal flood risk	<u>Construction</u> The construction of the reservoir and embankment is not predicted to have any impact on fluvial flood risk in study section 4 as it is upstream of the confluence with the Riders Lane Stream. The construction of the pipeline will include one watercourse crossing, namely Hermitage Stream between approx. CH 1150 – CH 1600. The approach for construction is currently open trench, which will entail the temporary damming of the watercourses. The construction design has assumed installation of a flume to ensure the downstream conveyance of flood flows up to and including the 1 in 100 (1%) AP. No change in flood risk is therefore expected. Material from the trenches will not be stored on site and therefore there are no predicted impacts on flood flow paths. The pipeline corridor red line boundary crosses into both Flood Zone 2 and 3 within study section 4. However, there	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			are no planned construction compounds within this study section.		
			<u>Operation</u> The operation of the reservoir and embankment is not predicted to have any impact on fluvial flood risk in study section 4 as it is upstream of the confluence with the Riders Lane Stream. The operation of the pipeline is not predicted to have any impact on fluvial flood risk in study section 4 as it is located below ground (and thus does not affect the flood plain area). However, it is expected that the routine drawdown system will be tested on commissioning up to the capacity of the watercourse. For routine testing, it is expected that there will be a small opening of the valves to allow 10% of the Emergency Discharge flow. For study section 4 this equates to a flow of about 0.4m ³ /s which is equivalent 5% of a 1 in 2 (50%) AP. This is expected to occur twice per year as per Environment Agency guidance. No impact is anticipated as a result of the size of this flow in context for river flows in the Hermitage Stream.	No Change	None
		Surface water flood risk	<u>Construction</u> The construction of the reservoir and embankment is not predicted to have any impact on surface water flood risk in study section 4 as it is upstream of the confluence with the Riders Lane Stream. Construction of the pipeline within study section 4, may have a temporary direct impact on increasing surface water flood risk, by localised increases in areas of hard standing. There are no planned construction compounds for the pipeline within study section 4.	Very Low Adverse	Negligible
			<u>Operation</u> The operation of the reservoir and embankment is not predicted to have any impact on surface water flood risk in	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			study section 4 as it is upstream of the confluence with the Riders Lane Stream. The operation of the pipeline is not predicted to have any impact on surface water flood risk in study section 4 as its operation is all below ground.		
Groundwater	Low	Changes to groundwater quantity	<u>Construction</u> No anticipated changes to groundwater quantity in this study section as the pipeline route is across clay deposits of the London Clay Formation (non-aquifer).	No Change	None
			<u>Operation</u> No anticipated changes to groundwater quantity in this study section as the pipeline route is across clay deposits of the London Clay Formation (non-aquifer).	No Change	None
		Changes to groundwater quality	<u>Construction</u> No anticipated changes to groundwater quality in this section as the pipeline corridor is across clay deposits of the London Clay Formation (non-aquifer).	No Change	None
			<u>Operation</u> No anticipated changes to groundwater quality in this section as the pipeline corridor is across clay deposits of the London Clay Formation (non-aquifer).	No Change	None

Table 15-41 - Assessment of effects (before mitigation) for study section 5 (Hermitage Stream – between confluence with Riders Lane Stream and NTL)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> As explained in Table 15-39, during reservoir construction, flow in study section 3 will be that originating from the reservoir construction site. Volumes can be large, which may result in a change in water quality in Section 5 as well as Section 3. However, the magnitude of change is considered to be low as a result of dilution by the Hermitage Stream.	Low Adverse	Minor
			<u>Operation</u> Results from water quality modelling are similar to study section 3, albeit somewhat reduced due to dilution. Results indicate a general improvement in water quality in study section 5 following operation of the reservoir, when compared to pre-reservoir conditions. It is noted that study section 5 contains the Environment Agency's routine water quality monitoring point in the catchment at New Road, which is used for WFD classification purposes. At the New Road (HT22) sample location, the model predicts the following mass balance changes in WFD parameters: reactive phosphorus (-2%), ammonia (-6%) BOD (-1%), and iron (-20%). The changes in phosphorus are considered to aid WFD status improvements, but wider catchment measures are required to achieve WFD 'good' status for reactive phosphorus. With regard to non-WFD parameters, the model predicts the following mass balance changes in non-WFD parameters: Alkalinity (8%), nitrates (5%), chloride (-2%), Calcium (8%), magnesium (-1%), manganese (-32%), aluminum (-13%) and turbidity (-17%). As with study section 3, works in this section are likely to result in an improvement in primary and secondary productivity (which is considered positive), with no negative	Low Benefit	Minor Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			effects on ecological functioning of watercourse or WFD status anticipated. As with study section 3, any changes to water quality as a result of emergency or maintenance discharges from the dam's spillway and the Emergency Discharge Valve located in this study section are likely to be short-lived.		
		Pollution	<u>Construction</u> There are no in-river works in this section, but there is potential for short term, direct surface water contamination from bankside (groundwater) dewatering, especially where this is very close to the river. Pollution risks associated with the pipeline corridor are likely to include sediments, hydrocarbons, metals and nutrients (notably ammonia from the reservoir construction work).	High Adverse	Moderate
			<u>Operation</u> Other than the upstream Emergency Discharge Valve, there will be no operational discharges in this study section and, therefore, there are no anticipated pollution risks.	No Change	None
Hydro morphology	High	Habitat loss	<u>Construction</u> It has been assumed that there are no in-river works in this study section and therefore there would be potential for any habitat loss, connectivity or geomorphology impacts.	No Change	None
			<u>Operation</u> There are not considered to be any impacts along this study section.	No Change	None
		Habitat connectivity	<u>Construction</u> There will be no in-river works in this study section and, therefore, no impacts on habitat connectivity.	No Change	None
			<u>Operation</u> There are not considered to be any operational impacts along this study section.	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
		Changes to hydrology	<u>Construction</u> There is no change to the hydrology in this study area as a consequence of the Scheme.	No Change	None
			<u>Operation</u> Three options being explored for the compensation flow downstream of the reservoir (see item FFF, Table 15-36). By the time water gets into this section of Hermitage Stream any effects on hydrology will be greatly reduced due to existing flows in the Hermitage Stream catchment. There will be a potential influence from the Emergency Discharge Valve discharges in this section, which will be up to 1.17 m ³ /s. The overall effect would be reduced due to larger existing flows in this section and may even be beneficial (i.e. as a flow building block) if timed correctly. At the very least there will be no change in the hydrology in this section of channel and if more flow is added there could be a small benefit, especially in context of the Hermitage Stream drying up historically.	Very Low Adverse or Low Beneficial	Negligible or Minor Benefit
		Changes to river geomorphology	<u>Construction</u> There are not considered to be any impacts on geomorphology along this study section.	No Change	None
			<u>Operation</u> There are not considered to be any impacts on geomorphology along this study section.	No Change	None
Flood risk	High	Fluvial/tidal flood risk	<u>Construction</u> During construction, study section 5 is likely to see a temporary reduction in flood risk for flood flows in excess of a 1 in 30 (3.33%) AP, due to flood attenuation in study section 2, and controlled flow through the culvert/scour pipe. The pipeline corridor red line boundary crosses into both Flood Zone 2 and 3 within study section 5. However, there are no planned construction compounds within this study area.	Low Beneficial	Minor Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> During operation of the reservoir, there will be a permanent, direct impact on fluvial flood risk. The presence of the reservoir will result in a reduction in peak flow, peak level and floodplain extent, for all AP including scenarios that might occur under climate change. During a 3.33% AP, there would be a reduction in peak flow of 2.91m³/s and a reduction in peak level of 0.15m at the upstream node, and 1.70m³/s and 0.04m at the downstream node. Between the two nodes the floodplain extent has reduced by 0.01km², which is a 33% reduction. During a 1% AP, there is a reduction in peak flow of 3.50m³/s and a reduction in peak level of 0.16m at the upstream node, and 3.20m³/s and 0.07m at the downstream node. Between the two nodes the floodplain extent has reduced by 0.01km², which is a 25% reduction. There are no operational impacts of the pipeline on fluvial flood risk in study section 5 as it is located below ground. However, it is expected that the drawdown system will be tested on commissioning up to the capacity of the watercourse. As part of operational testing, it is expected that there will be a small opening of the valves to allow 10% of the Emergency Discharge flow. This is expected to occur twice per year as per Environment Agency guidance. The total flow in this section will be approximately 1.17m³/s, which is equivalent to around 10% of the 1 in 2 (50%) AP for the whole watercourse. Therefore, testing of the emergency discharges will not have any impact on flood risk.	Moderate Benefit	Moderate Benefit
		Surface water flood risk	<u>Construction</u> There is no predicted change in surface water flood risk during construction of the reservoir as there are no works in study section 5. There is however a temporary, indirect impact to the discharge of surface water flows from the urban drainage	Very Low Adverse	Negligible

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			network into the Riders Lane stream. Due to the storage of flows upstream of the reservoir embankment, this will result in a reduction in both peak level and flow within the watercourse, providing more capacity for the surface water network to discharge into the channel. Construction of the pipeline within study section 5, may have a temporary direct impact on increasing surface water flood risk, by localised increases in hard standing. There are no planned construction compounds for the pipeline corridor within study section 5.		
			<u>Operation</u> There is no predicted change in surface water flood risk during operation of the reservoir as there are no elements of the Scheme in study section 5. The storage capacity of the reservoir would result in a reduction in both peak level and flow within the watercourse, providing more storage capacity for surface water runoff There are no operational impacts of the pipeline on surface water flood risk in study section 5.	Low Beneficial	Minor Benefit
Groundwater	Very High	Changes to groundwater quantity	<u>Construction</u> At the south of this study section, Lambeth Group is mapped as being at outcrop. This area is also close to the Chalk outcrop and Chalk groundwater appears at the surface at many nearby locations as springs. Depending on the depth of excavations for the pipeline corridor and the geology at any given location, shallow groundwater may be encountered and/or Chalk groundwater under artesian pressure. Any dewatering required for groundwater encountered in the Lambeth Group will have a temporary localised adverse direct impact on shallow groundwater in this Secondary A aquifer. Encountering the artesian chalk groundwater has the potential to have an indirect adverse effect on springs located in the East Hants Chalk groundwater body.	Low Adverse	Moderate

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> Once the pipeline is constructed, there are no anticipated changes to groundwater quantity in this section.	No Change	None
		Changes to groundwater quality	<u>Construction</u> Earthworks may result in contaminated surface water run-off and / or infiltration into the groundwater. The southern tip of the pipeline corridor directly overlies the South Hants Lambeth Group groundwater body. This area is also close to the Chalk outcrop and Chalk groundwater appears at the surface at many nearby locations as springs. Excavation of the pipeline trench (or digging shaft for boring machine) has the potential to temporarily create contamination pathways and have a direct adverse effect on groundwater quality. This could impact the South Hants Lambeth Group groundwater body or the East Hants Chalk groundwater body. The risk of pollution is particularly high as evidenced by the designation of this area as SPZ1.	Moderate Adverse	Major
			<u>Operation</u> Once the pipeline is constructed, there are no anticipated changes to groundwater quality in this section.	No Change	None

Table 15-42 - Assessment of effects (before mitigation) for study section 6 (Langstone Harbour)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Very High	Changes to water quality	<u>Construction</u> There are no construction activities in study section 6. As explained in Table 15-39, during reservoir construction, flow in study section 3 will be that originating from the reservoir construction site through overpumping. Volumes can be large, which may result in a change in water quality in Section 6 as well as Section 3 and 5. However, the magnitude of change is considered to be very low as a result of dilution.	Very Low	Minor
			<u>Operation</u> During operation, surplus Havant and Bedhampton spring water that currently overflows to Langstone Harbour will be pumped into the reservoir. Existing spring water is relatively high in nitrates (annual average of 33 mg/l). Model results show that nitrate inputs to Langstone Harbour are likely to decrease as a result of nitrogen being lost in the new reservoir because of natural denitrification processes along with the transfer of reservoir water to domestic supplier. Nitrogen loads are expected to decrease, on average, by 6.7% in Langstone Harbour. No other parameters have been modelled directly in relation to Langstone Harbour however, upstream receptors have shown a general improvement in water quality conditions resulting from the operation of the reservoir, notably in phosphorus and BOD. Therefore, a direct and permanent improvement in water quality is expected to be observed at Langstone Harbour as a result of the Scheme.	Moderate Beneficial	Major Beneficial
		Pollution	<u>Construction</u> There are no construction activities in study section 6, thus no impact has been assumed.	No Change	None
			<u>Operation</u>	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			There will be no operational activities in this study section and, therefore, there are no anticipated pollution risks.		
Hydro morphology	High	Habitat loss	<u>Construction</u> There will be no anticipated change to this study section as it is downstream of any impacted area.	No Change	None
			<u>Operation</u> There will be no anticipated change to this study section as it is downstream of any impacted area.	No Change	None
		Habitat connectivity	<u>Construction</u> There will be no anticipated change to this study section as it is downstream of any impacted area.	No Change	None
			<u>Operation</u> There will be no anticipated change to this study section as it is downstream of any impacted area.	No Change	None
		Changes to hydrology	<u>Construction</u> There is no change to the hydrology in this study area as a consequence of the Scheme.	No Change	None
			<u>Operation</u> Three options being explored for the compensation flow downstream of the reservoir (see item FFF, Table 15-36). By the time water gets into this section of Hermitage Stream and impact from the decision as to what flow regime to operate will be significantly reduced. At the very least there will be no change in the hydrology in this section of channel and if more flow is added there could be a small perceived benefit.	No change or Very Low benefit	None or Negligible Benefit
		Changes to river geomorphology	<u>Construction</u> There will be no anticipated change to this study section as it is downstream of any impacted area.	No Change	None
			<u>Operation</u> There will be no anticipated change to this study section as it is downstream of any impacted area.	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Flood risk	Low	Fluvial/tidal flood risk	<u>Construction</u> During construction, study section 6 is likely to see a temporary reduction in flood risk for flood flows in excess of a 1 in 30 (3.33%) fluvial AP, due to flood attenuation in study section 2, and controlled flow through the culvert/scour pipe. The benefit of this will be offset by the tidal influence and therefore no change. The construction of the pipeline has no impact on fluvial flood risk in study section 6.	No Change	None
			<u>Operation</u> During operation of the reservoir, there will be a permanent, direct impact on fluvial flood risk. The impact of the reservoir will result in a reduction in peak flow, peak level and floodplain extent, for all AP including climate change During a 3.33% AP, there is a reduction in peak flow of 1.70m ³ /s and a reduction in peak level of 0.04m at the upstream node, and 1.32m ³ /s and 0m at the downstream node. Between the two nodes there is no change in the floodplain extent. During a 1% AP, there is a reduction in peak flow of 3.20m ³ /s and a reduction in peak level of 0.07m at the upstream node, and 2.78m ³ /s and 0m at the downstream node. Between the two nodes there is no change in the floodplain extent. The effect of the tidal influence will reduce the impact of a reduction in flow level, and therefore this has been assessed as no change. There are no operation impacts of the pipeline on fluvial flood risk in study section 6 as the pipeline is not within this area.	No Change	None
		Surface water flood risk	<u>Construction</u> There is no predicted change in surface water flood risk during construction of the reservoir as there are no works in study section 6. The construction of the pipeline has no impact on surface water flood risk in study section 6.	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			Operation There is no predicted change in surface water flood risk during operation of the reservoir as there are no elements of the Scheme in study section 6. The operation of the pipeline has no impact on surface water flood risk in study section 6.	No Change	None
Groundwater	High	Changes to groundwater quantity	<u>Construction</u> The reservoir would be via flows captured from the Havant and Bedhampton springs. This major spring outfall is used as an abstraction source by Portsmouth Water. Unlike most groundwater abstractions, the supply is not pumped. Instead, the spring water is collected by gravity in catchpits. As the spring water is naturally brought to the surface and discharged as surface water, rather than being actively pumped from the Chalk aquifer, its use does not have an impact on the Chalk groundwater body. As the Chalk aquifer naturally discharges groundwater through springs which then flow through surface water channels out to the sea, there are no anticipated changes to groundwater quantity.	No Change	None
			<u>Operation</u> No anticipated permanent changes to groundwater quantity in this section	No Change	None
		Changes to groundwater quality	Construction The reservoir would be filled via flows captured from the Havant and Bedhampton springs. As the spring water is naturally brought to the surface and discharged as surface water, its use does not have an impact on the Chalk groundwater body. There are no anticipated changes to groundwater quality.	No Change	None
			Operation There are no anticipated changes to groundwater quality in this section	No Change	None

Table 15-43 - Assessment of effects (before mitigation) for study section 7 (Headwaters of the River Lavant)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> During construction, there will be no additional dewatering activities within study section 7. Wider site dewatering will be routed into study section 3. There is, therefore, no anticipated change to water quality within this study section.	No Change	None
			<u>Operation</u> There will be a loss of 0.8 km of ditch that forms part of the Lavant catchment in the footprint of the Scheme. This will be compensated by an additional 900 m of new toe ditch that will be constructed around the eastern perimeter of the reservoir; the ditch would discharge to the Lavant Stream. The original source for the eastern arm of the toe drain would not change, but the western arm of the toe drain would pick up (clean) surface water run-off from the embankment. As the ditch already drains an area of unimproved grassland, it is considered unlikely that this will result in a material change to overall water quality in this study section.	No Change	None
		Pollution	<u>Construction</u> Temporary direct impacts to study section 7 may result from the following construction activities: • Construction of Access roads around the northern edge of the reservoir in Q3 2021, including extension of culverts, which are used up to Q3 2024. • Construction of coffer dams (Q1 2022). • Construction of the main embankment. Potential pollution risks are likely to include sediments, hydrocarbons, metals and nutrients.	Moderate Adverse	Minor
			<u>Operation</u>	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			Following construction, there will be no operational discharges in this study section, removing pollution risks.		
Hydro morphology	Medium	Habitat loss	<u>Construction</u> There will be a loss of 0.8 km of ditch that forms part of the Lavant catchment in the footprint of the Scheme, resulting in the loss of stillwater or ditch features. This will be compensated by an additional 900m of new toe ditch that will be constructed around the eastern perimeter of the reservoir which will then discharge into the Lavant Stream. The impact will occur once the stream had been diverted but we have assumed the new toe ditch will be constructed and operational before any impacts are realised. There is an opportunity to improve the habitats in the new watercourses and increase their ecological potential to provide habitats to a wider range of species than they are expected to contain at the moment.	Low Beneficial	Minor Benefit
			<u>Operation</u> There are no operational activities in this study section	No Change	None
		Habitat connectivity	<u>Construction</u> There will be a loss of 0.8 km of ditch that forms part of the Lavant catchment in the footprint of the Scheme. This will be compensated by an additional 900 m of new toe ditch that will be constructed around the eastern perimeter of the reservoir which will then go into the Lavant Stream. The impact will occur once the stream had been diverted but we have assumed the new toe ditch will be constructed and operational before any impacts are realised.	Low Beneficial	Minor Benefit
			<u>Operation</u> There are no operational activities in this study section.	No Change	None
		Changes to hydrology	<u>Construction</u> There will be localised changes to the hydrology due to the loss of 0.8 km of ditch that forms part of the Lavant catchment in the footprint of the Scheme. This will be compensated by an additional 900 m of new toe ditch that will	Low Beneficial	Minor Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			be constructed around the eastern perimeter of the reservoir which will then discharge into the Lavant Stream. The new ditch is considered to provide a small overall benefit. Any impact will occur once the stream had been diverted but we have assumed the new toe ditch will be constructed and operational before any impacts are realized. The overall change in catchment area is negligible.		
			<u>Operation</u> There are no operational activities in this study section	No Change	None
		Changes to river geomorphology	<u>Construction</u> There will be localised changes to the geomorphology due to the loss of 0.8 km of ditch that forms part of the Lavant catchment in the footprint of the Scheme. This will be compensated by the additional 900m of new toe ditch that will be constructed around the eastern perimeter of the reservoir which will then discharge into the Lavant Stream. No significant change from the existing condition is anticipated. Any impact will occur once the stream had been diverted but we have assumed the new toe ditch will be constructed and operational before any impacts are realized.	Low Beneficial	Minor Benefit
			<u>Operation</u> There are no operational activities in this study section	No Change	None
Flood risk	High	Fluvial/tidal flood risk	<u>Construction</u> There will be a permanent, direct reduction in fluvial flood risk of the River Lavant during construction of the reservoir and embankment due to the headwaters being intercepted by the new embankment.	Low Beneficial	Minor Benefit
			<u>Operation</u> No additional impacts following construction.	No Change	None
		Surface water flood risk	<u>Construction</u> Surface water flood risk in this study section follows the same mechanism and flow path as fluvial flood risk as there is no	Low Beneficial	Minor Benefit

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			urban drainage. Benefits are the same as specified above under fluvial flood risk.		
			<u>Operation</u> No additional impacts following construction.	No Change	None
Groundwater	Low	Changes to groundwater quantity	<u>Construction</u> Bognor Sands are mapped as being at outcrop for part of this study section. Shallow groundwater may be encountered during the excavation of pipeline trench (or digging shaft for boring machine) and require temporary dewatering. There is a potential for a temporary adverse impact on shallow groundwater in this Secondary A aquifer. This will be very localised.	Very Low Adverse	Negligible
			<u>Operation</u> Once the pipeline is constructed, there are no anticipated changes to groundwater quantity in this section.	No Change	None
		Changes to groundwater quality	<u>Construction</u> Excavation of the pipeline trench (or digging shaft for boring machine) has the potential to temporarily create contamination pathways and have a direct adverse effect on shallow groundwater quality within the Bognor Sands.	Low Adverse	Minor
			<u>Operation</u> Once the pipeline is constructed, there are no anticipated changes to groundwater quality in this section.	No Change	None

Table 15-44 - Assessment of effects (prior to mitigation) for Section 8 (Park Lane Stream)

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
Water quality	Medium	Changes to water quality	<u>Construction</u> No changes to water quality are anticipated as there will be no construction work in or upstream of this study section.	No Change	None
			<u>Operation</u> No changes to water quality are anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section.	No Change	None
		Pollution	<u>Construction</u> No pollution risks are anticipated as there will be no construction work in or upstream of this study section.	No Change	None
			<u>Operation</u> No pollution risks are anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section.	No Change	None
Hydro morphology	Medium	Habitat loss	<u>Construction</u> No habitat loss is anticipated as there will be no construction work in or upstream of this study section.	No Change	None
			<u>Operation</u> No habitat loss is anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section.	No Change	None
		Habitat connectivity	<u>Construction</u> No risks to habitat connectivity are anticipated as there will be no construction work in or upstream of this study section.	No Change	None
			<u>Operation</u> No risks to habitat connectivity are anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section.	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
		Changes to hydrology	<u>Construction</u> No changes to hydrology are anticipated as there will be no construction work in or upstream of this study section	No Change	None
			<u>Operation</u> No changes to hydrology are anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section	No Change	None
		Changes to river geomorphology	<u>Construction</u> No changes to river geomorphology are anticipated as there will be no construction work in or upstream of this study section.	No Change	None
			<u>Operation</u> No changes to river geomorphology are anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section.	No Change	None
Flood risk	Low	Fluvial/tidal flood risk	<u>Construction</u> No changes to fluvial flood risk are anticipated as there will be no construction work in or upstream of this study section.	No Change	None
			<u>Operation</u> No changes to fluvial flood risk are anticipated as there will be no operational activities (e.g. discharges) in or upstream of this study section. The operation of the pipeline has no impact on fluvial flood risk in study section 8.	No Change	None
		Surface water flood risk	<u>Construction</u> It is assumed that all drainage from the visitor centre and car park will discharge to study section 2 therefore, there is no predicted change to surface water flood risk as there will be no construction work in or upstream of this study section. The construction of the pipeline has no impact on surface water flood risk in study section 8.	No Change	None

Receptor	Baseline importance	Type of Impact	Nature of Effect	Magnitude	Significance of Effect
			<u>Operation</u> It is assumed that all drainage from the visitor center and car park will discharge to study section 2 therefore, there is no predicted change to surface water flood risk as there will be no construction work in or upstream of this study section. The operation of the pipeline has no impact on surface water flood risk in study section 8.	No Change	None
Groundwater	High	Changes to groundwater quantity	<u>Construction</u> No anticipated changes to groundwater quantity in this study section	No Change	None
			<u>Operation</u> No anticipated changes to groundwater quantity in this study section	No Change	None
		Changes to groundwater quality	<u>Construction</u> No anticipated changes to groundwater quality in this section	No Change	None
			<u>Operation</u> No anticipated changes to groundwater quality in this section	No Change	None

Design, mitigation and enhancement measures

Design considerations

- 15.218 With relevance to the water environment, the following design considerations have been embedded in the Scheme as part of this preliminary design stage:
- The pipeline corridor has been diverted to avoid Great Copse woodland in study section 3 and thereby also avoided a section of the Riders Lane Stream;
 - Avoidance of working in water within the Hermitage Stream downstream of the Riders Lane Stream confluence.
 - No additional watercourse crossings or culverting of Headwater Streams 1-3 or Park Lane Stream.
 - No discharges into Park Lane Stream.

Mitigation measures

- 15.219 The REAC as part of the OEMP (Appendix A2.1 in ES Volume 4) and outline Biodiversity Ecological Mitigation and Compensation Strategy included with the planning application details the mitigation measures developed as part of the preliminary design stage.
- 15.220 During detail design these measures will be included in the following documents:
- Drainage Management Plan - this document will be prepared by the appointed contractor and apply to the whole Scheme (reservoir and access road, and pipeline corridor) and will include a set of main design principles for the foul and surface water drainage networks.
 - CEMP – developed by the appointed contractor, this would cover both surface water and groundwater, generic pollution prevention measures will be included in line with the requirements set out within the Environment Agency's General Guide to Prevention of Pollution (PPG 1), Works and maintenance in or near water (PPG 5) and Maintenance of structures over water (PPG 23) and Control of water pollution from construction sites CIRIA 532. The REAC as part of the OEMP in Appendix 2.1 in ES Volume 4 currently contains necessarily detail which will be transferred into the CEMP.
 - Detailed Biodiversity Mitigation and Compensation Strategy - covering both terrestrial and aquatic environment, with relevance to the water environment, this will be developed to identify opportunities for betterment in the catchment to mitigate and/or compensate for effects identified.
- 15.221 The amount of river habitat mitigation required remains to be finally resolved with the Environment Agency. Portsmouth Water commits to delivering the necessary level of aquatic habitat mitigation reasonably required to offset the impacts of the development on the Hermitage Stream waterbody. The detailed Biodiversity Mitigation and Compensation Strategy is intended by the Environment Agency and Natural England to be an adaptable document in relation to the ways in which these commitments are discharged and will therefore be amended and updated through the delivery process with their input and agreement.
- 15.222 In addition, the future compensation flow and reservoir water quality management regime will be documented as part of the site's Environmental Permits and associated Environmental Management Systems.
- 15.223 Further detail on some of the generic mitigation measures contained in the documents specified above have been set out below. The measures have been split into those applicable to construction and operation. Details on monitoring requirements to support the implementation of mitigation measures have been provided from paragraph 15.252 onwards.

Reservoir, access roads and pipeline corridor construction mitigation measures

Pollution prevention measures for surface water and groundwater

- 15.224 It is assumed that the Drainage Management Plan will include, as a minimum:
- Design standards - any areas of surface or foul water drainage affected by the works will be identified and each section of affected drainage should be briefly described, and a proposed solution provided.

- Pollution control/interception - any interceptor solutions will be identified on discipline specific drawings and reviewed during the relevant design stages. For example, any new car parks and associated access roads or haulage routes will incorporate, at least, oil interceptors before discharging to the receiving body of water to intercept potential oily substances that may build up on surfaces.
- Outfalls - known outfalls will be identified and where possible any drainage should tie in with the existing outfalls. Where no existing drainage outfalls are present/known, SuDS principles should be considered to ensure that the discharge rate and volume is suitable. The designing of new drainage catchments should include consideration of any potential attenuation sites. High-level drainage catchment assessments should be undertaken to determine the potential attenuation requirements. It is assumed that drainage scenarios which replicate the current un-attenuated drainage system will remain with no requirement to provide additional water storage.
- Earthworks - a review of existing earthworks and drainage provision will be undertaken to assess the required interventions to be developed at subsequent design stages. Areas are to be identified which currently do not have any drainage but is required.
- Access Roads and Haulage Routes –the development of drainage from the access roads and haulage routes including the modification/re-alignment, connection into or new access road / haulage road infrastructure will be included. Construction mitigation will include (but not be limited to) measures within the PPGs, e.g. to attenuate and treat polluted runoff.
- Third Party Land - drainage interventions to support the reservoir may affect third party land. Assessment of drainage interventions should account for the following scenarios but not limited to: third party land drainage which currently affects the infrastructure; drainage interventions required for the Scheme which may affect third party land; and, outfall required for drainage which is located within third party land. Stakeholder engagement and consultation will be undertaken at subsequent design stages when required drainage proposals are further defined. Continued stakeholder engagement will be necessary to obtain consents.

15.225 It is assumed the CEMP will include, as a minimum:

- An agreed process for managing the volume and quality of discharge of water for construction compounds (including CSS) and other areas of hard standing and haulage roads, which will discharge into the site water management systems via shut-off sluice valves which are normally in the closed position and only opened if surface water run-off is of a desired quality. The volume and quality maintenance regime will include an agreed process for monitoring and managed discharge of water from each compound via a sluice valve.
- Detail on where water treatment systems will be placed, Detail on the discharge water quality standards and flow rates to be attained and suitable technologies (e.g. settlement tanks, silt busters, etc.) which will be used to remove pollutants such as fine sediments (silts), debris and other pollutants during the dewatering process. The discharge methodology will be agreed with the EA where discharge consents are required. Treatment of arisings is required to maintain appropriate quality using treatment plant prior to discharge to the watercourse.
- The development of water quality monitoring plans to cover parameters monitored, sample locations frequency and duration of monitoring. This will include who will undertake sampling, any requirements for visual checks, inclusion of additional monitoring points as part of baseline monitoring, sampling/ laboratory analysis accreditation requirements.
- All oil or chemical storage areas will be bunded and lined in order to contain pollutants in the event of leakage. There will be no storage of materials (or chemicals/fuels) within 8m of any watercourse. All machines will use oil trays when parked on site; all fuel storage tanks shall be adequately bunded to prevent pollution of the river. All reasonable requirements specified by the Environment Agency will be in place to prevent fuel, lubricants, or any other fluids or materials entering the watercourse.
- Procedures to deal with accidental leakages or spillages of hydrocarbons and oils, or accidental release of hazardous substances during construction works.
- Debris for any polluting substances that are being brought on site and used as part of the construction process.

15.226 With regard to working in or near water, noting the outline design includes the provision to avoid periods of higher flows including outside of March to September periods, construction will be undertaken when flows are at or below the mean average as far as practicable to reduce the potential for sediment release and risk of scour and using appropriate methods to reduce the risk of pollution if flows were to increase suddenly.

15.227 Riverbanks are not to be re-profiled and any bank damage resulting directly or indirectly from the works is to be repaired so as to restore it to its former condition. This includes stabilisation replanting of riparian vegetation to prevent soil run-off and erosion. Any temporary works to be placed in the watercourse or within 8m metres of the bank of the watercourse shall be also entirely removed on completion of the works.

15.228 Where watercourses require permanent or temporary dewatering and/or over-pumping to permit construction activities, fish will be removed by means of electrofishing under Environment Agency FR2 consents and relocated prior to dewatering. Particular care should be taken to remove European eel (a critically endangered species) from soft sediments and culverts. Water flow/passage will also need to be sufficiently maintained as to not result in the drying of habitats downstream of construction activities. There shall also be no undue obstruction to the flow of the water in the watercourse shall be caused during the progress of the works.

Hydromorphology

15.229 The detailed Biodiversity Mitigation and Compensation Strategy will contain the following mitigation measures specific to hydromorphology:

- Construction flow management measures around the dewatering of the area within the footprint of the reservoir to ensure the waters from the headwaters are captured and diverted around the site and fed into the top of the Riders Lane Stream downstream of the footprint with proper attenuation and flow management in place, notably to not allow the stream to dry up; and prevent peak flows.
- Gravels from the headwater streams impacted will be moved to nearby headwater systems to try and mitigate against the loss of Near Threatened, nationally notable and scarce macroinvertebrate species on site, notably in Headwater Streams 1 and 2, where higher numbers of notable species were recorded.
- The riverbed at the location of pipeline corridor crossings will be restored using finer materials (gravel, pebbles, cobbles) which will be placed on top of the concrete seals
- Finer materials will be placed inside the new culvert pipes, providing fish passage improvements.
- An inverted entry/exit will be implemented to new culvert pipes along with the installation of soft habitats within the pipe to improve watercourse connectivity.
- Enhancing the 250 m of new habitat in the relict Riders Lane Stream between the reservoir embankment and the confluence of the compensation flow to provide both in-channel and backwater features.
- Additional backwater habitats in Riders Lane Stream for refugia for fish in case of operational drawdown events.
- Noise, vibration and light spill will be minimised by working back from the watercourses where possible. Construction lighting will be angled away from the watercourse to reduce the potential for disturbance.
- Where practicably possible percussive (hammer) piling will be avoided in favour of softer alternatives (e.g. silent sheet piling, vibratory sheet piling). Where this is not possible, soft start piling procedures will be utilised to provide time for fish to locate away from the source of disturbance prior to full exposure. It is advised that the soft-start duration should be a period of not less than 20 minutes. All piling activities should ideally be of a period no greater than 20 minutes. Following the cessation of piling activities, the soft start procedure should be repeated.
- Visual daily monitoring will be undertaken to ensure that the discharge does not result in any scouring of the beds and banks or churn up of silts from the riverbed.

15.230 In addition to the measures detailed above, to compensate for the significant loss of watercourse on site, addition restoration will be provided within the water bodies of the Hermitage Stream catchment. The level of restoration, including river length and location, will be informed by site walkovers such as the Modular River Physical Surveys (MoRPh) surveys undertaken by Atkins with further discussions with Portsmouth Water and the Environment Agency. MoRPh surveys were undertaken on the 26 June, 29 June and 2 July 2020 to provide a river condition assessment to feed into the beta version of Defra's Biodiversity Metric 2.0 and the findings of these surveys have been detailed in Appendix A15.4 (Biodiversity Net Gain for Rivers) in ES Volume 4.

Flood risk

- 15.231 Most of the mitigation required to safely manage flood risk is already embedded in the construction and scheme design. This includes measures such as pipes, culverts and flumes to ensure the continued pass forward of flows downstream. Structures will all be sized to ensure there is no increase in fluvial flood risk.
- 15.232 It is assumed the following flood-related mitigation measures are implemented:
- The Drainage Management Plan will also include details of how increased surface water runoff from new areas of hardstanding (i.e. access roads, visitor centre, car parks etc) will be managed to ensure no increase in flood risk. Sustainable Drainage Systems (SuDS) should be included in the drainage design where possible. The drainage design will follow the SuDS manual and guidance from the Local Plans/SFRAs will be incorporated.
 - The Drainage Management Plan will also include details of how the construction compounds will safely manage surface water flows in line with Environment Agency PPG guidance.
 - The CEMP will make provision for attenuating surface water run-off generated as part of the reservoir and pipeline construction, which has additional benefits of better management of water quality. The appointed contractor will be expected to attenuate flows up to a 1:30 return period.

Groundwater

- 15.233 The generic mitigation measures set out for the Drainage Management Plan and CEMP are of relevance to protecting groundwater resources.
- 15.234 The risk of pollution during construction will be reduced by the adoption of good working practices. Although now withdrawn by the Environment Agency, their Pollution Prevention Guidelines still detail good practice advice for undertaking works which may have the potential to result in water pollution. In general terms, by following these guidelines, significant impacts to the water environment will be avoided.
- 15.235 Pollution prevention measures have been included within the REAC as part of the OEMP Appendix A2.1 in ES Volume 4, to mitigate the potential impact on the quality of the groundwater resources. Areas which may generate contaminated water, such as oil storage areas, must be bunded and have water discharged to self-contained units with treatment facilities.
- 15.236 In addition, particular care will need to be taken with pipeline excavations at the southern end of the pipeline corridor where shallow groundwater in the South Hants Lambeth Group groundwater body and artesian Chalk groundwater from the East Hants Chalk groundwater body may be encountered. Trench excavations and any shafts will need to be designed in accordance with industry standards. A risk assessment will need to be carried out by the appointed contractor to ensure the selected excavation method does not introduce contamination pathways into the aquifer. The design will include a contingency plan in the event that artesian groundwater flow is encountered.
- 15.237 In context of a sensitive Secondary A and Principal Aquifer used for drinking water, construction and operational discharges to groundwater will be avoided. Access roads and road runoff drainage systems will be designed to minimise runoff soakaway drainage to ground and pollution control measures will be installed on all access roads.

Reservoir operational mitigation measures

- 15.238 In terms of reservoir operation, reservoir management techniques to reduce risk from algae will include mixing and biomanipulation, with particular regard to short term hot static periods which would increase any risk from soluble metals.
- 15.239 Potential risks to reservoir water quality from pesticides will include catchment management in the upstream forestry area. Potential risks to hydrocarbons (from dumping) will include physical security and monitoring for organic pollutants with abstraction control. Potential risks from nitrates will also include abstraction control. Potential risks from ammonia will include artificial mixing.

Enhancement measures

Water quality

- 15.240 In summary, benefits of the Scheme to water quality include:
- Improvements to water quality in the Riders Lane Stream (study section 3, Hermitage Stream (study section 5) and Langstone Harbour (study section 6) including contribution to Langstone Harbour's conservation objectives for nitrogen as a result of nitrogen being lost in the new

reservoir because of natural denitrification and along with the transfer of reservoir water as drinking water;

- The aeration equipment included within the reservoir design may deliver further downstream water quality benefits.
- Creation of wetland habitats in the north east corner of the reservoir site (study section 2, minor benefit – see Chapter 9 Biodiversity in ES Volume 2 for a further description);
- Depending on the operational regime for compensatory flows there is a potential benefit to the the Riders Lane Stream (study section 3, moderate benefit) and downstream Hermitage Stream (study section 5, minor benefit) resulting from the continual maintenance of flows;
- Reduction in flood risk as a result of the presence of the reservoir in Riders Lane Stream (study section 3, minor benefit to surface water flood risk, moderate benefit to fluvial flood risk) and Hermitage Stream (study section 5, minor benefit to surface water flood risk, moderate benefit to fluvial flood risk); and
- Benefits to habitat, connectivity, hydrology and hydromorphology, fluvial and surface water flood risk as a result of new drainage systems created towards the east of the reservoir (study section 7, all low benefit).

Hydromorphology

- 15.241 A compensation flow will be maintained during the operational phase. This would provide the opportunity to maintain year-round flows within the watercourses and if could provide a 'flushing' benefit provided that additional riparian habitat is provided.
- 15.242 The created wetland retaining structures and wetland habitat are key benefits of the scheme, predicted to attract a range of different wildlife and bird species to the site. It will have an area of 6.8 ha at 38.8 mAOD and an area of 10.2 ha at TWL (39.5 mAOD). The wetland bund will be key in retaining levels in the wetland area as reservoir water levels reduce. The design will include the following habitats:
- Open water;
 - Shallow water with emergent plant vegetation;
 - Reed and sedge beds;
 - Seasonally inundated bird nesting island; and
 - Wet woodland.
- 15.243 An area of wet grassland habitat will also be created towards the east of the retained wetland (Area 0) ~1.3ha in size. This will include ephemeral shallows and raised areas. These areas will largely be left to colonise naturally, although some import of wetland plants will be required for key landscaping elements

Flood risk

- 15.244 The reservoir will reduce flood risk along the Riders Lane Stream and downstream to the Hermitage Stream by managing flows.
- 15.245 The increased culvert capacity proposed for three Riders Lane Stream culverts will reduce flood risk in that catchment.

Assessment of effects

- 15.246 A summary of the potential construction and operational effects of the Scheme, as presented in Table 15-37 to Table 15-44, has been provided in Table 15-45 below. As described in Table 15-3, the study sections are described as follows:
- study section 1 - Headwater Streams 1, 2 and 3 up to reservoir site footprint;
 - study section 2 - Headwater Streams 1, 2, 3, 4, 5, Upper Lake and short section of Riders Lane Stream all under reservoir site footprint;
 - study section 3 – Riders Lane Stream between Reservoir footprint up to Hermitage Stream confluence, including The Lake Stream joining Riders Lane Stream from Leigh Lake;
 - study section 4 – Hermitage Stream – between A3(M) and confluence with Riders Lane Stream;
 - study section 5 - Hermitage Stream – between confluence with Riders Lane Stream and Nominal Tidal Limit (NTL);

- study section 6 - Langstone Harbour;
 - study section 7 - Headwater Streams under reservoir site footprint draining east towards River Lavant; and,
 - study section 8 - Park Lane Stream.
- 15.247 For those effects deemed minor or above, further detail on the effects following implementation of mitigation measures has been provided in Table 15-46 (Reservoir site and access roads construction – summary of residual significance of effects), Table 15-47 (Pipeline corridor construction – summary of residual significance of effects), Table 15-48 (Reservoir operation – summary of residual significance of effects) and Table 15-49 (Pipeline operation - summary of residual significance of effects) below.
- 15.248 In addition to ‘wider benefits of the Scheme’ set out above, the Scheme does offer (ongoing) benefits to the water environment, which have been provided in Table 15-48 and Table 15-49.
- 15.249 As described in paragraph 15.35, those effects with a significance of Moderate or above are considered to be significant in EIA terms for the purpose of this assessment. Effects of Minor or Negligible significance are not considered to be significant and will therefore not be reported as significant residual effects. Residual effects with a significance of Moderate or above are summarised in Table 15-50).
- 15.250 The Water Framework Directive Assessment (Appendix A15.1 WFD Assessment in ES Volume 4.) identifies that no deterioration is considered likely for the following WFD water bodies screened into the assessment:
- Langstone Harbour transitional TraC WFD water body;
 - River Lavant (Hants) WFD surface water body;
 - Langstone Harbour transitional water body;
 - East Hants Lambeth groundwater body;
 - East Hants Chalk groundwater body; and,
 - South Hants Lambeth Group groundwater body.
- 15.251 There remains a concern that on the Hermitage Stream WFD water body the potential for deterioration at a water body scale remains for invertebrates, hydromorphology, macrophytes and phytobenthos for the Hermitage Stream WFD waterbody (GB107042016370). This cannot be readily mitigated or compensated against despite the mitigation and compensation offered as part of the Scheme’s detailed Biodiversity Mitigation and Compensation Strategy. It is noted that an Article 4.7 deterioration assessment is likely to be required to seek a derogation for the Scheme as necessary under the WFD legislation where a potential deterioration is deemed a possibility.

Overview (before mitigation)

Table 15-45 - Summary of significance of effect for each study section (before mitigation) as set out in Table 15-37 to Table 15-44. Moderate and major adverse effects have been highlighted in red whilst benefits have been highlighted in green.

Receptor	Type of Impact	Nature of Effect	Study section 1	Study section 2	Study section 3	Study section 4	Study section 5	Study section 6	Study section 7	Study section 8
Water quality	Changes to water quality	Construction	None	None	Moderate	None	Minor	Minor	None	None
		Operation	None	Minor*	Minor Benefit*	None	Minor Benefit	Major Benefit	None	None
	Pollution	Construction	Minor	Moderate	Moderate	Moderate	Moderate	None	Minor	None
		Operation	None	Minor	Minor	None	None	None	None	None
Hydromorphology	Habitat Loss	Construction	Minor	Moderate	Minor	Minor	None	None	Minor Benefit	None
		Operation	None	Minor Benefit	None	None	None	None	None	None
	Habitat Connectivity	Construction	Moderate	Moderate	Minor	Negligible	None	None	Minor Benefit	None
		Operation	None	None	None	None	None	None	None	None
	Changes to hydrology	Construction	Minor	Moderate	Moderate	Negligible	None	None	Minor Benefit	None
		Operation	None	None	(Benefit)	Minor	(Benefit)	None	None	None
	Changes to river geomorphology	Construction	Moderate	Moderate	Major	Minor	None	None	Minor Benefit	None
		Operation	None	None	None	None	None	None	None	None
Flood Risk	Fluvial / tidal flood risk	Construction	None	None	Negligible	Minor	Minor Benefit	None	Minor Benefit	None
		Operation	None	None	Moderate Benefit	None	Moderate Benefit	None	None	None
	Surface water flood risk	Construction	None	Minor	Negligible	None	Negligible	None	Minor Benefit	None
		Operation	Negligible	Minor	Minor Benefit	None	Minor Benefit	None	None	None
Groundwater		Construction	Minor	Minor	Moderate	None	Moderate	None	Negligible	None

Receptor	Type of Impact	Nature of Effect	Study section 1	Study section 2	Study section 3	Study section 4	Study section 5	Study section 6	Study section 7	Study section 8
	Changes to groundwater quantity	Operation	Minor	Minor	Minor	None	None	None	None	None
	Changes to groundwater quality	Construction	Minor	Minor	Moderate	None	Major	None	Minor	None
		Operation	Minor	None	None	None	None	None	None	None

*This impact will move to a temporary 'Moderate' impact on reservoir water quality (study section 2) and a 'Minor' impact on Riders Lane Stream water quality (study section 3) during 1 in 5 and 1 in 10-year drought conditions. Effects are temporary and ameliorated as the reservoir refills over winter.

Table 15-46 - Reservoir site and access roads construction – summary of residual significance of effects

Receptor	Type of Impact	Study section	Summary of reservoir construction effects	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
Water quality	Changes to water quality	3, 5, 6	Risk of changes to water quality as a result of dewatering in the reservoir footprint.	Moderate (3); Minor (5,6)	Implementation of pollution prevention and flow attenuation (flood risk) measures as set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4.	Negligible
	Pollution	2	Risk of temporary watercourse pollution as a result of reservoir dewatering activities.	Moderate	Implementation of pollution prevention measures as set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4. (including sediment management measures to protect hydromorphology).	Negligible
Hydro morphology	Habitat loss	2	The reservoir construction period will initiate a permanent, direct loss of 3.7 km of watercourse and a small still waterbody (Upper Lake) as a result of the presence of a reservoir.	Moderate	The loss in habitat cannot be readily mitigated or compensated against despite the mitigation and compensation offered as part of the detailed Biodiversity Mitigation and Compensation Strategy.	Moderate
	Habitat connectivity	1, 2	The reservoir construction period will initiate a permanent, direct, reduction in habitat connectivity as a result of the embankment and creation of the reservoir. There will be a direct loss of 3.7km of watercourses.	Moderate	The loss in habitat connectivity cannot be readily mitigated or compensated against despite the mitigation and compensation offered as part of the detailed Biodiversity	Moderate

Receptor	Type of Impact	Study section	Summary of reservoir construction effects	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
					Mitigation and Compensation Strategy.	
	Changes to hydrology	2, 3	The reservoir construction period will initiate a permanent change in the flow regime in the Riders Lane Stream.	Moderate	Implementation of hydromorphology measures set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4., notably construction flow management measures around the dewatering of the area within the footprint of the reservoir to ensure the waters from the headwaters are captured and diverted around the site and fed into the top of the Riders Lane Stream downstream of the footprint with proper attenuation and flow management in place.	Minor
	Changes to river geo morphology	1, 2, 3	The reservoir construction period will initiate a permanent discontinuity in the system and will trap any sediment that is coming from the headwater systems.	Moderate (1, 2), Major (3)	The discontinuity in sediment transport cannot be readily mitigated or compensated against despite the mitigation and compensation offered as part of the watercourse mitigation and compensation plan.	Moderate (1, 2), Major (3)
Flood risk	Fluvial/tidal flood risk	-/-	-/-	-/-	-/-	-/-
	Surface water flood risk	2	Potential risk of additional surface water flooding due to new access roads.	Minor	Implementation of flood risk mitigation measures as set out in Drainage Management Plan.	Negligible

Receptor	Type of Impact	Study section	Summary of reservoir construction effects	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
Groundwater	Changes to groundwater quantity	3	Removal of Secondary A aquifers (and hence groundwater) within reservoir footprint during construction. This will be permanent once construction is complete and clay seals are installed. On completion of the works, and construction of the embankment, the Secondary A aquifers to the north of the reservoir will have a permanent barrier to groundwater flow. From a WFD perspective, although this affects the Secondary A aquifers, these are not part of the mapped WFD groundwater bodies in the study area.	Moderate	No mitigation measures available - removal of permeable material, emplacement of clay barriers and embankment are required in order to build a reservoir.	Moderate
	Changes to groundwater quality	3	The access roads, haulage roads and earthworks (notably excavation of borrow pits) all have the potential for contamination pathways to superficial aquifers during construction. The risk will be removed once clay seals and embankment are completed.	Moderate	Implementation of pollution prevention measures as set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4.	Negligible

Table 15-47 - Pipeline corridor construction - summary of residual significance of effects

Receptor	Type of Impact	Study section	Summary of pipeline corridor construction effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
	Pollution	3 ,4, 5	Risk of temporary watercourse pollution as a result of pipeline dewatering activities and working in- and near rivers.	Moderate	Implementation of pollution prevention measures as set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4. (including sediment management measures to protect hydromorphology).	Negligible
Hydro morphology	Habitat loss	3, 4	Risk of temporary habitat loss (total of 40 m in study section 3, 20 m in study section 4) as a result of pipeline corridor work in river. Risk of permanent habitat loss (15 x 10 m assumed) as a result of Emergency Discharge Valve construction.	Minor	Implementation of hydromorphology measures set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4., notably reinstatement of all pipeline crossings using finer materials (gravel, pebbles, cobbles) placed onto the concrete pipe cover. The potential impacts to habitat loss as part of the pipeline crossings can be avoided by changing construction methodology to directional drill / pipe jacking.	Negligible (or in case of using directional drill) None
	Habitat connectivity	3	Risk of temporary loss of habitat connectivity as a result of culvert upgrades and pipeline corridor work in river.	Minor	Implementation of hydromorphology measures set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4., notably an inverted entry/exit to new culvert pipes and install soft	Negligible (or in case of using directional drill – None)

Receptor	Type of Impact	Study section	Summary of pipeline corridor construction effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
					habitat within pipe to improve watercourse connectivity. The potential impacts to Habitat connectivity as part of the pipeline crossings can be avoided by changing construction methodology to directional drill / pipe jacking	
Groundwater	Changes to groundwater quantity	5	Risk of changes in groundwater level in relation to superficial aquifer (Harwich Formation and Lambeth Group, both Secondary A aquifers) and/or bedrock aquifer (Chalk, Principal Aquifer) as a result of pipeline construction work.	Moderate	Implementation of good working practices, notably use of risk assessments for pipeline trench construction as set out in the REAC as part of the OEMP in Appendix 2.1 in ES Volume 4.	Minor
	Changes to groundwater quality	5	Risk of groundwater pollution in relation to superficial and/or bedrock aquifers as a result of pipeline construction work.	Major	Implementation of pollution prevention measures as set out in REAC as part of the OEMP in Appendix 2.1 in ES Volume 4.	Minor

Reservoir operation

Table 15-48 - Reservoir operation - summary of residual significance of effects

Receptor	Type of Impact	Study section	Summary of operational effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
Water quality	Changes to water quality	2, 3, 5, 6	<u>Normal operation</u> There is, overall, judged to be a minor impact on water quality in the reservoir itself. Importantly, this is compared to the current watercourse baseline as a result of water originating from groundwater springs, although there will be an improvement in BOD and dissolved oxygen as a result of aeration No downstream effects are anticipated and there will be an expected improvement in primary and secondary productivity in Riders Lane Stream (study section 3) and Hermitage Stream (study section 5), which has been deemed as beneficial. A benefit in water quality is predicted for Langstone Harbour (study section 6) in relation to nitrogen loading. <u>Drought</u> During 1 in 5 and 1 in 10-year drought periods, there could be a period up to 6 months (between the period	Minor impact in study section 2 (permanent) Minor benefit in study section 3 and 5 (permanent) Major benefit in study section 6 Moderate impact during drought (temporary)	No further mitigation measures available, but ongoing water quality monitoring is recommended (see below).	Minor impact on study section 2 (permanent) Benefits to study section 3, 5, 6 unchanged. Moderate impact during drought (temporary)

Receptor	Type of Impact	Study section	Summary of operational effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
			between October and March) where water quality can deteriorate within the reservoir as levels are drawn down. Effects on Riders Lane Stream are ameliorated through a higher-level offtake within the reservoir.			
	Pollution	2, 3	Risk of temporary watercourse pollution due to new access roads, car parks and buildings.	Minor	Implementation of pollution prevention measures (e.g. SuDS) as set out in Drainage Management Plan.	Negligible
Hydro morphology	Habitat loss	2, 7	New wetland habitats will be created towards the north west of the reservoir. New aquatic habitats are created towards the east of the reservoir (study section 7) to allow existing streams to flow around the reservoir. There are opportunities to improve these habitats during construction.	Minor benefit	-/-	-/-
	Habitat connectivity	7	New aquatic habitats are created towards the east of the reservoir (Gipsies Plain) to allow existing streams to flow around the reservoir. There are opportunities to improve these habitats during construction.	Minor benefit	-/-	-/-

Receptor	Type of Impact	Study section	Summary of operational effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
	Changes to hydrology	3, 5	Following construction of the reservoir, there will be a compensation flow. Three options being explored for the compensation flow downstream of the reservoir site. There are potential benefits to the Riders Lane Stream and Hermitage Stream depending on which option is selected (further work is required to determine this), especially if the streams are not allowed to dry up and operational discharges are timed correctly.	None or up to Moderate benefit	-/-	-/-
	Changes to river geo morphology	7	New aquatic habitats are created towards the east of the reservoir (Gipsies Plain) to allow existing streams to flow around the reservoir. There are opportunities to improve these habitats during construction.	Minor benefit	-/-	-/-
Flood risk	Fluvial/tidal flood risk	3, 5	Presence of reservoir will result in a reduction in both peak level and flow within the downstream Riders Lane Stream and Hermitage Stream.	Moderate benefit	-/-	-/-
	Surface water flood risk	2	Potential risk of additional surface water flooding due to new access roads.	Minor	Implementation of flood risk mitigation measures as set	Negligible

Receptor	Type of Impact	Study section	Summary of operational effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
					out in Drainage Management Plan.	
Groundwater	Changes to groundwater quantity	1, 2, 3	Permanent change to outline of superficial aquifers as a result of the reservoir footprint.	Minor	No mitigation measures available.	Minor
	Changes to groundwater quality	1	Potential ongoing, direct risk of contamination of superficial aquifers and indirect risk of contaminating bedrock (Chalk) aquifers as a result of access roads.	Minor	Implementation of pollution prevention measures as set out in Drainage Management Plan.	Negligible

Table 15-49 - Pipeline operation - summary of residual significance of effects

Receptor	Type of Impact	Study section	Summary of operational effect	Unmitigated significance of effect (Table 15-45)	Summary of mitigation/compensation	Significance following mitigation
Water quality	Changes to water quality	-/-	-/-	-/-	-/-	-/-
	Pollution	-/-	-/-	-/-	-/-	-/-
Hydro morphology	Habitat loss	-/-	-/-	-/-	-/-	-/-
	Habitat connectivity	-/-	-/-	-/-	-/-	-/-
	Changes to hydrology	-/-	-/-	-/-	-/-	-/-
	Changes to river geo morphology	-/-	-/-	-/-	-/-	-/-
Flood risk	Fluvial/tidal flood risk	-/-	-/-	-/-	-/-	-/-
	Surface water flood risk	-/-	-/-	-/-	-/-	-/-
Groundwater	Changes to groundwater quantity	-/-	-/-	-/-	-/-	-/-
	Changes to groundwater quality	-/-	-/-	-/-	-/-	-/-

Table 15-50 - Summary of significance of effect for each study section (after mitigation) as set out in Table 15-46 to Table 15-49. Moderate and major adverse effects have been highlighted in red whilst benefits have been highlighted in green.

Receptor	Type of Impact	Nature of Effect	Study section 1	Study section 2	Study section 3	Study section 4	Study section 5	Study section 6	Study section 7	Study section 8
Water quality	Changes to water quality	Construction	None	None	Negligible	None	Negligible	Negligible	None	None
		Operation	None	Minor*	Minor Benefit*	None	Minor Benefit	Major Benefit	None	None
	Pollution	Construction	Minor	Negligible	Negligible	Negligible	Negligible	None	Minor	None
		Operation	None	Negligible	Negligible	None	None	None	None	None
Hydromorphology	Habitat Loss	Construction	Minor	Moderate	Negligible **	Negligible **	None	None	Minor Benefit	None
		Operation	None	Minor Benefit	None	None	None	None	None	None
	Habitat Connectivity	Construction	Moderate	Moderate	Negligible	Negligible	None	None	Minor Benefit	None
		Operation	None	None	None	None	None	None	None	None
	Changes to hydrology	Construction	Minor	Minor	Minor	Negligible	None	None	Minor Benefit	None
		Operation	None	None	(Benefit)	Minor	(Benefit)	None	None	None
	Changes to river geomorphology	Construction	Moderate	Moderate	Major	Minor	None	None	Minor Benefit	None
		Operation	None	None	None	None	None	None	None	None
Flood Risk	Fluvial / tidal flood risk	Construction	None	None	Negligible	Minor	Minor Benefit	None	Minor Benefit	None
		Operation	None	None	Moderate Benefit	None	Moderate Benefit	None	Minor Benefit	None
	Surface water flood risk	Construction	None	Negligible	Negligible	None	Negligible	None	Minor Benefit	None
		Operation	Negligible	Negligible	Minor Benefit	None	Minor Benefit	None	Minor Benefit	None
Groundwater		Construction	Minor	Minor	Moderate	None	Minor	None	Negligible	None

Receptor	Type of Impact	Nature of Effect	Study section 1	Study section 2	Study section 3	Study section 4	Study section 5	Study section 6	Study section 7	Study section 8
	Changes to groundwater quantity	Operation	Minor	Minor	Minor	None	None	None	None	None
	Changes to groundwater quality	Construction	Minor	Minor	Negligible	None	Minor	None	Minor	None
		Operation	Negligible	None	None	None	None	None	None	None

*This impact will move to a temporary 'Moderate' impact on reservoir water quality (study section 2) and a 'Minor' impact on Riders Lane Stream water quality (study section 3) during 1 in 5 and 1 in 10-year drought conditions. Effects are temporary and ameliorated as the reservoir refills over winter.

**Could be 'None' if directional drill is used.

Monitoring

- 15.252 The monitoring programme will reflect the dynamic nature of the project. As noted above, permits will be required for any discharges to watercourses, which will have monitoring and record keeping requirements.

Reservoir site and access road construction

- 15.253 It is recommended, as a minimum, that there should be provision for:
- Use of continuous monitoring sondes to measure turbidity and dissolved oxygen downstream of the reservoir construction area. These sondes should be telemetered and alarmed to allow corrective action to be taken immediately.
 - Regular visual watercourse checks (e.g. for discolourations, oils and sediments) along with routine spot samples taken downstream of the reservoir construction areas.
 - Testing of soils brought on site for contaminants.

Pipeline construction

- 15.254 It is recommended, as a minimum, that there should be provision for:
- Use of automated water quality sondes to measure turbidity upstream and downstream of pipeline sections being constructed. As above, these should be telemetered and alarmed to allow corrective action to be taken immediately.
 - Regular visual watercourse checks (e.g. for discolourations, oils and sediments) along with routine spot samples taken downstream of the pipeline construction areas.
 - Testing of soils brought on site for contaminants.

Reservoir and pipeline operation

- 15.255 The following water quality monitoring will be undertaken during reservoir operation:
- To develop a protocol for algal management and identify treatment requirements:
 - Immediately following reservoir filling, undertake vertical profiling for temperature and dissolved oxygen.
 - Undertake (initial) plankton food chain monitoring (phytoplankton, zooplankton and blue-green algae) to understand food chain dynamics as the reservoir's ecology develops.
 - The reservoir temperature will be monitored at various depths to establish the temperature profile and identify the onset of thermal stratification. This system will be complemented by dissolved oxygen monitoring at depth. The live monitoring system will be used to initiate the mixing system to achieve efficient destratification.
 - Continuous monitoring of ammonia, volatile organic compounds (VOC, to monitor potential hydrocarbon risks) and nitrate at abstraction intake.
 - Continuous monitoring for temperature at the compensation flow discharge location.
 - Noting that there is a preference for catchment measures to manage pesticides originating from the upstream woodland area, a Granulated Activated Carbon (GAC) filter will be available for use in case of pesticides being present in the raw water supply.
 - Raw water quality spot sampling will be undertaken in accordance with Drinking Water Regulations (it is assumed WFD parameters such as total phosphorus and chlorophyll a will be covered by the Environment Agency as part of waterbody classification).
 - Additional monitoring for specific pollutants and priority (hazardous) substances will be risk-based and it recommended initial monitoring is undertaken to understand this risk for the reservoir.
 - It is recommended any main reservoir spot sampling is replicated within one or more selected wetland area to understand the general status and development over time but also the relative contribution of wildfowl to nutrient levels (this will not necessarily involve all of the wetland areas and those selected may include those with more wildfowl).
- 15.256 The following flow monitoring will be undertaken during reservoir operation:
- Abstraction flow monitoring.
 - Monitoring the reservoir compensation flow at the outlet channel (which will be operable remotely) and also flow or level at a fixed location within Riders Lane Stream.

- Monitoring in the Riders Lane Stream should start before the construction period to:
 - Establish the current baseline;
 - Determine the influence of dewatering on flow during construction; and,
 - Develop an accretion protocol to understand the influence of the future compensation flow regime.

- 15.257 A monitoring strategy will be required to identify the benefits of the detailed Biodiversity Mitigation and Compensation Strategy, which will include:
- Ecological (succession) monitoring of the wetland area – e.g. flora and wildfowl species.
 - Ecological monitoring of the three headwater streams (HS1-3) before construction and after the implementation of headwater mitigation measures (notably surrounding any translocation of macroinvertebrates).
 - Ecological (response) monitoring of watercourses before and after the implementation of channel/habitat improvements (notably river restoration measures).

Overall assessment findings

Reservoir site and access road

Construction

- 15.258 The significant residual effects of the Scheme relate to the construction of the reservoir site itself. The Scheme will result in the loss of 3.7 km of headwater stream habitats and result in a permanent effect on aquatic habitat connectivity and geomorphology in the river system, which will affect the downstream Riders Lane Stream (Moderate adverse in study sections 1 and 2; Major in study section 3). There is also a permanent change to the outline of superficial aquifers as a result of the presence of the reservoir (Moderate adverse).
- 15.259 Whilst compensation and mitigation will be undertaken, there remains potential for deterioration for invertebrates, hydromorphology, macrophytes and phytobenthos for the Hermitage Stream WFD waterbody (GB107042016370). It is noted that an Article 4.7 deterioration assessment is likely to be required to seek a derogation for the Scheme as necessary under the WFD legislation where a potential deterioration is deemed a possibility. There are no deterioration risk for other surface water, transitional or groundwater WFD waterbodies.

Operation

- 15.260 There are no significant residual effects in relation to operation of the reservoir.
- 15.261 There is significant reduction in flood risk in the Riders Lane Stream (study section 3) and Hermitage Stream (study section 5) as a result of the presence of the reservoir.
- 15.262 Overall, water discharged from the reservoir into the Riders Lane Stream will be of a more consistent quality with improvements identified in nutrient levels notably a significant (Major) benefit to the downstream Langstone Harbour SAC SPA SSSI Ramsar in terms of nitrogen load.

Pipeline

Construction

- 15.263 The pipeline impacts are largely temporary during the construction phase and, upon successful implementation of mitigation measures identified in the REAC as part of the OEMP Appendix A2.1 in ES Volume 4, would not result in significant adverse effects on the water environment.

Operation

- 15.264 There are no significant residual effects associated with the operation of the pipeline.

Summary

Construction

- 15.265 Overall, upon successful implementation of mitigation measures identified in the REAC as part of the OEMP Appendix A2.1 in ES Volume 4, the significant residual impacts associated with reservoir construction include Moderate adverse effects on aquatic habitats, habitat connectivity and geomorphology within study section 2 and Major effects on habitat connectivity and geomorphology within study section 3. These are associated with the construction of the reservoir which will result in 3.7 km of headwater stream habitats being lost. There is also a permanent change to the outline of superficial aquifers as a result of the presence of the reservoir (Moderate adverse).
- 15.266 There is a potential for deterioration for invertebrates, hydromorphology, macrophytes and phytobenthos Quality Elements for the Hermitage Stream WFD waterbody (GB107042016370). It is noted that an Article 4.7 deterioration assessment is likely to be required to seek a derogation for the Scheme as necessary under the WFD legislation where a potential deterioration is deemed a possibility. There are no deterioration risks for other surface water, transitional or groundwater WFD waterbodies.
- 15.267 There are no significant residual effects associated with the pipeline construction upon successful implementation of mitigation measures identified in the REAC as part of the OEMP Appendix A2.1 in ES Volume 4.

Operation

- 15.268 There are no significant residual effects associated with the operation of the reservoir or pipeline.
- 15.269 There are significant benefits associated with the presence of a reservoir, including a moderate benefit in relation to a reduction in flood risk in the Riders Lane Stream and Hermitage Stream. There is also a major benefit to the downstream Langstone Harbour SAC SPA SSSI Ramsar in terms of nitrogen load.



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