Teddington Direct River Abstraction

Preliminary Environmental Information Report

Appendix 5.1 – Surface Water Resources and Water Quality Baseline Information

Volume: 3

Date: June 2025

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Appendix 5.1 – Surface Water Resources and Water Quality Baseline Information

A.1 Introduction

A.1.1 This appendix provides supporting information for Chapter 5: Water Resources and Flood Risk of the Preliminary Environmental Information (PEI) Report for the Teddington Direct River Abstraction (TDRA) Project (hereafter referred to as 'the Project'. This appendix evidences the baseline relevant to the identified potential effects described within the Environmental Impact Assessment (EIA) Scoping Report (J698-AJ-C03X-TEDD-RP-EN-100007), in relation to surface water resources and water quality. This appendix also provides results of hydrodynamic modelling undertaken to support assessment and its interpretation.

A.1.2 Flood risk has been assessed within Appendix 5.2 Flood Risk Assessment. Water quality in relation to aquatic ecology effects is detailed in Appendix 6.2 Additional Environmental Data to Support Aquatic Ecology Assessment, while water quality concerning human receptors is covered in Chapter 16: Human Health.

A.1.3 The Project Description is provided in Chapter 2: Project Description of the PEI Report and includes the Project's activities during construction and operation phases. The potential effects and impact assessment related to water resources and flood risk for the Project are detailed in Chapter 5.

Scope of assessment

A.1.4 From the assessment undertaken for the EIA Scoping Report, Chapter 5 details the scope of the assessment in relation to surface water resources and water quality for the PEI Report. The study area for the assessment of likely significant effects on these resources or receptors was defined to ensure the proportionate assessment appropriately focuses on aspects and matters where a likely significant effect may occur. The Scoping Opinion responses are provided in Chapter 5 and considered in the scope of the assessment. A summary of the scoping of the assessment for surface water receptors is provided in Table A.1 below.

A.1.5 At EIA Scoping stage, River Crane, Duke of Northumberland's River, Whitton Brook and Lee Valley Reservoirs were scoped out of the assessment and therefore not considered in the study area.

Table A.1 Summary of scoping assessment for surface water resources and water quality receptors

Site	Development Infrastructure/Activity	Surface Water Resources	Water Quality
Construction phase			
Mogden Sewage treatment works (STW)	Tertiary treatment plant (TTP)	Scoped out	Scoped out
Ham Playing Fields	Intermediate shaft	Scoped out	Scoped in
Burnell Avenue	Intake, outfall, shafts	Scoped in	Scoped in
Tudor Drive	TLT connection shaft and conveyance pipeline	Scoped out	Scoped out
Operation phase			
Mogden STW	Change to current discharge water quality at Isleworth Ait	Scoped in	Scoped in
Burnell Avenue	Intake/outfall	Scoped in	Scoped in
Pipeline to TLT	Pipeline	Scoped out	Scoped out

Surface water resources and water quality study area

A.1.6 The study area for the surface water resources and water quality area is shown in Figure 5.1 in Volume 2 PEI Report Figures. The potential impact of construction and operation activities will be assessed for the above ground sites which have been scoped in for assessment, as detailed in Table A.1. In addition, operational impacts will be assessed on any water features which form part of the tidal River Thames to Battersea Bridge. The study area was identified based on professional judgment with regard to sensitive receptors and potential pathways.

A.1.7 The study area includes the freshwater River Thames from the Project's proposed intake site termed Burnell Avenue to the normal tidal limit at Teddington Weir. In addition, the study area includes part of the tidal River Thames. The tidal River Thames starts on the downstream side of the Teddington Weir and flows 100km to the North Sea.

A.1.8 For the surface water resources and water quality aspects, the tidal River Thames component of the study area extends for the 22km from Teddington Weir, beyond the Richmond Half-tide Sluice seawards to Battersea Bridge, which is the extent of the Thames River Basin District (RBD)'s River Basin Management Plan's 'Thames Upper' transitional Water Framework Directive

(WFD) water body. This section, the upper estuary, is influenced by river conditions, both flow and quality, and therefore potentially impacted by operation of the Project.

A.1.9 Seawards of Battersea Bridge, marine conditions exert greater influence on estuarine processes, in the middle estuary, especially at the times of low river flow conditions and low river influence when the Project's intake and outfall would be abstracting and discharging.

Data sources

A.1.10 Baseline data for the study area has been sourced from the following monitoring programmes and public data sources. These are listed for physical environment evidence relating to flow and hydrodynamics under Primary physical environment evidence section.

A.1.11 TELEMAC-2D model has been developed for the freshwater reach of the River Thames between Molesey and Teddington Weir to support the assessment of the hydrodynamic baseline of the freshwater River Thames and the potential impact of operation of the Project's intake and outfall on river currents, flow velocity, water level and mixing of the discharge from the outfall into the river. The modelling focuses on an extent 270m upstream of the proposed intake and immediately downstream of Teddington Weir. This model is described further under Freshwater River Thames; TELEMAC 2D hydrodynamic model section.

A.1.12 TELEMAC-3D model has been developed for the estuarine reach of the Thames Estuary between Teddington Weir and Southend-on-Sea to support the assessment of the hydrodynamic and water quality baseline of the tidal River Thames and the potential impact of operation of the Project's outfall on water quality; and the potential impact of operation of the TTP on the discharge volume at Isleworth Ait on tidal elevation, current speed, water temperature, salinity, suspended solids and water quality hydrodynamics, mixing of the discharge from the outfall into the river. The modelling focuses on an extent 22km seawards of Teddington Weir, to Battersea Bridge. This model is described further under Tidal River Thames; TELEMAC 3D hydrodynamic model section.

Primary physical environment evidence

A.1.13 Physical environment data were collated for the period covering 1 January 2010 to 31 December 2024. The watercourses of the monitoring study area for the Project includes:

a. The freshwater River Thames from Shepperton Weir to the tidal limit at Teddington

b. The tidal River Thames from the tidal limit at Teddington to Battersea, which is the edge of the Thames Upper estuarine water body where the character of the estuary changes to brackish.

A.1.14 Physical environment data for these watercourses were sourced from the Environment Agency, Port of London Authority and Thames Water. In addition, flow data pertaining to the all the STWs discharging to these water courses were sourced from Thames Water.

A.1.15 Table A.2 details the primary evidence. Note several of the datasets have been used specifically to calibrate and validate the numerical models of the freshwater and tidal River Thames, whose outputs are directly used by this assessment.

Table A.2 Physical Environment Evidence Base

Data	Site name	NGR	Parameter	Frequency	Range
River flow data (National Rivers Flow Archive)	River Thames at Walton (39121)	TQ099670	River discharge (cubic metres per second)	Daily	1 Jan 1990 - 31 Dec 2024 (or where available in this time period).
	River Thames at Kingston (39001)	TQ177698			
	Crane at Marsh Farm (39094)	TQ154734			
	Brent at Costons Lane Greenford (39131)	TQ149822			
Hydraulic information (Ricardo EE)	Standard acoustic dopler current profiler (ADCP) and multi beam sonar at each site showing bed profile, flow and velocity profiling in Richmond Pound Site 1 (<1km downstream of Teddington Weir) and Richmond Pound Site 4 (<1km US of Richmond Half-tide Sluice).	TQ 16357 71829 TQ 18016 73965	Discharge (cubic metres per second) Depth (metres) Flow velocity (metres per second)	Instantaneous	One survey in October 2023 prior to Richmond Lock Drawdown. One survey at the end of November 2023 towards the end of the Richmond Lock Drawdown.
Hydraulic information (Ricardo EE)	Lower Thames areas of marginal habitat. Standard ADCP and multi beam sonar cross-section at each site showing bed profile, flow and velocity profiling. Riparian based bank profiling extension of the channel transect.	Sunbury Creek TQ 10093 67650 River Mole Confluence TQ 15656 68227 Trowlock Island back channel TQ 17602 70930	Discharge (cubic metres per second) Depth (metres) Flow velocity (metres per second)	Instantaneous	Three different flow conditions (taken between July – December 2023).
Bathymetry (Ricardo EE)	Full bathymetry and multi-beam sonar survey of weir pool to 200m downstream of weir.	TQ 17150 71358	Depth (metres)	Instantaneous	Three different flow conditions (taken between July – December 2023).

Data	Site name	NGR	Parameter	Frequency	Range
	To include flow and velocity profiling. To include 200m longitudinal mid-channel transect of DO and temperature CTD profiling. US Teddington Weir				
	Teddington Weir pool	TQ 16952 71443	Depth (metres)	Instantaneous	Three different flow conditions (taken between July - December) 23/24. Near bank surveys July 2024.
	Teddington Lock upstream	TQ166715	Depth (metres)	Instantaneous	Three different flow conditions (taken between July - December) 23/24. Near bank surveys July 2024.
STW effluent flow (Thames Water)	Mogden STW	TQ156749	Effluent discharge (cubic metres per day)	15 minutes	1 Jan 2010 to 31 December 2024.
Tidal level data (Port of London Authority)	Richmond Lock (downstream)	TQ169750	Tidal level (metres)	15 minutes	1 Jan 2011 to 1 Oct 2021.
	London Bridge (Tower Pier)	TQ328805			
Richmond Pound (Port of	Richmond Pound drawdown maintenance schedule	NA	Dates	Annual	2015-2023

Data	Site name	NGR	Parameter	Frequency	Range
London Authority)					
Weir and fish pass schematics	Schematic diagrams of each of the fish passes at Teddington Weir	NA	Elevation (metres Above Ordnance Datum)	---	N/A
Water company abstraction data at time of hydraulic surveys	Thames Water Hampton intake	TQ1337869216	Abstraction (cubic metres per second)	Hourly	1 Nov 2021 to 31 Dec 2024
	Thames Water Surbiton intake	TQ1664867120			
STW effluent flow (Thames Water)	Mogden STW	TQ1578175346	Effluent discharge (cubic metres per day)	15 minutes	1 Jan 2010 to 31 Dec 2024
	Beckton STW	TQ4547881673			
	Crossness STW	TQ4908980829			
River flow data (National Rivers Flow Archive)	River Thames at Walton (39121)	TQ099670	River discharge (cubic metres per second)	Daily	1 Jan 1990 - 31 Dec 2024 (or where available in this time period)
	River Thames at Kingston (39001)	TQ177698			
	Beverley Brook at Wimbledon Common (39005)	TQ216717			
	Wandle at South Wimbledon (39003)	TQ265705			
	Ravensbourne at Catford Hill (39056)	TQ372732			
	Quaggy at Manor House Gardens (39095)	TQ394748			
	Cray at Crayford (40016)	TQ510745			
	Darent at Hawley (40012)	TQ552718			

Data	Site name	NGR	Parameter	Frequency	Range
	Crane at Marsh Farm (39094)	TQ154734			
	Brent at Costons Lane Greenford (39131)	TQ149822			
	Lee Flood Relief Channel at Low Hall (38023)	TQ356880			
	Lee Navigation at Lea Bridge Weir (38032)	TQ351872			
	River Roding at Redbridge (37001)	TQ414883			
	Beam at Bretons Farm (37019)	TQ515853			
	River Lee at Rye Bridge	TL385098			
	River Stort at Glen Faba	TL391092			
	River Lee at Feildes Weir	TL390091			
	Cobbins Brook Ewardstone Road	TQ387999			
	River Lee Feildes Weir (ultrasonic)	TL3908508588			
	Lee FRC Rammey Marsh	TQ3758699888			
	Ingrebourne at Gaynes Park (37018)	TQ551861			
	Mar Dyke at Stifford (37034)	TQ596803			
Water level (Environment Agency)	Teddington Lock (Head)	TQ17007140	Water level (metres)	15 minutes	1 Jan 2011 to 31 December 2024
	Teddington Lock (Tail)	TQ17007140			

Primary water quality evidence

A.1.16 Environmental water quality data were collated for the period covering 1 January 2010 to 31 December 2024. The watercourses of the monitoring study area for the Project include:

a. The freshwater River Thames from Shepperton Weir to the tidal limit at Teddington.

b. The tidal River Thames from the tidal limit at Teddington to Battersea, which is the edge of the Thames Upper estuarine water body where the character of the estuary changes to brackish.

A.1.17 Water quality data for these watercourses were sourced from the Environment Agency and Thames Water United Ltd. In addition, water quality data pertaining to the STW discharging to these water courses were sourced from Thames Water.

A.1.18 Table A.3 details the primary evidence collected continuously from in situ water quality monitoring sondes. Table A.4 details the primary evidence collected by spot sample with laboratory analysis. Note several of the datasets have been used specifically to calibrate and validate the numerical models of the tidal River Thames, whose outputs are directly used by this assessment.

Table A.3 Environmental water quality evidence base: continuous sonde data

Data	Site Name	NGR	Parameter	Frequency	Range
Freshwater River Thames					
Thames Water	River Thames upstream of Hogsmill River	TQ 16648 67120	Temperature	30-minute	2020-2024
			Conductivity	30-minute	2020-2024
			Dissolved oxygen concentration	30-minute	2020-2024
Environment Agency	Teddington AQMS	TQ 16993 71348	Temperature	30-minute	2010-2017
			Dissolved oxygen concentration	30-minute	2010-2017
Thames Water	River Thames at Teddington Weir	TQ 17020 71370	Temperature	30-minute	2017-2018 2020-2024
			Conductivity	30-minute	2021-2024
			Dissolved oxygen concentration	30-minute	2017-2018 2020-2024
Tidal River Thames					
Environment Agency Meteor	Brentford Barge	TQ 18036 77023	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
			Turbidity	15-minute	2010-2024
	Kew Barge		Temperature	15-minute	2010-2024

Data	Site Name	NGR	Parameter	Frequency	Range
Environment Agency Meteor		TQ 19442 77635	Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
			Turbidity	15-minute	2010-2024
Environment Agency Meteor	Chiswick Pier	TQ 21670 77302	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
			Turbidity	15-minute	2010-2024
Environment Agency Meteor	Hammersmith	TQ 22954 78085	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
			Turbidity	15-minute	2010-2024
Environment Agency Meteor	Putney	TQ 24226 75735	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024

Data	Site Name	NGR	Parameter	Frequency	Range
			Turbidity	15-minute	2010-2024
Environment Agency Meteor	Cadogan Pier	TQ 27406 77517	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
			Turbidity	15-minute	2010-2024
Thames Water	Tower Pier	TQ 33331 80494	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
Thames Water	Greenwich Pier	TQ 38344 78010	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
Thames Water	North Greenwich Pier	TQ 39544 80055	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
Environment Agency Meteor	Barrier Gardens Pier	TQ 41831 79401	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024

Data	Site Name	NGR	Parameter	Frequency	Range
			Dissolved oxygen concentration	15-minute	2010-2024
Thames Water	Pier at Crossness STW	TQ 48935 81132	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
Environment Agency Meteor	Erith Barge	TQ 51615 78300	Temperature	15-minute	2010-2024
			Conductivity	15-minute	2010-2024
			pH	15-minute	2010-2024
			Dissolved oxygen concentration	15-minute	2010-2024
Environment Agency Meteor	Purfleet	TQ 56728 76774	Temperature	15-minute	2016-2024
			Conductivity	15-minute	2016-2024
			pH	15-minute	2016-2024
			Dissolved oxygen concentration	15-minute	2016-2024
Sewage					
Thames Water	Mogden STW Final Effluent	TQ 16777 75653	Temperature	30-minute	2010-2024
			Conductivity	30-minute	2021-2024
			Dissolved oxygen concentration	30-minute	2010-2024

Table A.4 Environmental water quality evidence base: spot sampling data

Data	Site Name	NGR	Parameter/Suite	Frequency	Range
Freshwater River Thames					
Environment Agency WIMS	River Thames at Teddington Weir	TQ 17103 71351	Water temperature	13 spot values	2015
			Dissolved oxygen	12 spot values	2015
			Ammonia	12 spot values	2015
			Chlorophyll	12 spot values	2015
			Ortho Phosphate	12 spot values	2015
			Total Phosphorus	12 spot values	2015
Thames Water	River Thames at Teddington Weir	TQ 17020 71370	Ammonia	Four spot values	2021
			Chlorophyll	Four spot values	2021
			Ortho Phosphate	Four spot values	2021
			Total Phosphorus	Four spot values	2021
Environment Agency WIMS	River Wey above Thames (TH-PWER0030) River Mole above Thames (TH-PMLR0022)	TQ 07480 65520 TQ 15330 68180	Water temperature	Monthly	2015, 2021
			Dissolved oxygen	Monthly	2015, 2021
			Biochemical oxygen demand	Monthly	2015, 2021
			Ammonia	Monthly	2015, 2021
			Nitrite	Monthly	2015, 2021
			Nitrate	Monthly	2015, 2021
			Chlorophyll	Monthly	2015, 2021

Data	Site Name	NGR	Parameter/Suite	Frequency	Range
			Total Phosphorus	Monthly	2015, 2021
			Suspended solids	Monthly	2015, 2021
Thames Water	River Thames at Kingston Bridge	TQ 17756 69345	Olfaction suite	Monthly	2022-2024
Thames Water	River Thames at Teddington Weir	TQ 17020 71370	WFD Directions suite[1]	Monthly	2020-2024
			Suite of other chemicals with environmental quality standards[2]	Monthly	2020-2024
			Olfaction suite	Monthly	2021-2024
			Physico-chemical parameters	Monthly	2021-2024
Tidal River Thames					
Thames Water	Thames Tideway at Kew Bridge	TQ 19029 77799	WFD Directions suite	Monthly	2021-2024
			Olfaction suite	Monthly	2021-2024
			Physico-chemical parameters	Monthly	2021-2024
Environment Agency	Thames at Isleworth	TQ 16950 76060	Suspended Solids	Monthly	2020-2024
Sewage					

[1] With reference to chemicals listed as priority hazardous substances, priority substances and specific pollutants with environmental quality standards on gov.uk at https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit

[2] With reference to chemicals listed as other pollutants with environmental quality standards and chemicals with operational environmental quality standards on gov.uk at https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit

Data	Site Name	NGR	Parameter/Suite	Frequency	Range
Thames Water	Mogden STW Final Effluent	TQ 16777 75653	Biochemical oxygen demand	Daily	2011-2024
			Ammoniacal nitrogen	Daily	2011-2024
			Temperature	Infrequent	2011-2024
			Ortho Phosphate	Daily	2011-2024
			WFD Directions suite	Monthly	2020-2024
			Suite of other chemicals with environmental quality standards	Monthly	2020-2024
			Olfaction suite	Monthly	2021-2024

Freshwater River Thames; TELEMAC 2D hydrodynamic model

A.1.19 The hydrodynamic model used to simulate the reach of the River Thames was developed using the TELEMAC-2D model in 2022 during Gate 2 of the Regulators' Alliance for Progressing Infrastructure Development (RAPID) Gated process, covering the reach between Molesey Lock to Teddington Lock. The model reach was reduced to between ~270m upstream of the proposed intake to Teddington Weir and Teddington Lock for Gate 3 of the RAPID Gated Process in 2023/24 with some subsequent refinements.

A.1.20 The initial model developed for Gate 2 extended from Molesey Lock to Teddington Lock with a mesh size of ~3m at the river banks and increasing to 10m in coarser areas (with an 8% growth rate transitioning between the two mesh sizes), producing 79,000 mesh elements. Model channel banks were defined by superimposing Environment Agency bathymetry onto Ordnance Survey (OS) mapping. The bathymetry was defined using 2014 data collected by the Environment Agency, but this was subsequently updated using a composite of 2017-2021 data for the Gate 3 version of the model. When required, thin-plate-spline interpolation and extrapolation was used to process the bathymetry data, and when this was sparse or absent (e.g. downstream of Teddington Weir), best judgement extrapolation was used to enumerate these areas.

A.1.21 The hydrodynamic model is driven by upstream river flows and downstream water level, and downstream of Teddington Weir a water level of 3.88m above ordnance datum (AOD) is imposed as the lower boundary condition. For each model scenario, the initial conditions set flow velocities to zero, with water levels at 4.38m AOD upstream of Teddington Weir and 3.88m AOD downstream. The model runs last for 48 hours, with the first 24 hours allowing for flow stabilisation, followed by the final 24 hours simulating the operation of the Project. As the 2D version of TELEMAC was used, depth averaging across the vertical channel profile was used, and assumed that any vertical density variations are small, and that the river was uniformly mixed at Teddington. This allowed vertical velocity variations to be assumed to be logarithmic and simulated using appropriate 2D model equations. Model validation was undertaken by ensuring that the water level at Teddington Weir was close to the standard water level of 4.38m AOD.

A.1.22 The model was developed to simulate hydrodynamics (flow velocity and depth) and water temperature. Outputs were provided for each specific model run in the following formats:

a. Planform plots of the whole model area around the intake and outfall, including Teddington Weir to illustrate changes in hydrodynamics and water temperature between the baseline and the Project.

b. Cross-section plots at selected locations starting at the intake and continuing to just before Teddington Weir to illustrate vertical and horizontal changes in water flow velocity and temperature.

c. Selected longitudinal plots covering the model reach, with one located along the left bank, one along the right bank and one in the channel thalweg to illustrate vertical and horizontal changes in water flow velocity and temperature.

Tidal River Thames; TELEMAC 3D hydrodynamic model

A.1.23 The hydrodynamic model used to simulate the reach of the tidal Thames was developed from an existing TELEMAC 3D model of the tidal River Thames which was developed and calibrated for an AMP5 study and included a number of improvements which enhanced overall model accuracy linked to the availability of enhanced computing power and developments of the TELEMAC model software. The primary enhancement was linked to improved model mesh resolution and adding second order solvers for advection, improved representation of the Mogden sewer outfalls and verification of the operation of Richmond Sluice. The water quality component of the model used Delft3d-WAQ driven by the TELEMAC flow data, whose depth was integrated into Delft3d-WAQ as a depth average (identified as a suitable approximation for the area). The model covered the areas of the tidal River Thames from Teddington Weir to Southend.

A.1.24 With respect to flow hydrodynamics, the existing model, from which the current model was developed, was calibrated for the later September – early October 2004 period which included spring and neap tides and a pass forward flow at Teddington Weir of 800-1,000Ml/d. Validation of the updated model was further undertaken to include low flows during a period in December 2011 when pass forward flows at Teddington Weir were 400Ml/d. Water levels in the tidal River Thames section were validated using several Port of London Authority level gauges, specifically Teddington (downstream), Richmond Lock (downstream), Chelsea Bridge, Westminster, London Bridge (Tower Pier), Charlton, Silvertown, Erith and Tilbury for the December 2011 period. Good agreement between measured and modelled data was found in all calibrations, although a 1m discrepancy between measured and modelled levels occurred at Teddington due to the calibration period occurring during a draw off period on Richmond Sluice. This had no impact on downstream water levels or other determinands and the model was considered to be validated.

A.1.25 The model was developed to simulate a range of different determinands, specifically suspended sediments, dissolved oxygen (DO), and biochemical oxygen demand. The biochemical oxygen demand was modelled with both a relatively high rate decay fraction to represent sewage and a relatively low rate decay fraction to represent natural oxygen demand as well as sediment oxygen demand. Additionally, the model simulated ammoniacal nitrogen, temperature, and salinity, all of which were individually validated. Suspended sediments were validated using ADCP data monitoring flux through five specific transects collected during the AMP5 study between Tower Bridge and Crossness, while all other water quality determinands were validated using a range of measured data, including:

a. Environment Agency Air Quality Monitoring System (AQMS) at Chiswick, Kew Barges, Brentford Barges, Teddington Weir (upstream) for 2011-2015 for DO, temperature and salinity.

b. Ricardo/Thames Water sondes deployed throughout 2011-2015 at Syon Park (2013-2015), Isleworth Ait (2015), Richmond Lock (landward of lock, 2011, 2013-2015) and Richmond Pier (landward of lock, 2013-2015).

c. Environment Agency spot water quality samples (1995-2011 and later WIMS data) for Teddington, Richmond, Isleworth, Kew and Barnes.

d. Environment Agency spot samples from Mogden STW effluent (1995-2015).

e. Environment Agency AQMS data for Mogden STW effluent (2011, 2013-2015).

A.1.26 Specifically, DO was calibrated between 1-20 August 2011 when flows at Teddington Weir were generally below 800Ml/d and water temperature was calibrated for the period in August 2011. Overall the modelled data were in relatively good agreement throughout, with occasional deviations from the measured data in some places, particularly with respect to DO and temperature. The model was therefore deemed suitably calibrated and validated for use in the investigation.

A.1.27 Model outputs were provided for specific variables notably, flow velocity, tidal level, salinity, temperature and suspended sediments for each specific model run in the following formats:

a. Longitudinal plots along the entire model chainage from Teddington Lock to Southend, showing key statistical parameters (median and 95th percentile) and differences between the baseline and the Project runs.

b. Planform plots of specific model areas around Beckton and Mogden STWs to illustrate changes in determinands under a range of model scenarios.

c. Data extraction of determinands at key chainage intervals along the model reach to allow for custom visualisations.

d. Conservative tracer outputs providing tracer locations as cartesian coordinates and tracer concentrations.

A.2 Surface water resources and water quality baseline

A.2.1 The following section details the relevant baseline data from literature, surveys and data collected to support the assessment of the Project. Where numerical modelling has been undertaken for assessment of change, the baseline model scenarios are described alongside the assessment scenarios to allow for comparison.

A.2.2 Given the volume of data available for the freshwater River Thames and tidal River Thames, this appendix includes baseline data and numerical modelling relevant to the assessment of potential effects from the Project to ensure the assessment is proportionate.

A.2.3 The EIA Scoping assessment identified potential receptor for the Mogden STW existing discharge and Ham Playing Fields and Support Work Area as the tidal River Thames, and Burnell Avenue as the freshwater River Thames.

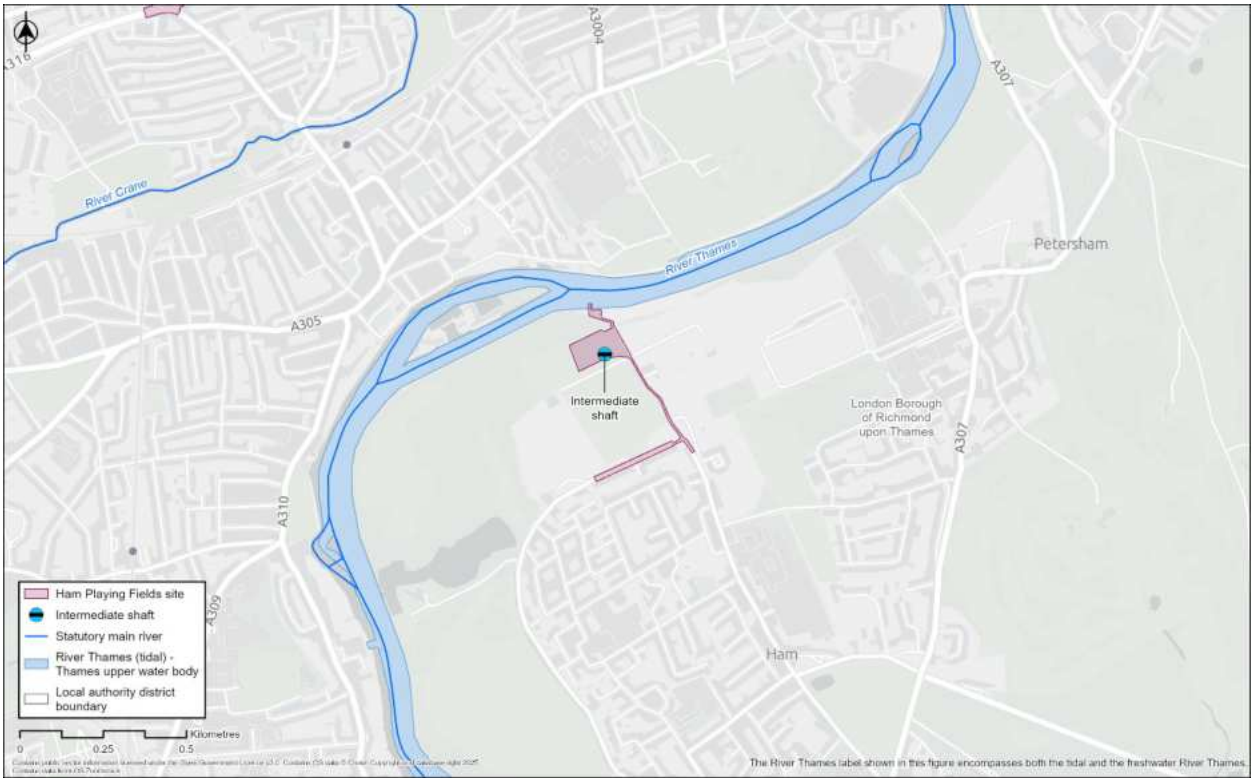
Ham Playing Fields

A.2.4 This section describes the relevant water resources and water quality baseline to support the impact assessment of potentially significant effects of the construction phase of the Project at Ham Playing Fields site. No potentially significant effects were identified for the operation phase at this site.

A.2.5 Ham Playing Fields site has been scoped in for assessment in PEI Report in Chapter 5 for the following construction activities: dewatering and contamination (such as accidental fuel spill, sediment runoff and the introduction of silt to the river and concrete runoff). The water quality baseline of the river and its sensitivity to contamination from sediment runoff and the introduction of silt is described under the Surface water quality section below. Scoping identified no construction phase activities associated with this site for the surface water resources aspects of hydrodynamics and geomorphology.

A.2.6 The location of development activities during construction at the Ham Playing Fields site is identified in Plate A.1 below.

Plate A.1 Development activities during construction at Ham Playing Fields site



Surface water quality

A.2.7 Ham Playing Fields site is located in proximity to the tidal River Thames in its half-tidal reach between Teddington Weir and Richmond Half-Tide Sluice. The Support Work Area boundary is adjacent to the tidal reach. The Main Work Area boundary is approximately 200m to 250m inland from the estuary bank.

A.2.8 The baseline considers the fine sediment character of the tidal River Thames as a potential receptor for runoff from Main Work Area and Support Work Area. Excess fine sediment in a watercourse creates negative impacts on physico-chemical water quality which are:

a. Turbidity – causing reduced light penetration.

b. Pollutant transfer – via adsorption of nutrients or metals onto fine sediment.

c. Sediment oxygen demand – increasing oxygen demand and reducing dissolved oxygen in the water column.

A.2.9 Excess fine sediment plays an important role in determining the environmental fate of many pollutants. This is due to the fact that fine sediment fractions (≤0.062mm[3]) are chemically active and negatively charged and therefore have the capacity to absorb a wide range of pollutants, such as nutrients like phosphorus (Walling and Collins, 2005), heavy metals such as mercury (Schoellhamer *et al.*, 2007) and pesticides via adsorption processes (Wang *et al.*, 2009). The amount of chemical interaction can be influenced by a range of factors such as sediment size, pollutant concentration, pH and redox potential.

[3] Silt and clay, using the Wentworth Scale (1922)

Changes in redox potential and pH may prompt the desorption of pollutants adsorbed to the surface of fine sediment particles. This allows the pollutants to enter the watercourse and be available for contamination of the water. Fine sediments therefore act as a source and a sink of pollutants. The fine sediment baseline of the tidal River Thames adjacent to the Support Work Area, and in proximity to the Main Work Area is evidenced under the Fine sediment in the water column section below.

A.2.10 Sediment Oxygen Demand is a contributor to reducing the amount of DO in the water column of watercourses (rivers, lakes and estuaries) (Giga and Uchrin, 1990). Sediment Oxygen Demand is the rate at which decomposing organic matter contained within the fine sediment load removes oxygen from the water column. Oxygen removal by Sediment Oxygen Demand is also governed by the reduction of ionic species such as iron (Fe^{2+}), manganese (Mn^{2+}) and sulphur (S^{2-}); the degradation of the organic matter in these fine sediments can also release adsorbed nutrients and heavy metals into the water column (Price *et al.*, 1994). Sediment Oxygen Demand from excessive fine sediments has the potential of causing both significant reduction of oxygen in the water column as well as an increase in pollutant substance (if these are adsorbed to the fine sediment particles or already present on the bed of a watercourse) (Sear *et al.*, 2003). The DO baseline of the tidal River Thames adjacent to the Support Work Area, and in proximity to the Main Work Area is evidenced under the Dissolved oxygen section below.

Fine sediment in the water column

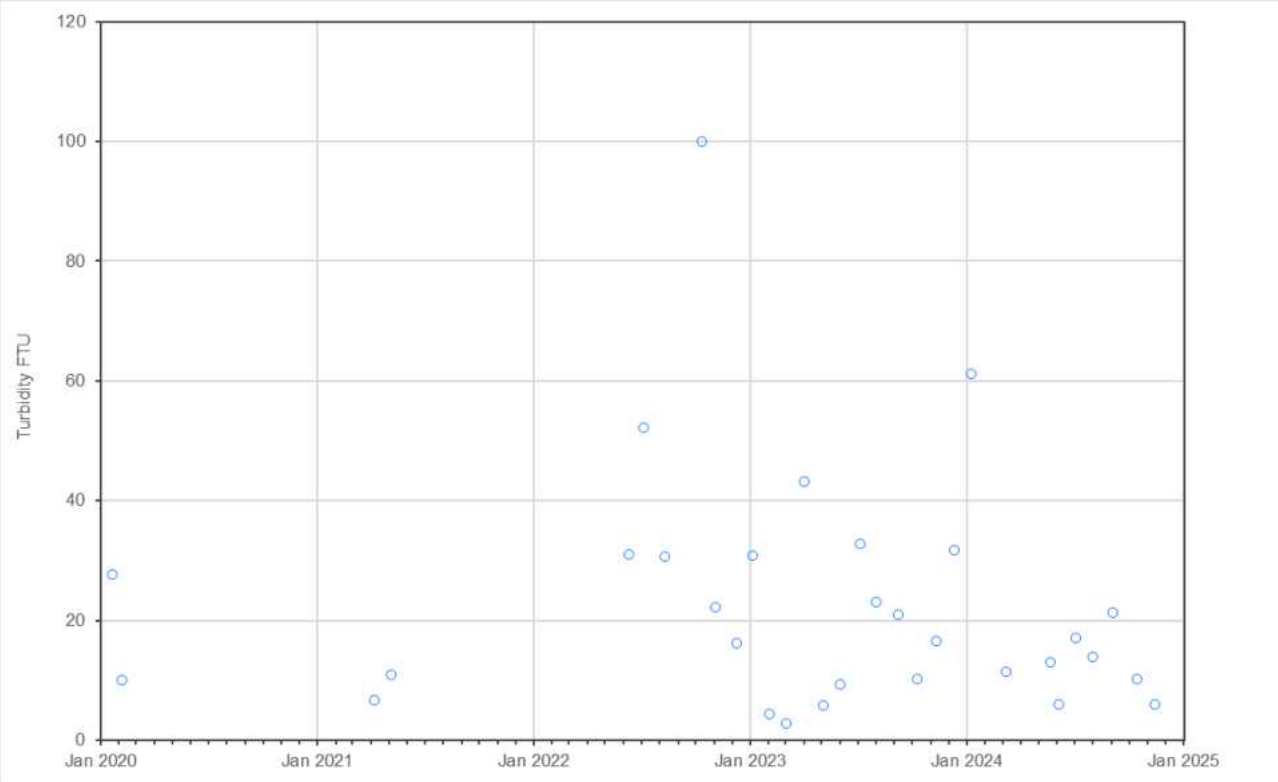
A.2.11 The baseline considers the finer sediments which are moved as suspended loads, which are particles ≤0.062mm in diameter. Fine sediments in this fraction are commonly derived from erosion of soil. Fine sediment is measured as suspended solids, which involves a laboratory measurement of a water sample to identify its suspended solid content. Turbidity is used as a surrogate. Turbidity is a measurement of how cloudy water is, essentially the number of particles of matter present in water and their ability to scatter light. Turbidity is not a measurement of the amount of sediment in the water, but rather a measurement of the amount of suspended matter, both inorganic and organic, of varying sizes.

A.2.12 A summary of the turbidity baseline can be seen in Table A.5 and Plate A.2. The closest available monitoring site subject to tidal conditions has been used, noting this is 4.0km seawards, fully tidal and in proximity to the treated sewage discharge from Mogden STW. There is no locally relevant suspended solids data. There are no regulatory standards for classifying the amount of suspended material in a river as an indicator of river health. Turbidity is reported as variable. Of the 31 turbidity samples in the period, 68% are 25 Formazin Turbidity Units (FTU) or less, with the remaining samples up to 100 FTU indicating that values can be considerably higher on occasion.

Table A.5 Fine sediment baseline data for the tidal River Thames locally to the Support Work Area site, and in proximity to the Ham Playing Fields site

Determinand	Units	Mean	Max	Median	Number of samples	Number greater than limit of detection
Turbidity[4]	FTU	22	100	17	31	31

Plate A.2 Turbidity spot samples, tidal River Thames at Isleworth (2020 – 2024 inclusive)



Dissolved oxygen (DO)

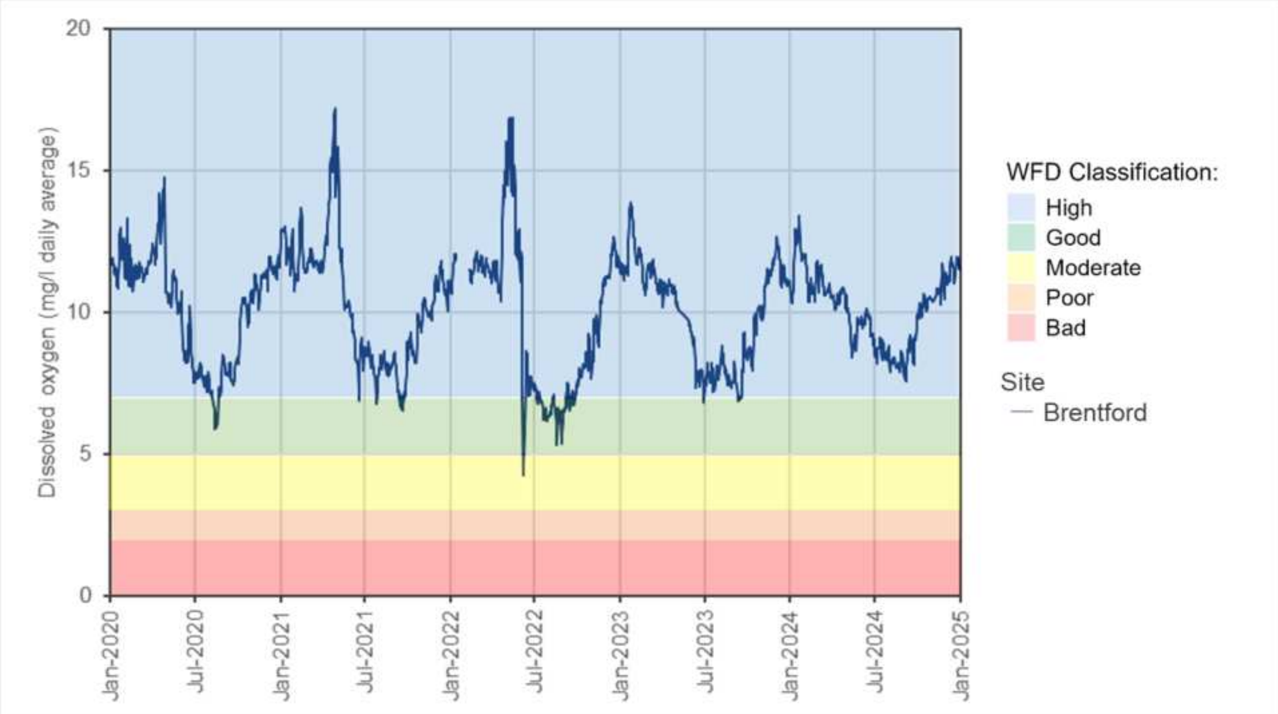
A.2.13 The baseline considers the DO quality of the tidal River Thames as a sensitive receptor to fine sediment contamination. Continuous monitoring data from a sonde at Brentford, with 15-minute recording, is used as evidence, with daily average values presented in Table A.6 and Plate A.3. The data identify DO concentration as routinely consistent with high status (using the WFD Directions standards for transitional waters). Supersaturation, associated with seasonal algal growth was recorded in late spring 2020, late spring 2021, and late spring 2022. This is followed by a seasonal reduction in DO saturation in each summer. These summer reductions are the only recorded periods of DO not consistent with high status.

[4] Data collected from EA WIMS Thames at Isleworth site from 2020-2024.

Table A.6 Dissolved oxygen baseline data for the tidal River Thames locally to the Support Work Area, and in proximity to the Main Work Area

Determinand	Units	Mean	Max	5th %ile (as used in WFD status classification by EA)
Dissolved oxygen[5]	mg/l	10.1	17.2	6.9

Plate A.3 Dissolved oxygen Sonde Readings (2020 – 2024 inclusive)



A.2.14 The Thames RBD 3rd cycle River Basin Management Plan (RBMP3) identifies the water body that includes this reach of the estuary[6] as without status for DO (2019) with an interim update (2022) of Good status. Based on this classification, the sensitivity of the Main Work Area and Support Work Area to fine sediment contamination is High.

Burnell Avenue

A.2.15 This section describes the relevant water resources and water quality baseline to support the impact assessment of potentially significant effects of the construction and operation phases of the Project at Burnell Avenue site.

[5] Data collected from EA WIMS Thames_Brentford Barge_E_200807 site from 2020-2024.

[6] Thames Upper Transitional Water Body: https://environment.data.gov.uk/catchment-planning/WaterBody/GB530603911403

Baseline relevant to construction activities

A.2.16 The Project construction activities which have been identified to require assessment for likely significant effects on water resources and flood risk at Burnell Avenue site are the following:

a. Construction of the intake and outfall structures at the bank or near the bank of the River Thames could lead to some localised impact on the geomorphology of the channel bank and bed.

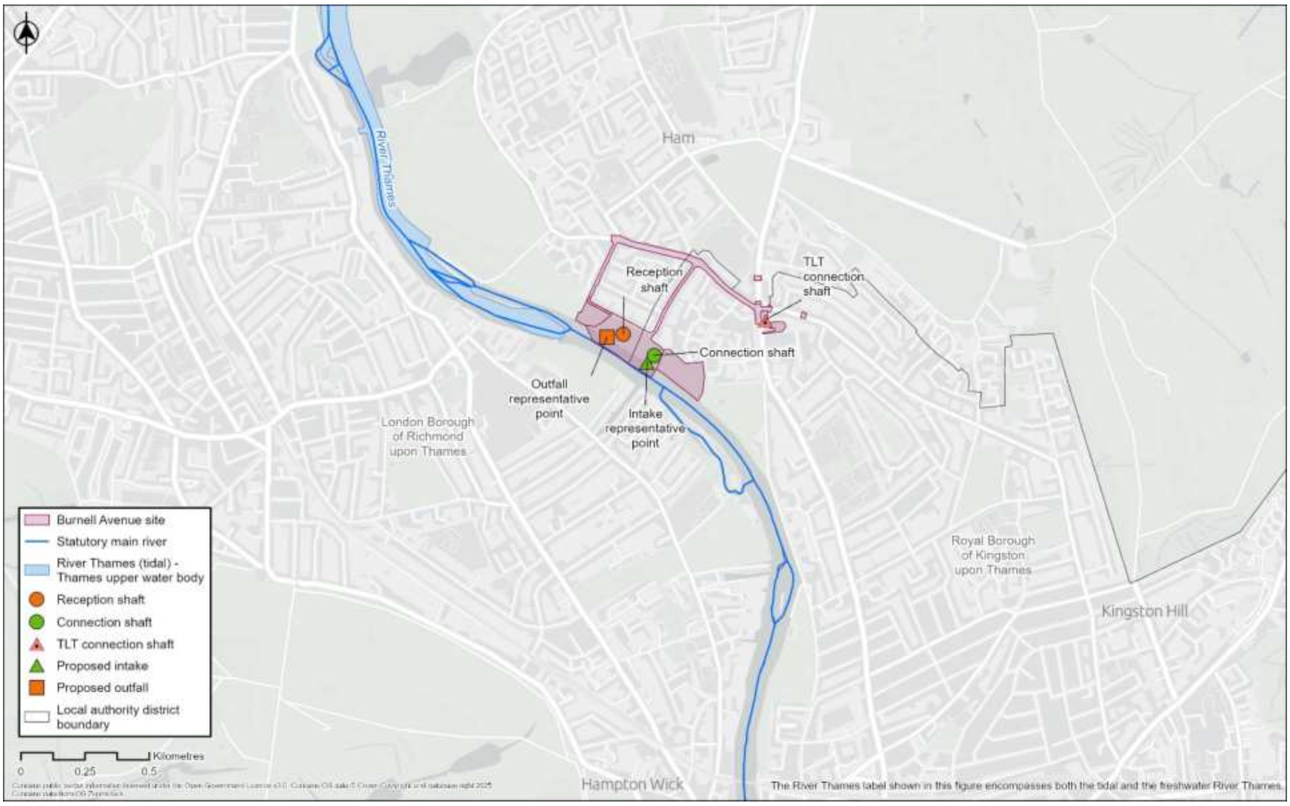
b. Locally at construction sites with pathways to surface waters, there is risk of temporary impacts on surface water quality from construction activities.

c. Excavation works, such as in the construction of the shafts, has the potential to cause localised changes to groundwater resources.

A.2.17 The geomorphology baseline of the river and its sensitivity is described under the Surface water resources section. The water quality baseline of the river and its sensitivity to contamination from sediment runoff and the introduction of silt is described under the Surface water quality section.

A.2.18 The location of development activities during construction at the Burnell Avenue site are identified in Plate A.4 below.

Plate A.4 Development activities during construction at Burnell Avenue



Surface water resources

A.2.19 The freshwater River Thames at Teddington, adjacent to the Burnell Avenue site, is a level managed and heavily modified urban river (see Plate A.5). Teddington Weir, situated on the River Thames serves as the artificial transition point between the river's non-tidal and tidal sections. Upstream of the weir, the Thames flows slowly and remains with a stable water level due to the weir's impounding effect, while downstream, current direction and water level are influenced by tidal changes from the North Sea.

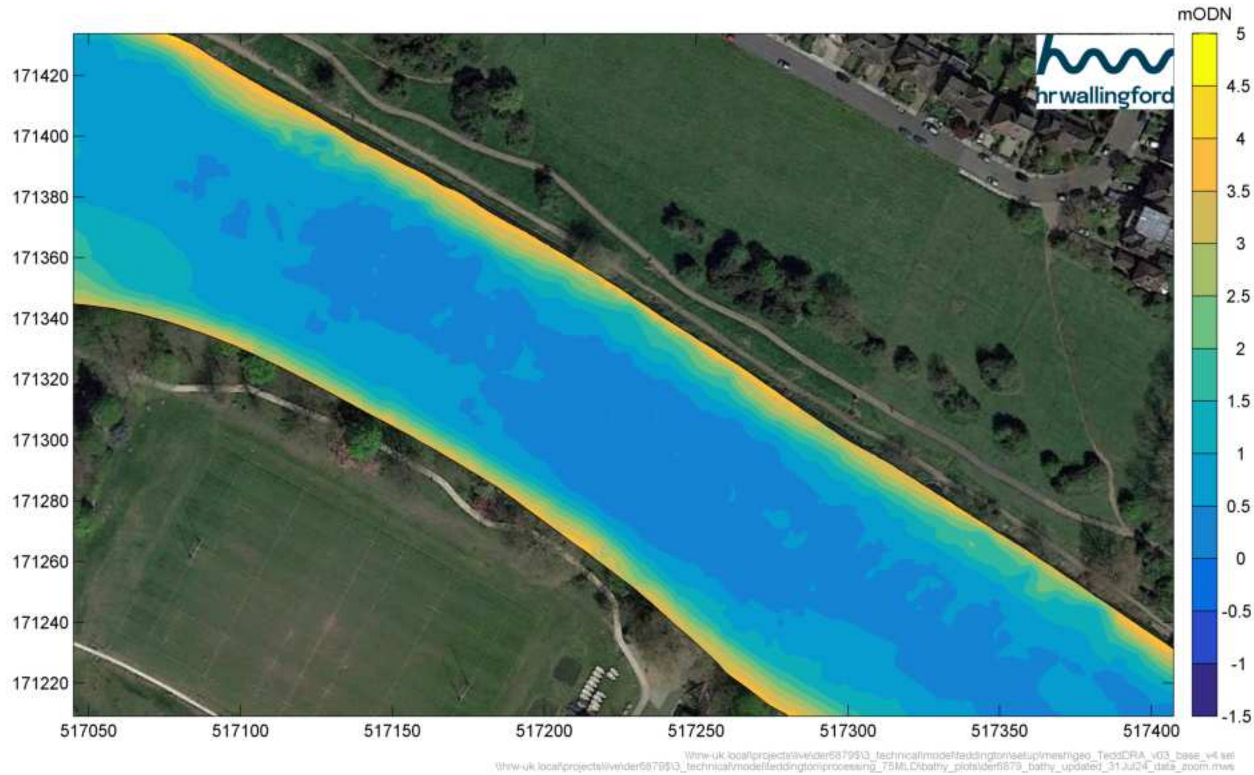
Plate A.5 Aerial image of freshwater River Thames from above Teddington Weir looking upstream to the Burnell Avenue site (image left), Ricardo 2024

A.2.20 Teddington Weir forms an artificially wide and deep channel for navigation, measuring approximately 80m in width and 4m in depth, as evidenced from bathymetric survey including the bank areas of the channel in 2024 (see Plate A.6). The banks are steep and reinforced with concrete or sheet piling, and this, combined with the slow-flowing, ponded reach, is likely to result in limited natural geomorphological processes. The weir is likely to have a significant impact on the natural functions of the Thames. In the Thames RBD RBMP3, the river water body this reach is in is acknowledged as non-natural for flow and geomorphology, designated as a heavily modified water body for the designated uses of drinking water supply, flood protection and navigation including ports. At RBMP3 the Environment Agency state[7] that mitigation

[7] Cf. water body objectives: https://environment.data.gov.uk/catchment-planning/WaterBody/GB106039023232

measures to reduce the impacts of these designated uses was not complete[8] and currently technically infeasible.

Plate A.6 Bathymetry of the River Thames adjacent to Burnell Avenue site from survey undertaken by Ricardo 2024



A.2.21 Several green open spaces, such as the Ham Lands local nature reserve, can be found near Teddington Weir. However, much of the surrounding land is residential or commercial, resulting in a lack of natural vegetation. This is compounded by the unnatural banks, allowing for limited to no marginal habitat for aquatic plants.

A.2.22 Although bed substrate has not been surveyed, there is likely fine sediment accumulation upstream of the weir. The artificially deep and slow-moving conditions created by the impounding effect allow sediments to settle, leading to the silting of the riverbed. In natural systems the flow of the river would sort and change the sediments to create new habitats. However, the impounding effect can often lead to homogenous, over-deep and slow flowing habitat. This process can negatively impact aquatic habitats and contribute to water quality problems. Beyond natural sediment, the slower flow also results in the accumulation of debris, such as shopping trolleys and bicycles, further degrading the river environment and creating the need for regular maintenance.

[8] Mitigation measures assessment is reported as “Moderate or less” which is not consistent with the Good Ecological Potential target which would recognise appropriate mitigation is in place.

A.2.23 Flows over the weir are managed by the Environment Agency through a system of controlled gates in the weir. Under low river flow conditions flow is mostly over the c.90m long fixed-crest side weir directing river flow along the true right of the river towards the lock cut and side weir. The weir also disrupts the movement of migratory fish species, presenting a physical barrier that prevents them from traveling freely between upstream and downstream habitats.

A.2.24 Fish and eel passes have been installed to mitigate this issue, they only provide a partial solution and themselves affect the current profile. The eel pass is installed at the end of the fixed-crest weir by the lock island and at low flows the Environment Agency operate the sluice gate at this point to assist a flow pathway to the eel pass. The multi-species fish pass is towards the true left of the river, a vertical slot on the river bank side of the two large roller sluices used to manage water level under high flow conditions. The multi-species fish pass conveys a lesser proportion of the flow under lowest flow conditions than the fixed-crest side weir.

A.2.25 In terms of future baseline, the Environment Agency are proposing to make structural amendments to the high flow conveyance of Teddington Weir, notably amending the two large roller sluices across to the centre of the river channel and installing a new multi-species fish pass between that structure and the true left bank. The proportion flow take of the proposed multi-species fish pass under low flow conditions is not currently available from the Environment Agency.

A.2.26 Operation of the lock also draws water along the lock cut, along the true right of the river. It is not known whether the Environment Agency, as navigation authority for the freshwater River Thames, have a planned dredging regime for the lock cut and main river. On spring tides Teddington Weir is overtopped at high water for short periods of time. This includes short periods of current reversal in the local area of the freshwater River Thames at Burnell Avenue. This also exacerbates the slow-moving conditions leading to fine sediment deposition upstream of Teddington Weir.

Surface water quality

A.2.27 As mentioned in the baseline section for Ham Playing Fields, the baseline considers the finer sediments which are moved as suspended loads, which are particles ≤0.062mm in diameter. The fine sediment baseline of the River Thames adjacent to the Burnell Avenue site is evidenced below under Fine sediment in the water column section. The DO baseline of the River Thames adjacent to the Burnell Avenue site is evidenced below under Dissolved oxygen section.

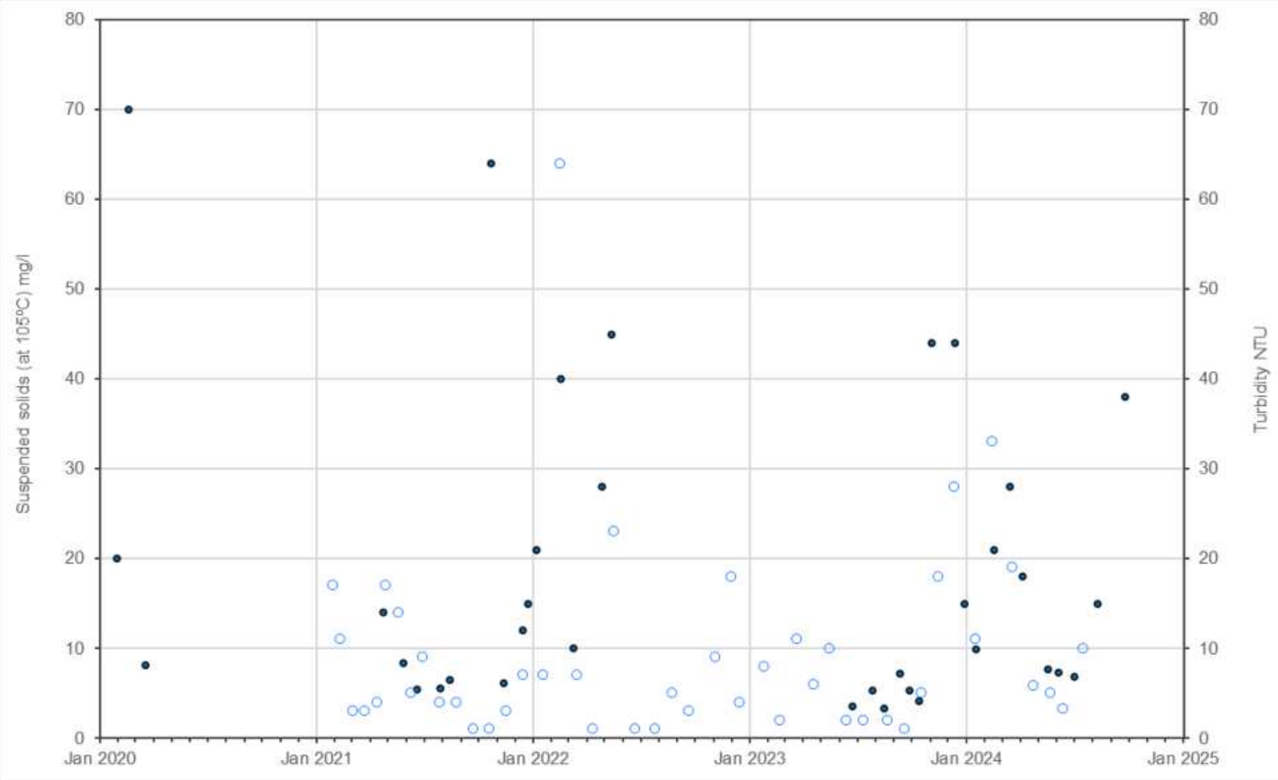
Fine sediment in the water column

A.2.28 A summary of the suspended solids and turbidity baseline can be seen in Table A.7 and Plate A.7. There are no regulatory standards for classifying the amount of suspended material in a river as an indicator of river health. Suspended solids concentration and turbidity are variable. Of the 35 suspended sediment samples in the period, 50% were 10mg/l or less, with the remaining samples up to 70mg/l indicating that values can be considerably higher on occasion. The same pattern of low base and variability to higher values is repeated for turbidity.

Table A.7 Fine sediment baseline data for the River Thames locally at Burnell Avenue site

Determinand	Units	Mean	Max	Median	Number of samples	Number greater than limit of detection
Suspended Solids[9]	mg/l	18.9	70	12	35	35
Turbidity[10]	NTU[11]	9.3	64	5.4	46	43

Plate A.7 Suspended solids (black dot) and turbidity (blue ring) spot samples, Thames at Teddington (2020 – 2024 inclusive)



Dissolved oxygen (DO)

A.2.29 The baseline considers the DO quality of the River Thames as a sensitive receptor to fine sediment contamination. Continuous monitoring data from a sonde at Teddington Weir, with hourly recording, is used as evidence, as presented in Table A.8 and summarised as daily average values Plate A.8. The data identify DO saturation as routinely consistent with high status (using the

[9] Data collected from EA WIMS Thames at Teddington site from 2020-2024

[10] Data collected by Thames Water at Teddington site from 2021-2024

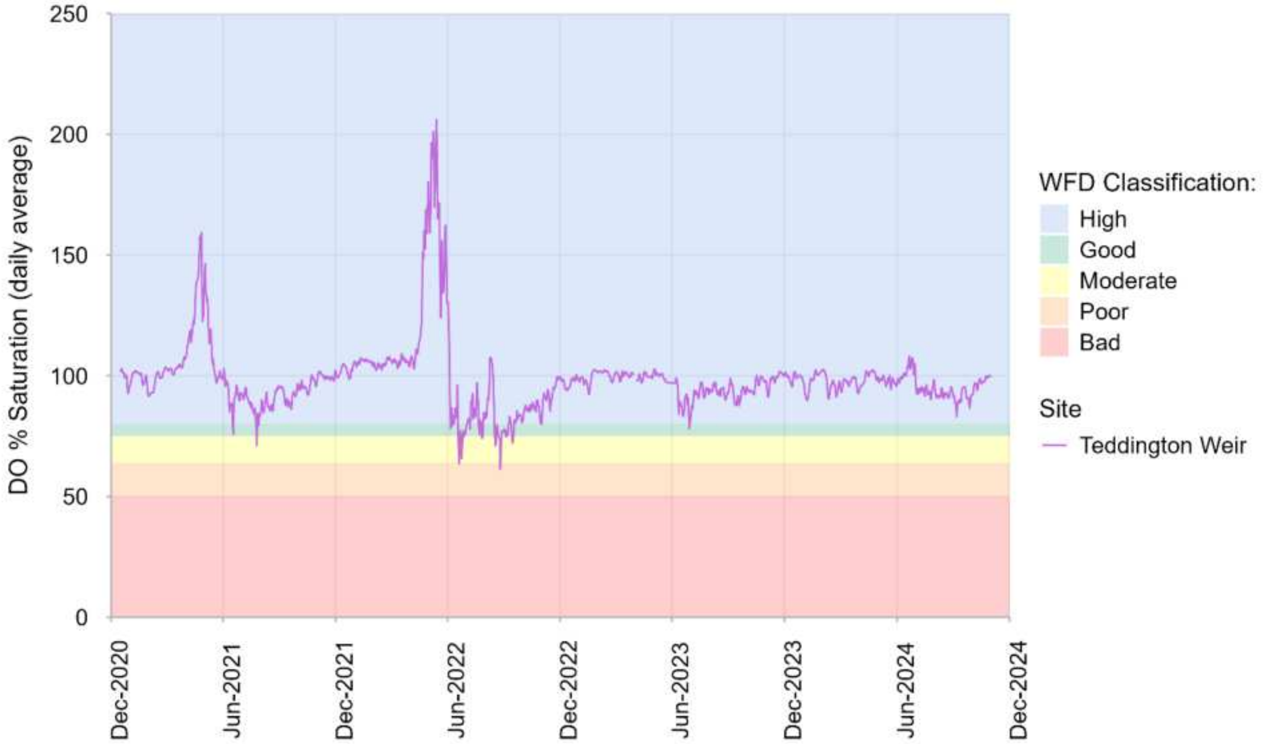
[11] Nephelometric Turbidity Units. Note 1 NTU ≡ 1 FTU

WFD Directions standards for salmonid waters). Supersaturation, associated with seasonal algal growth, is recorded in late spring 2021 and late spring 2022. This is followed by a reduction in DO saturation in early summer 2021, 2022 and to a lesser extent 2023. These summer reductions, associated with algal die-back are the only recorded periods of DO not consistent with high status.

Table A.8 Dissolved oxygen baseline data (hourly) for the River Thames locally at Burnell Avenue site

Determinand	Units	Mean	Max	10th %ile (as used in WFD status classification by EA)
Dissolved oxygen[12]	% saturation	98	264	85.3

Plate A.8 Dissolved oxygen Sonde Readings (Dec 2020 – Oct 2024)



A.2.30 The Thames RBD RBMP3 identifies the water body that includes this reach of river[13] as Good status for DO (2019) with an interim update (2022) also of Good status. This Good status is also reflected at the specific Environment Agency monitoring site closest to Burnell Avenue at Teddington Weir[14], in 2019 and 2022, noting this spot sampling site is a component part of the water body status classification by the Environment Agency. Based on this classification, the sensitivity of the Burnell Avenue site to fine sediment contamination is High.

[12] Data collected by Thames Water at Teddington site from 2021-2024

[13] Thames (Egham to Teddington) Water Body: https://environment.data.gov.uk/catchment-planning/WaterBody/GB106039023232

[14] https://environment.data.gov.uk/catchment-planning/MonitoringSite/353617

Baseline relevant to operation activities

A.2.31 The Burnell Avenue site has the following operational activities scoped in for assessment:

a. Abstraction at the intake, occurring during low river flow conditions, has the potential to locally impact river currents and river velocities, which may in turn impact geomorphological processes in the river such as sedimentation rates. River levels would remain the same as these are controlled by the weir level at Teddington Weir.

b. The input of recycled water, from the TTP, at the outfall would restore river flows and river velocities to those without the Project - in the length of remaining freshwater River Thames to Teddington Weir, and the river's contribution to the tidal River Thames over the weir. As the recycled water mixes into the river water locally at the outfall, there is potential for impact on the low river currents and low river velocities at times of low flow. The recycled water itself has the potential for impact on water quality standards in the River Thames, noting this would be treated at the TTP and would be subject to a discharge permit from the Environment Agency to ensure environmental protection. River and recycled water temperatures are similar during summer months, but seasonal differences in water temperature between the recycled water and river water identify there is the potential for impact on water temperature in the River Thames at the outfall itself, dispersing with river flow.

c. Where there is potential for the recycled water to affect the water quality or water temperature of the freshwater River Thames, there is the potential for water passed forward over Teddington Weir to affect the water quality and temperature in the tidal River Thames. Further investigation to be undertaken to determine the significance of the effect in the freshwater River Thames.

A.2.32 The geomorphological and hydromorphological baselines of the River Thames, including their sensitivity to flow changes and impacts on water currents and velocities, are described under Surface water resources. The water quality baseline of the river and its sensitivity to water temperature change and water quality standards from TTP discharge is described in Surface water quality.

A.2.33 The location of operation phase activities at the Burnell Avenue site are identified in Plate A.4.

A.2.34 TELEMAC-2D model has been developed and refined for the freshwater reach of the River Thames between Molesey and Teddington Weir to support the assessment of the hydrodynamic baseline of the freshwater River Thames and the potential impact of operation of the intake and outfall on river currents, flow velocity, water level and mixing of the discharge from the outfall into the river. The modelling focuses on an extent 270m upstream of the proposed intake and immediately downstream of Teddington Weir. The flows in the simulated channel reach are calibrated against measured flows.

Surface water resources

A.2.35 The Burnell Avenue site would include abstraction from the freshwater River Thames, with discharge of matching flow rate a short distance downstream at the outfall, with no net change in flow downstream.

A.2.36 The baseline considers the hydrodynamics of the freshwater River Thames in the zone of influence of the proposed intake and outfall. Potential hydrodynamic and geomorphological risks from the abstraction of river water and discharge of recycled water include:

a. River flow regime – change to flow quantity between intake and outfall – see River flow regime section below.

b. River depth and velocity characteristics – change in river hydrodynamics, potentially with linked effects to geomorphological change - see River depth and velocity characteristics section below.

River flow regime

A.2.37 The River Thames at its normal tidal limit of Teddington Weir drains a catchment (CEH, n.d.a) of 9,900km (EA, n.d.a). Downstream of Windsor there is significant influence of licenced abstraction for water resources on river flow, managed through the Lower Thames Operating Agreement (LTOA) and its Lower Thames Control Diagram (LTCD) between Thames Water and the Environmental Agency. This manages abstraction against river flow at the Environmental Agency's Kingston flow gauge (EA, EA, n.d.b), downstream of all abstractions, approximately 1.5km upstream of Burnell Avenue. The LTOA also includes controls relative to Thames Water's total amount of storage in its London Reservoirs and stated levels of service commitments to customers (Thames Water, 2024):

a. Under normal conditions, flows at Kingston are managed to maintain a minimum of 800Ml/d, although flows are routinely significantly higher (see Plate A.1).

b. In the spring, summer and autumn period from 1 March to 31 October, agreement between Environmental Agency and Thames Water can manage abstractions to maintain a minimum of 700Ml/d at Kingston. With reference to Plate A.9 these flows are occasional (9% of days) in the spring summer and autumn period.

c. In the spring, summer and autumn period from 1 March to 31 October, at Thames Water's Drought Saving Level 1 and following commencement of a media awareness campaign, agreement between Environmental Agency and Thames Water can manage abstractions to maintain a minimum of 300Ml/d at Kingston. With reference to Plate A.9, these flows are rare (1% of days) in the spring, summer and autumn period.

d. In the winter period from 1 November to 28/29 February, agreement between Environmental Agency and Thames Water can manage abstractions to maintain a minimum of 600Ml/d at Kingston. A flow target of 700Ml/d on 31 October transfers to a flow target of 600Ml/d on 1 November where river flows and reservoir storage are constant. With reference to Plate A.9, these flows are occasional (3% of days) in the winter period.

e. In the winter period from 1 November to 28/29 February, at Thames Water's Drought Saving Level 1 and following commencement of a media awareness campaign, agreement between Environmental Agency and Thames Water can manage abstractions to maintain a minimum of 400Ml/d at Kingston. This target is also applicable to Thames Water's Drought Saving Level 3. A flow target of 300Ml/d on 31 October transfers to a flow target of 400Ml/d on 1 November, where river flows and reservoir storage are constant, unless Drought Saving Level 3 is in place. With reference to Plate A.9, these flows are rare (2% of days) in the winter period.

f. In the winter period from 1 November to 28/29 February, at Thames Water's Drought Saving Level 3, the trigger of a severe drought - with non-essential use bans from Government and at the same trigger as application for drought permits by Thames Water, agreement between Environment Agency and Thames Water can manage abstractions to maintain a minimum of 300Ml/d at Kingston. With reference to Plate A.9, these flows are very rare (less than 1% of days) in the winter period.

A.2.38 For context, at times of low flow, naturalised flow at Kingston, without licenced water abstraction and permitted discharges, is higher (National River Flow Archive, n.d.). The naturalised Q99 extreme low flow statistic (1/1/1951-30/9/24) is 1,620Ml/d, compared to the gauged value of 325Ml/d as shown on Plate A.9.

A.2.39 The current LTCD has been in place since 2016 (Thames Water, 2022) and gauged flows earlier than then do not represent the abstraction management regime currently in place. Also, non-recent gauged flows do not represent the demand for water in London and abstraction rates for public water supply by both Thames Water and Affinity Water. Gauged river flows in this period are shown in Plate A.10. Daily flows are benchmarked against long term records for the period 1 January 1951 to 31 December 2025 using the flow band approach, which was initially created by the Centre for Ecology and Hydrology (CEH) (CEH, n.d.b). Low flows are variable across the nine-year period, with exceptionally low band flows recorded in five of the years. Most frequently, exceptionally low band flow dates were recorded 30 times in the water resources year 2017-18 and 25 times in 2022-23. In no other water resources year since 2016 were ten or more exceptionally low band flow dates recorded.

Plate A.9 Flow duration curve Thames at Kingston river flow gauge 1/1/1951-31/12/2024; also showing seasonal flows for periods consistent with LTOA

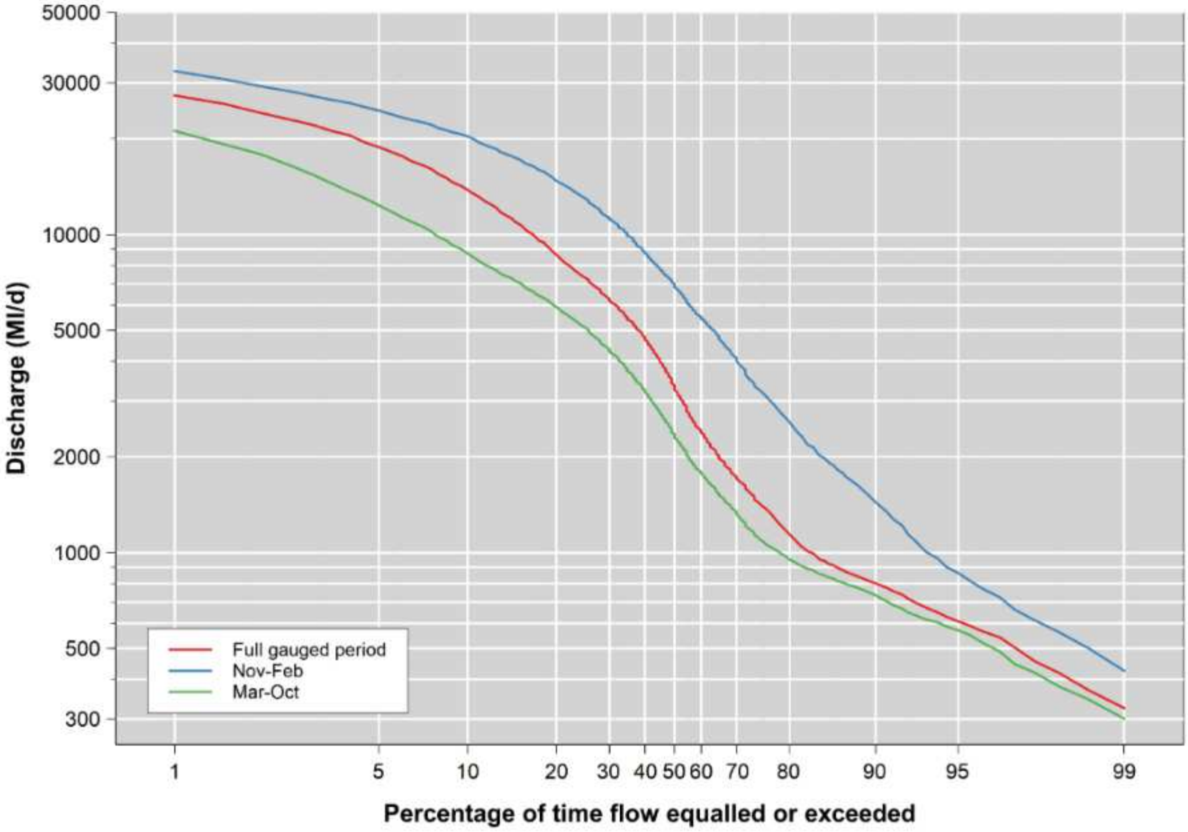
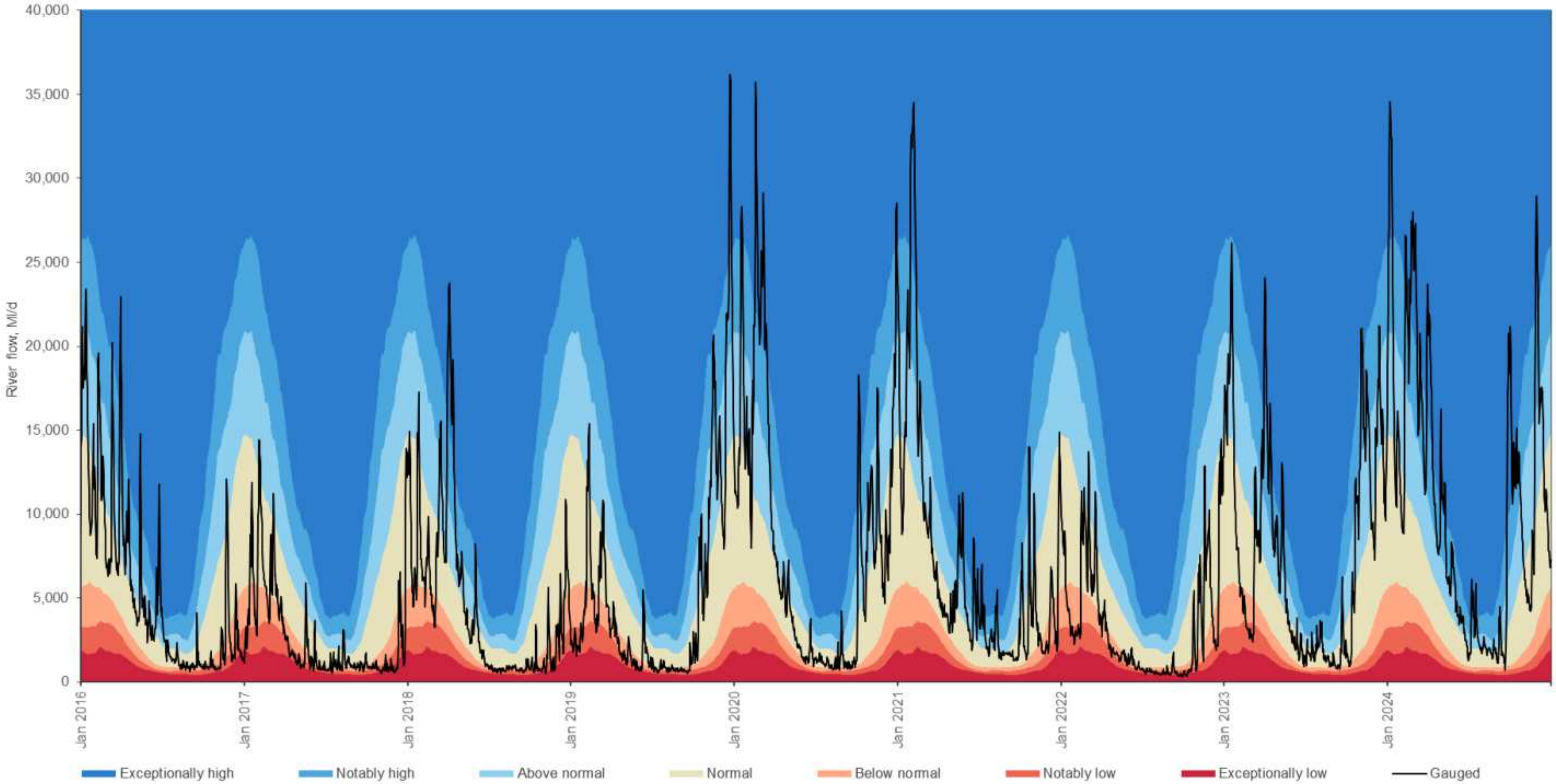


Plate A.10 Bands benchmarking the long-term typical flow regime for the Thames at Kingston river flow gauge 1/1/1951-31/12/2024; also showing gauged daily mean flow 1/1/2016-31/12/2024



A.2.40 The shortness of the gauged flow record of the River Thames since the change to the LTCD does not provide confidence in the potential river flow regime from which to undertake assessment. To support the environmental assessments representative years with typical flow characteristics of certain return frequency years have been developed. The approach uses the 19,200-year stochastic flow series developed for the River Thames catchment for the Water Resources South East (WRSE) group. The stochastic flow series represent contemporary climate conditions and provide information on the return frequency, or regularity, of river flow conditions. The full range of flows in the stochastic series for the Thames at Teddington are shown as a flow duration curve in Plate A.11. With reference to the gauged flow duration curve in Plate A.9, the model output shows a precision in abstraction to the flow management targets that is not achieved in reality. With this optimistic precision, there is an increase in managed abstractions to specific values in the model.

a. In the spring, summer and autumn period from 1 March to 31 October there are 10% of days with a management target of 700Ml/d at Teddington, with reference to in Plate A.11.

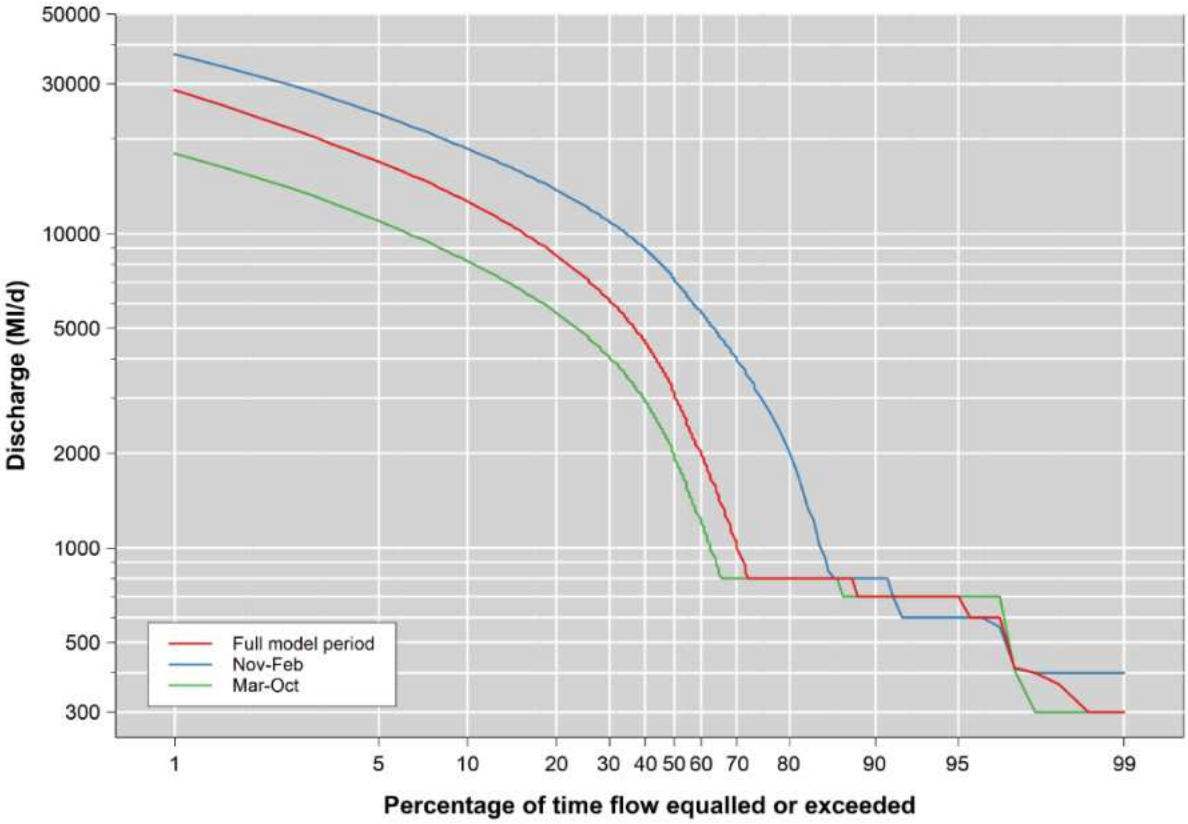
b. In the spring, summer and autumn period from 1 March to 31 October there are 1.5% of days with a management target of 300Ml/d at Teddington, with reference to in Plate A.11.

c. In the winter period from 1 November to 28/29 February there are 5% of days with a management target of 600Ml/d at Teddington, with reference to in Plate A.11.

d. In the winter period from 1 November to 28/29 February there are 2.5% of days with a management target of 400Ml/d at Teddington, with reference to in Plate A.11.

e. In the winter period from 1 November to 28/29 February there are less than 1% of days with a management target of 300Ml/d at Teddington, with reference to in Plate A.11.

Plate A.11 Flow duration curve Thames at Teddington WRSE stochastic flow series; also showing seasonal flows for periods consistent with LTOA



A.2.41 The representative model years selected for the assessment are

a. A 1:5 return frequency year with moderate-low flows in the River Thames at Teddington.

b. A 1:20 return frequency year with very low flow years in the River Thames at Teddington.

A.2.42 Noting the Project would only be used on a 1:20 return frequency, these scenarios capture a suitable range of circumstances and have been discussed and reviewed with the regulators during the Strategic Resource Options (SRO) Gated process.

A.2.43 To select the representative years, CEH flow bands were derived for each individual day from the full modelled 19,200 years and from these each year was assigned a return frequency based on the number of days in each flow band, weighted to the low bands. The modelled years were ranked in order of this weighted value, with drier years having a higher rank. This was converted into statistical measurement of the recurrence frequency, termed return period, for each modelled year. From these rankings, the 21 middle representative stochastic modelled years were selected for the 1 in 5 return period (moderate low flow) and the 1 in 20 return period (very low flow). The median value for each of the dates within the modelled years were used to define an average flow for each return period.

A.2.44 Visual comparison of the dominant patterns in seasonality of onset and break of the low flow period and the presence/absence of high flow episodes during the low flow period were used to guide the selection of individual representative years. For modelling purposes, the selected 1:5 return frequency moderate-low flow year is referenced as A82 and the 1:20 return frequency very low flow year is referenced as M96. The bands and selected years are shown in Plate A.12 and focussing on low flows only in Plate A.13.

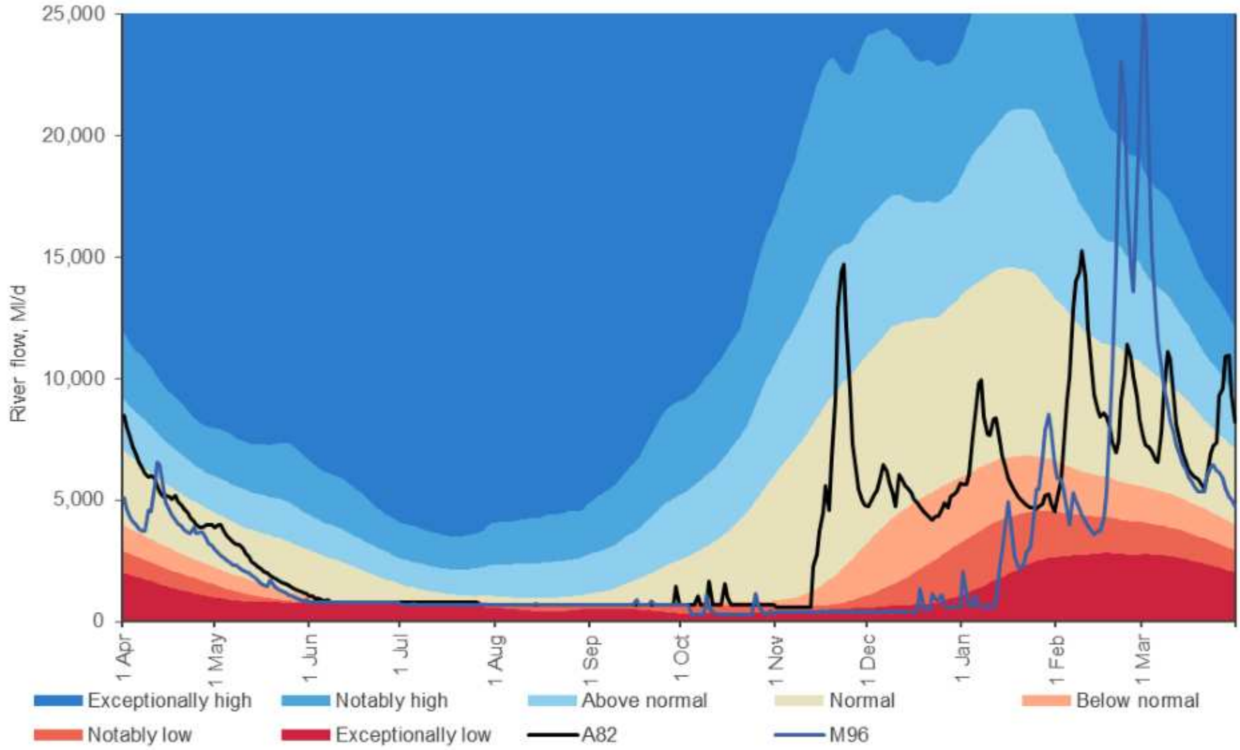
A.2.45 The representative 1:5 model year (A82) starts the water resources year with above normal flows that fall in line with the typical seasonal pattern while remaining in the normal band until June. From 8 June to 26 July flows are modelled as managed to the 800Ml/d abstraction management value, which is the lower edge of normal flows for the time of year.

A.2.46 From 27 July to 31 October flows are modelled as managed to the 700Ml/d abstraction management value – this is a below normal flow for later July/early August and from mid-September to end October, but a normal flow for early August to mid-September. During this period of management to the 700Ml/d abstraction management value there are three occasions of small flow elevations to around 1,500Ml/d, which is a typical pattern for a 1:5 return frequency year.

A.2.47 From 1 November the abstraction management value switches to 600Ml/d and this below normal flow is maintained for 12 days, edging notably low flow, before returning to normal flow, and then above normal on 21 November with a flow peak of 14,700Ml/d. The flow peak is short duration, and the winter does not include any notably high flows, but a pattern fluctuating between below normal, normal and above normal.

A.2.48 The water resources year ends in early spring with above normal flows. Reviewed against the gauged baseline in Plate A.9, the spring into summer transition is most similar to 2020, with the slight delay to return to normal autumn flows most similar to 2019, and the absence of notably high flows in the winter period similar to 2016/17 and 2018/19.

Plate A.12 Selected representative model years used in the assessment, full flow range



A.2.49 The representative 1:20 model year (M96) starts the water resources year with normal flows that fall faster than the typical seasonal pattern and become below normal by mid-May. From 1 June to 30 June flows are modelled as managed to the 800Ml/d abstraction management value, which is between below normal and normal flows for the time of year.

A.2.50 From 1 July to 3 October flows are modelled as managed to the 700Ml/d abstraction management value – this is an earlier onset than the typical pattern and notably low flow but becoming a normal flow by early August through to mid-September. The typical pattern for 1:20 return frequency years of no small flow elevations during the summer period is seen in the representative year.

A.2.51 From 4 October the abstraction management value reduces to 300Ml/d. 300Ml/d is an exceptionally low flow in early October. There are two small flow increases with brief increase to normal flows in October, as is the typical pattern for 1:20 return frequency years.

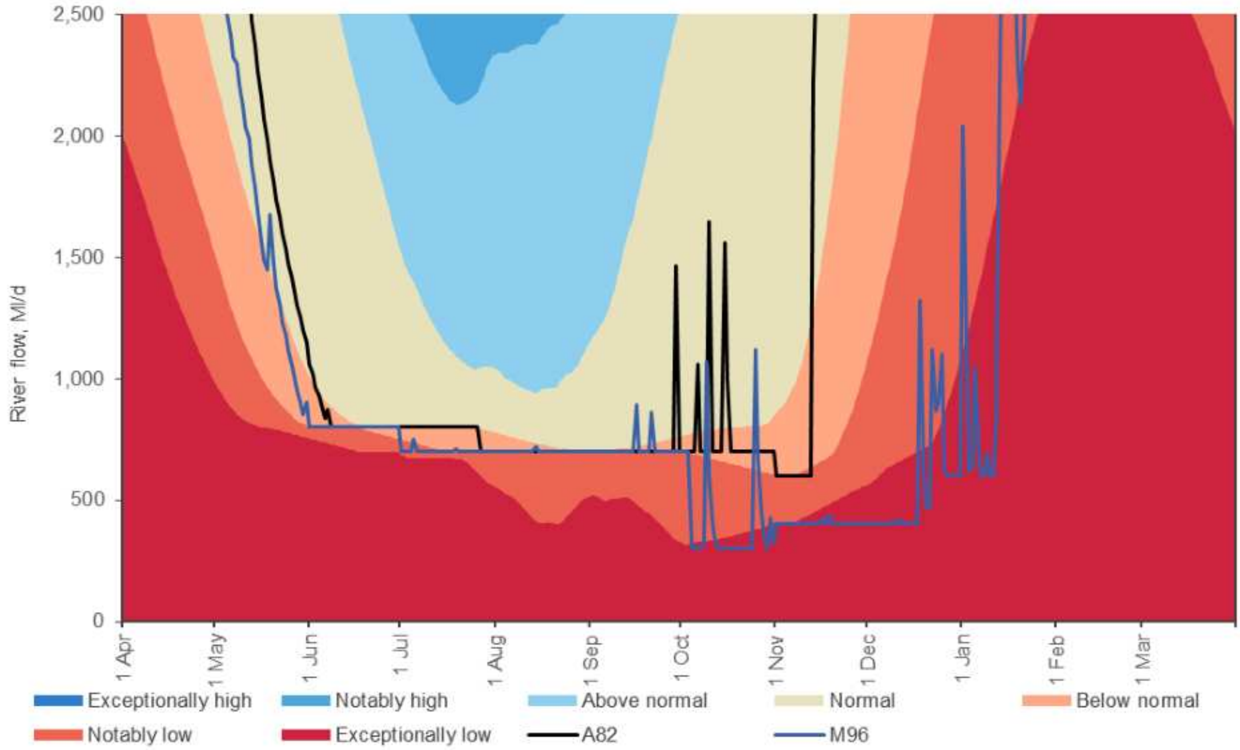
A.2.52 On 1 November the severe drought trigger has not been reached and the abstraction management value switches to 400Ml/d and remains as exceptionally low seasonal flow until the beginning of the return to higher flows on 18 December.

A.2.53 As the recovery to higher flows is seasonally very late, as is the typical pattern of 1:20 return frequency years, the flow remains as exceptionally low or notably low until mid-January, and still mostly notably low or below normal into mid-February.

A.2.54 By late February flows are exceptionally high, albeit those flows are not sustained, and the water resources year ends in early spring with normal flows. Reviewed against the gauged baseline in Plate A.10, the spring into summer transition is most similar to 2017 and 2022.

A.2.55 The summer and autumn low flows are more severe than those seen in 2016-2024. A late return to higher flows was seen in 2017, but again M96 and other representative 1:20 very low flow years include an extension to this pattern

Plate A.13 Selected representative model years used in the assessment, showing low flows only



River depth and velocity characteristics

A.2.56 Data for the baseline has been divided up based on the presence of six cross-sections (C1 to C6), three longitudinal sections (L1 to L3) and planform of the Project reach study area within the River Thames (Plate A.14). The proposed intake and outfall location are shown in order to ensure the baseline characterisation of the appropriate reach of river.

A.2.57 Outputs are presented as contour maps of depth-averaged current speed and surface excess temperature, and vertical sections (longitudinal and cross-sections) of current speed and excess temperature. The location and extent of the sections are shown in Plate A.14 and are summarised as:

a. C1: cross-section 50m upstream of the upstream edge of the intake screen.

b. C2: cross-section at the intake screen centreline.

c. C3: cross-section halfway between the upstream edge of the outfall channel and the upstream edge of the intake screen.

d. C4: cross-section at the outfall channel centreline.

e. C5: cross-section 50m downstream of the outfall channel centreline.

f. C6: cross-section 150m downstream of the upstream edge of the outfall channel.

g. L1: longitudinal section 10m from the right bank (when moving downstream).

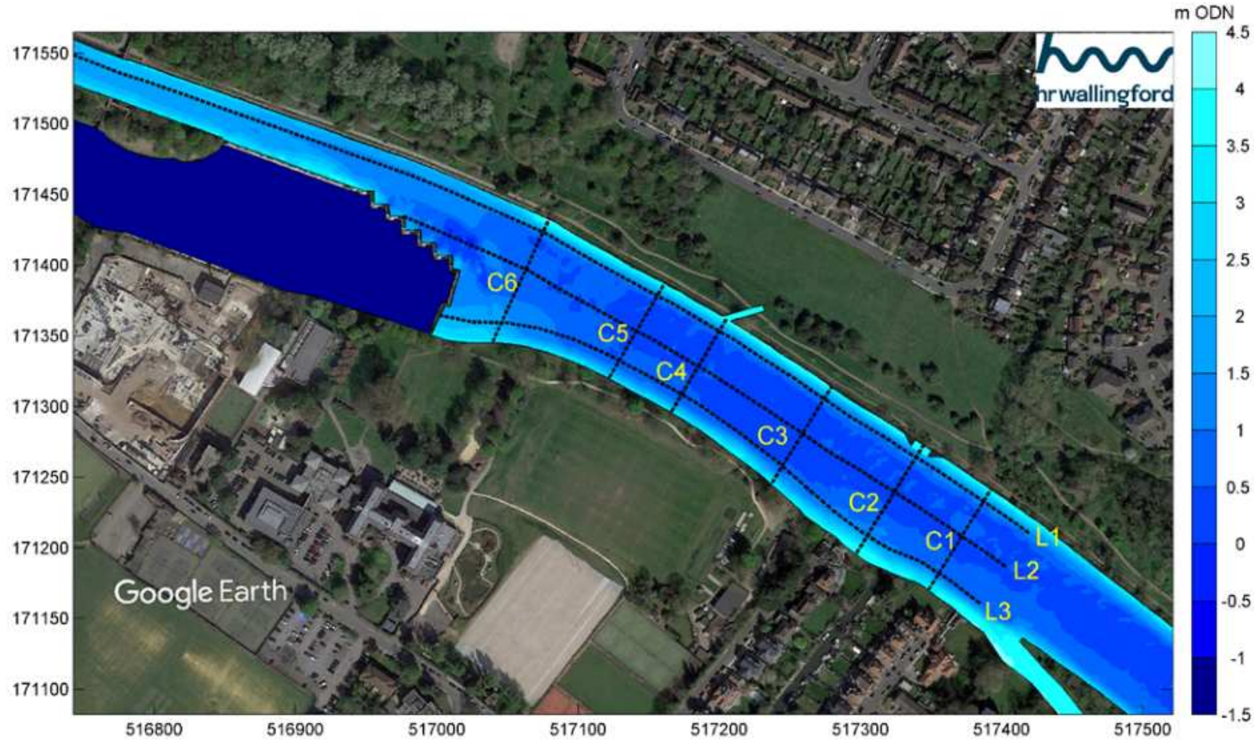
h. L2: longitudinal section at the centre of the river channel.

i. L3: longitudinal section 15m from the left bank (when moving downstream).

A.2.58 The contours used in the plan and cross-sections use the same colour scale for ease of comparison.

A.2.59 The cross-sections are oriented looking downstream and the longitudinal sections are oriented with the upstream end at 0m. Baseline output data from the modelling for 700Ml/d, 400Ml/d and 300Ml/d river flows are produced for each section. The 0m point on each cross-section is located on the left bank, while the 0m point on the longitudinal sections are located at the upstream start of the reach.

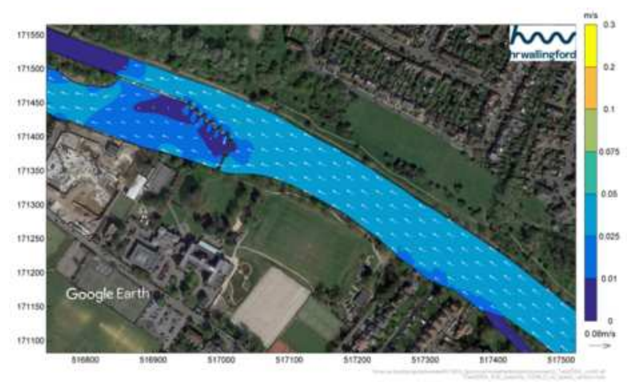
Plate A.14 Section locations for the Project model area



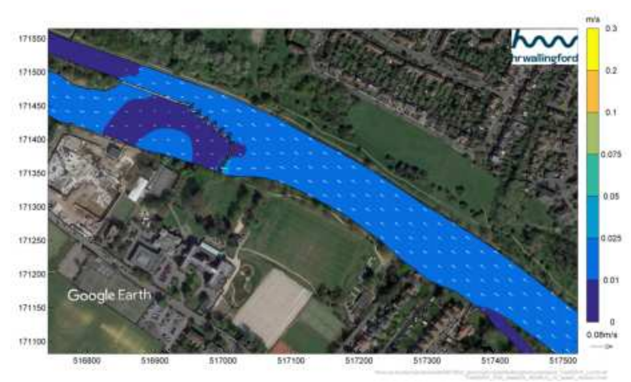
A.2.60 A) presents the baseline flow velocity planforms for each scenario; 700Ml/d, 400Ml/d, and 300Ml/d, A, B, and C, respectively.

Plate A.15 Modelled baseline flow velocity planforms

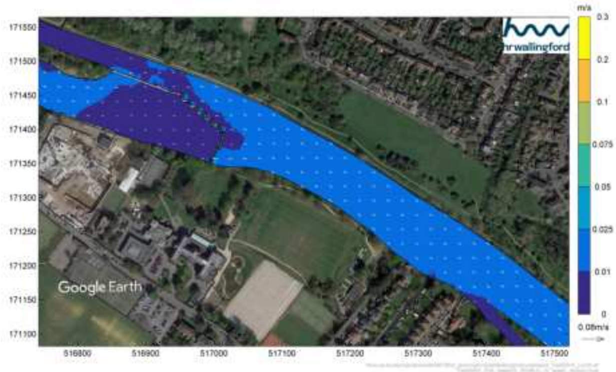
A) 700Ml/d



B) 400Ml/d



C) 300Ml/d



A.2.61 The 700Ml/d planform (A)A) shows most of the river with flow velocities of 0.025-0.05m/s, faster than the 300Ml/d and 400Ml/d baseline flows. Slow flow velocities are simulated within the weir pool and also in Teddington lock, where velocities of 0-0.01m/s occur. The 400Ml/d planform (A)B) indicates baseline flow velocities of 0.01-0.025m/s for the majority of the river to the weir, with slower velocities of between 0-0.01m/s at the weir pool. The baseline flows indicate increased flow velocities around the fish pass of 0.025-0.05m/s. The 300Ml/d planform (A)C) shows that the baseline velocity for most of the river to Teddington Weir is between 0.01-0.025m/s, with the weir pool area downstream of Teddington Weir having a flow velocity of between 0-0.01m/s. There is a localised increase in flow velocity of between 0.025-0.05m/s at the upstream face of the fish pass on the weir.

A.2.62 For each of the 700Ml/d, 400Ml/d and 300Ml/d scenarios, there are no gross changes in flow vectors, with these indicating downstream flow in a north-west direction towards Teddington weir, followed by a southerly flow over the weir and then resuming in a north westerly flow direction downstream of the weir.

A.2.63 Plate A.16 presents the baseline flow velocities for the 700Ml/d, 400Ml/d and 300Ml/d river flows for sections C1, C2 and C3 while Plate A.17 presents the baseline flow velocities for the 700Ml/d, 400Ml/d and 300Ml/d river flows for sections C4, C5 and C6. The locations of each cross-section are presented on Plate A.14.

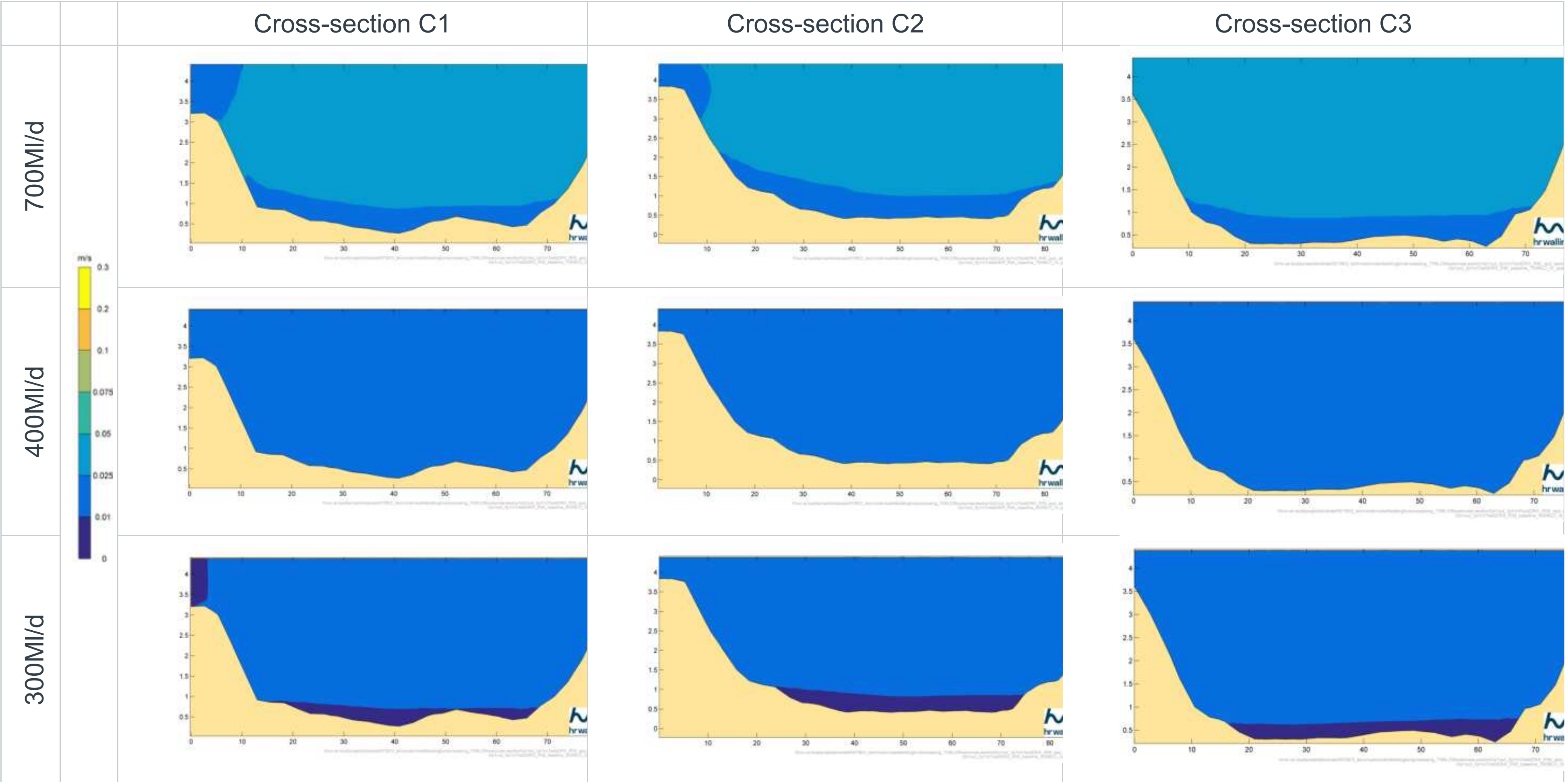


Plate A.16 Modelled baseline flow velocities for cross sections C1, C2 and C3

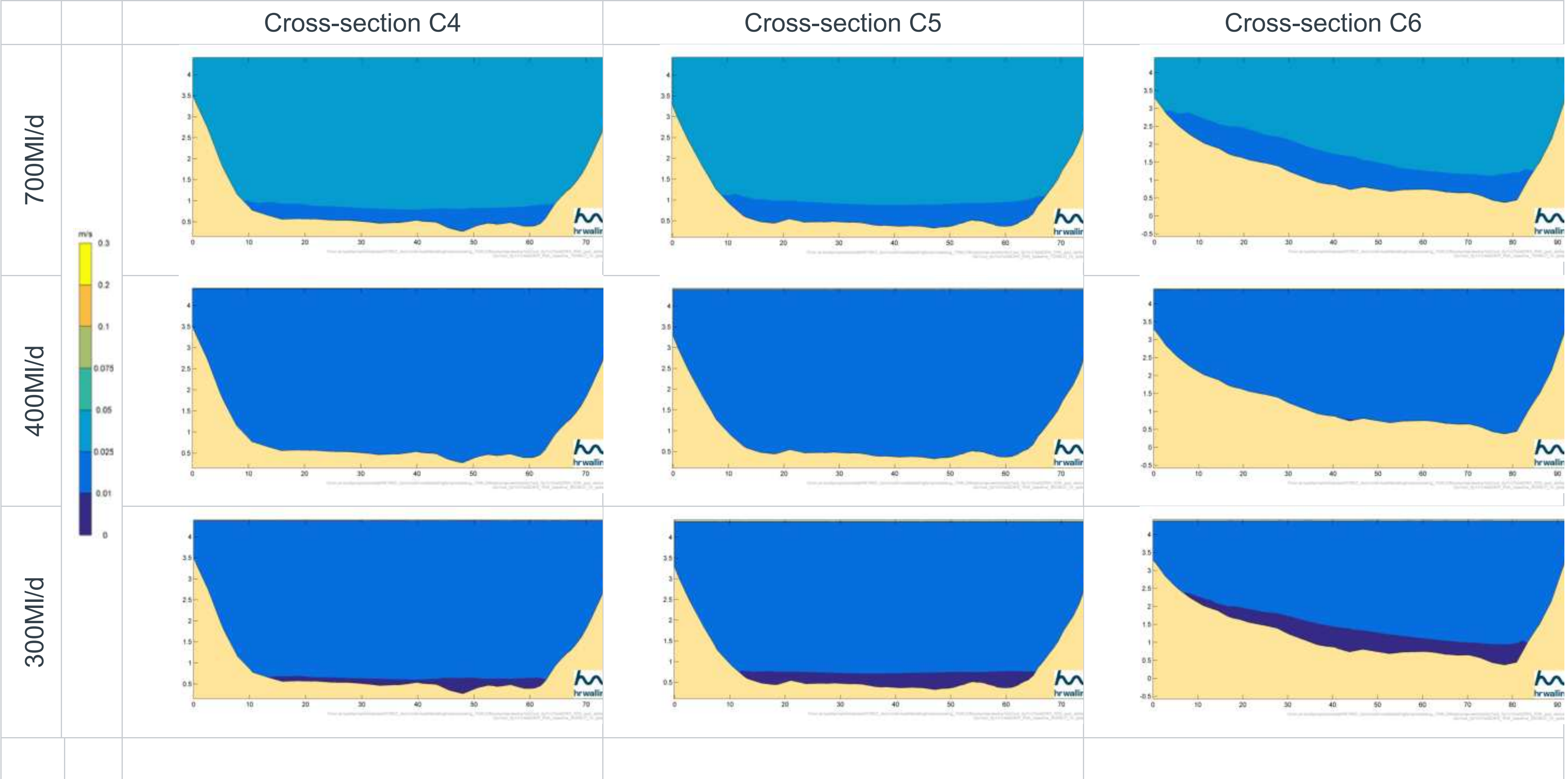


Plate A.17 Modelled baseline flow velocities for cross sections C4, C5 and C6

A.2.64 For context it is noted that in the section of the River Thames that is ponded upstream of Teddington Weir, river velocities are homogenous across the river channel, noting slower boundary layers at the channel bed and margins. The baseline flow velocities at each cross-section are briefly described below:

a. Cross-section C1 (Plate A.16):

   i. 700Ml/d flow – Flow velocities are predominantly 0.025-0.05m/s, with some slower flow velocities along the riverbed and on the right bank at 0.01-0.025m/s.

   ii. 400Ml/d flow – Flow velocities range from 0.01-0.25m/s uniformly over the cross-section.

   iii. 300Ml/d flow – Flow velocity is predominantly 0.01-0.025m/s, with the exception of localised areas on the right bank and close to the bed of the river where the velocity is 0-0.01m/s.

b. Cross-section C2 (Plate A.16):

   i. 700Ml/d flow – Flow velocities are predominantly 0.025-0.05m/s, with some slower flow velocities along the riverbed and on the right bank at 0.01-0.025m/s.

   ii. 400Ml/d flow – Flow velocities range from 0.01-0.25m/s uniformly over the cross-section.

   iii. 300Ml/d flow – Flow velocity is predominantly 0.01-0.025m/s, with the exception of the area close to the bed of the river where the velocity is 0-0.01m/s.

c. Cross-section C3 (Plate A.16):

   i. 700Ml/d flow – Flow velocities are predominantly 0.025-0.05m/s, with some slower velocities of 0.01-0.025m/s along the river bed.

   ii. 400Ml/d flow – Flow velocities range from 0.01-0.25m/s uniformly across the section.

   iii. 300Ml/d flow – Flow velocity is predominantly 0.01-0.025m/s, with the exception of the area close to the bed of the river where the velocity is 0-0.01m/s.

d. Cross-section C4 (Plate A.17):

   i. 700 Ml/d flow – Flow velocities are predominantly 0.025-0.05m/s, with some slower velocities along the river bed at 0.01-0.025m/s.

   ii. 400 Ml/d flow – Flow velocities range from 0.01-0.25m/s uniformly over the cross section.

   iii. 300 Ml/d flow – Flow velocity is predominantly 0.01-0.025m/s, with the exception of the area close to the bed of the river where the velocity is 0-0.01m/s.

e. Cross-section C5 (Plate A.17):

   i. 700 Ml/d flow – Flow velocities are predominantly 0.025-0.05m/s, with some slower velocities along the riverbed at 0.01-0.025m/s.

   ii. 400 Ml/d flow – Flow velocities range from 0.01-0.25m/s uniformly over the cross-section.

iii. 300 Ml/d flow – Flow velocity is predominantly 0.01-0.025m/s, with the exception of the area close to the bed of the river where the velocity is 0-0.01m/s.

f. Cross-section C6 (Plate A.17):

i. 700 Ml/d flow – Flow velocities are predominantly 0.025-0.05m/s, with some slower velocities along the river bed at 0.01-0.025m/s.

ii. 400 Ml/d flow – Flow velocities range nearly wholly from 0.01-0.25m/s over the cross section, with a very small area at around 43m across the reach at the bed where flow velocities are 0-0.01m/s.

iii. 300 Ml/d flow – Flow velocity is predominantly 0.01-0.025m/s, with the exception of the area close to the bed of the river where the velocity is 0-0.01m/s.

A.2.65 Plate A.18 presents the baseline flow velocities for the 700Ml/d, 400Ml/d and 300Ml/d river flows for the longitudinal sections L1, L2 and L3.

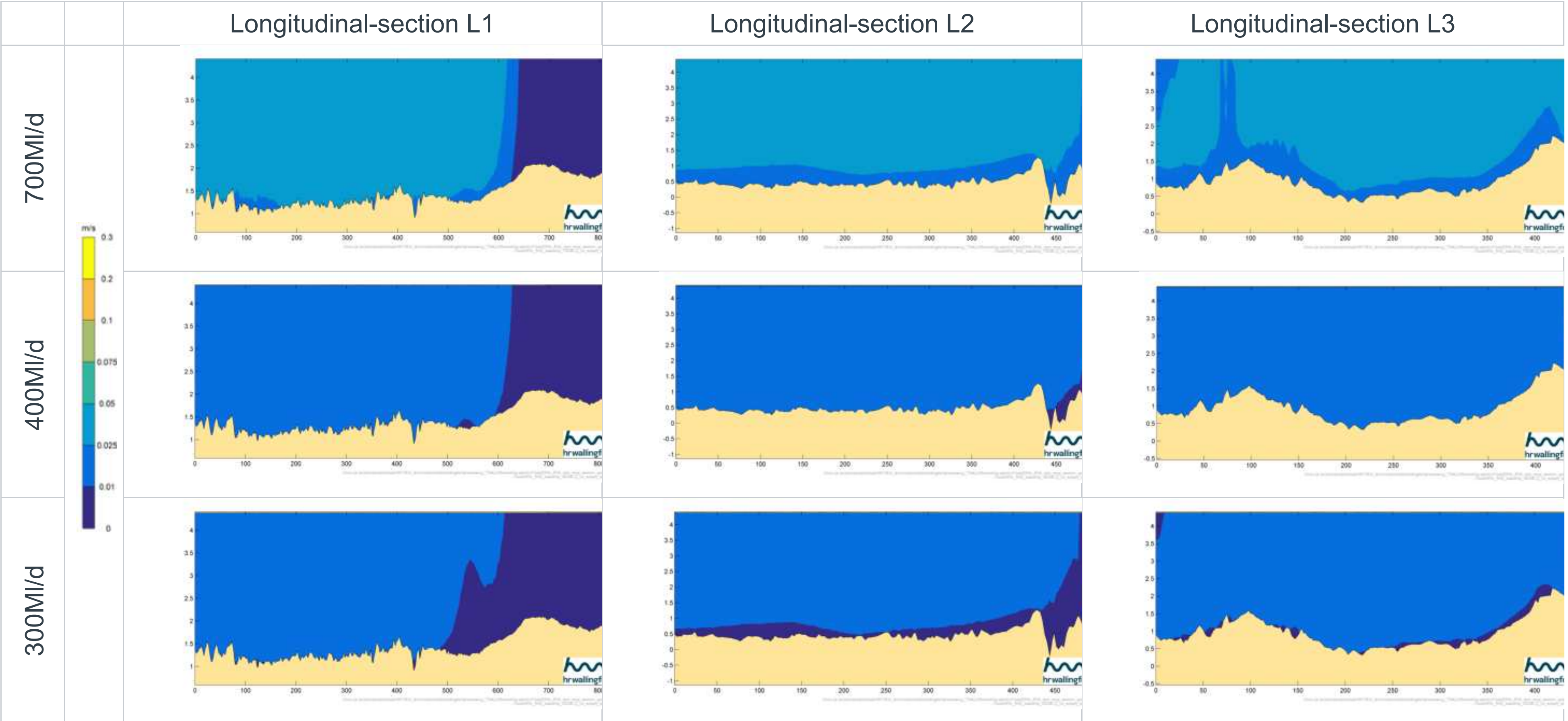


Plate A.18 Modelled baseline flow velocities for longitudinal sections L1, L2 and L3 moving downstream from left side of the plot (at 0m) to right side of the plot (at 450m downstream)

A.2.66 The baseline flow velocities at each longitudinal section are briefly described below.

a. Longitudinal section L1:
   i. **700Ml/d flow** – Flow velocity is predominantly 0.025-0.05m/s to ~600m, upon which velocities decline to 0.01-0.025m/s around ~650m chainage, followed by a further decline to 0-0.01m/s over the remaining section as Teddington Weir and lock is approached.
   ii. **400Ml/d flow** – Flow velocity is predominantly 0.01-0.025m/s to ~600m, upon which velocities decline to 0-0.01m/s over the section as Teddington Weir and lock is approached.
   iii. **300Ml/d flow** – Flow velocity is predominantly 0.01-0.025m/s down to ~500m upon which velocities decline to 0-0.01m/s over the whole section towards Teddington Weir and lock.
b. Longitudinal section L2:
   i. **700Ml/d flow** – Flow velocity is predominantly 0.025-0.05m/s over most of the section to ~500m chainage, with the exception of lower velocities of 0.01-0.025m/s forming a narrow band along the whole bed. From ~500m chainage, velocities decline to 0.01-0.025m/s over the whole section as Teddington Weir is approached.
   ii. **400Ml/d flow** – Flow velocity is predominantly 0.01-0.025m/s over most of the section. Two spatially limited areas of low velocities between 0-0.01m/s occur on the bed around ~450m chainage and at the very end of the section around Teddington Weir.
   iii. **300Ml/d flow** – Flow velocity is predominantly 0.01-0.025m/s over much of the section to ~450m chainage with the exception of lower velocities of 0-0.01m/s at the bed. From ~450m chainage velocities decline to 0-0.01m/s over the whole section as Teddington Weir is approached.
c. Longitudinal section L3:
   i. **700Ml/d flow** – Flow velocity is predominantly 0.025-0.05m/s over the majority of the section, with the exception of a slower band at 0.01-0.025m/s close to the bed for most of the section. There are also areas of lower flow velocities (0.01-0.025m/s) modelled at the start and ~80m chainage.
   ii. **400Ml/d flow** – Flow velocity is predominantly 0.01-0.025m/s over the majority of the section. There is a very spatially limited area of low velocity flow of 0-0.01m/s at the bed at the end of the section as well as a larger area of increased velocity of 0.025-0.05m/s covering two thirds of the section depth at the end of the section, likely in response to water flow over Teddington Weir.
   iii. **300Ml/d flow** – Flow velocity is predominantly 0.01-0.025m/s over the majority of the section. There are areas of lower flow velocity of 0-0.01m/s around the bed over most of the section at the surface around the start of the section. An area of increased velocity to 0.025-0.05m/s occurs at the surface at the end of the section, likely in response to water flow over Teddington Weir.

Surface water quality

A.2.67 The Burnell Avenue site would include discharge from the Project's outfall to the freshwater River Thames. The baseline considers the water quality of the freshwater River Thames at the point of proposed discharge. Potential water quality risks from the discharge of recycled water include:

a. Water temperature – change from local water conditions – see Water temperature.

b. General physico-chemical water quality – change to local conditions of pH, acid neutralising capacity, oxygen balance and ammonia – see General physico-chemical water quality.

c. Nutrient quality – change to local conditions of soluble, biologically available forms of phosphorus and nitrogen – see Nutrient quality.

d. Hazardous chemicals – change to local conditions of those chemicals listed in the WFD Directions[15] – see Hazardous chemicals.

Water temperature

A.2.68 The baseline considers the water temperature of the River Thames as a sensitive receptor to discharge of recycled water. Continuous monitoring data from a sonde at Teddington Weir, with hourly recording, is used as evidence, as presented in Table A.9 and Plate A.19. Water temperature follows a distinct seasonal pattern, warmer in the summer and colder in the winter. The daily average data identify water temperature as routinely consistent with high status (using the WFD Directions standards for salmonid waters) except in summer when values are routinely consistent with good status, and moderate status in the summers of 2013, 2018, 2020, 2021 and 2022. For purposes of impact assessment this pattern has been associated with the day of the year with a goodness of fit r^2 of 91%, as shown in Plate A.20.

Table A.9 Physico-chemical sonde measurements and indicative WFD classification

Determinand	Units	Mean	Mean	Max	98 %ile - WFD (Temp)
Water temperature[16]	ºC	2.0	12.8	24.4	22.1

[15] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

[16] Data collected by Thames Water at Teddington site from 2021-2024 for SRO programme
Data collected by Thames Water at Teddington site from 2017-2020 for non-SRO programme
Data collected by EA WIMS Thames at Teddington site pre-2016

Plate A.19 Teddington Temperature Sonde Readings (January 2010 – October 2024)

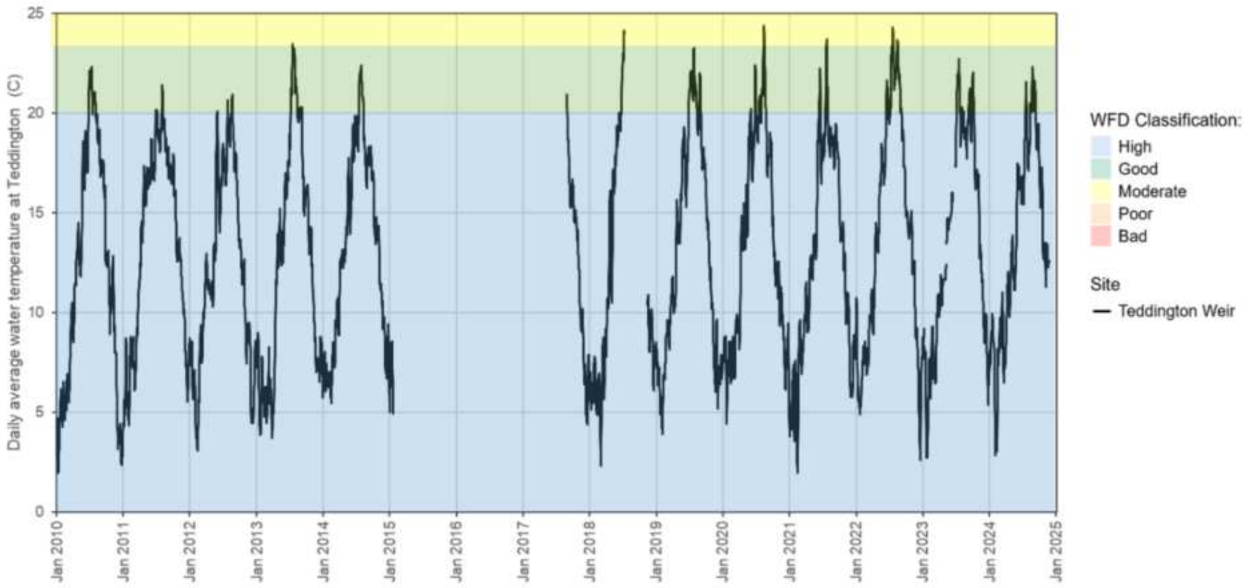
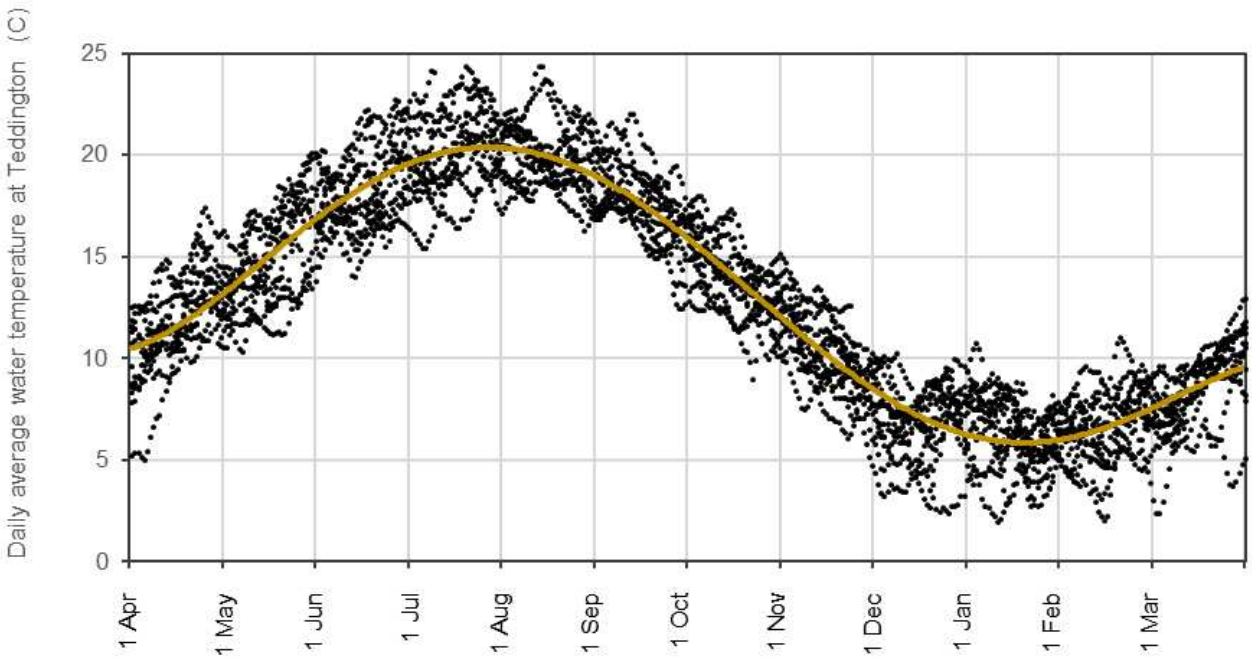


Plate A.20 Analysis of measured temperature from 2010-2024 (Teddington), best fit line in gold



A.2.69 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as Moderate status for temperature (2019) with an interim update (2022) also of Moderate status. This Moderate status is also reflected at the

[17] Thames (Egham to Teddington) Water Body: https://environment.data.gov.uk/catchment-planning/WaterBody/GB106039023232

Environment Agency monitoring site closest to Burnell Avenue, Thames at Teddington Weir (EA, n.d.c) in 2022. It is noted that the Environment Agency stopped continuous water temperature monitoring at this site in 2015 and status is now based on scheduled interval measurements. The Thames Water data since 2016 also indicates that temperature has stayed within the Moderate threshold for temperature. Based on this the sensitivity of the Burnell Avenue site water temperature change is Medium.

General physico-chemical water quality

pH

A.2.70 The baseline considers the pH for the River Thames to the discharge of recycled water. Hourly recordings from the continuous sonde at Teddington Weir, is presented in Table A.10 and Plate A.21. The pH data does not follow a seasonal pattern and indicates a High WFD status (using the WFD Directive standards for salmonid waters and acknowledging that only the Environment Agency can classify status).

A.2.71 The Thames Water data since 2020 indicated High status for pH at this site is reasonable and based on this classification, the sensitivity of the Burnell Avenue site pH changes is High.

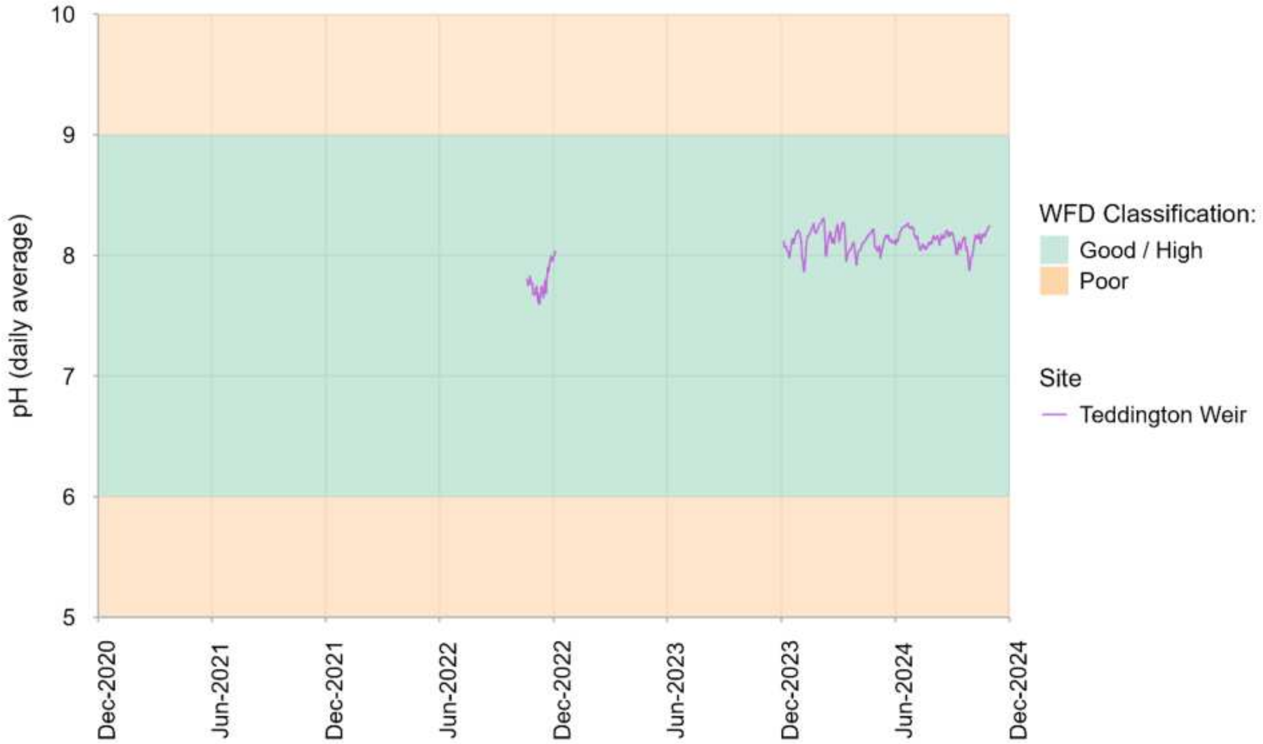
A.2.72 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as High status for pH (2019) with an interim update (2022) also of High status. This High status is also reflected at the specific Environment Agency monitoring site closest to Burnell Avenue, Thames at Teddington Weir, in 2022. The Thames Water data since 2020 indicated High status for pH at this site is reasonable and based on this classification, the sensitivity of the Burnell Avenue site acid neutralising capacity (ANC) changes is High.

Table A.10 pH measurements summary Thames at Teddington

Determinand	Units	Mean	Mean	Max	WFD (10 %ile)
pH[18]	pH Units	7.52	8.09	8.32	7.88

[18] Data collected Thames at Teddington 2022-2024

Plate A.21 pH sonde readings (Dec 2020 – Oct 2024)



Acid neutralising capacity (ANC)

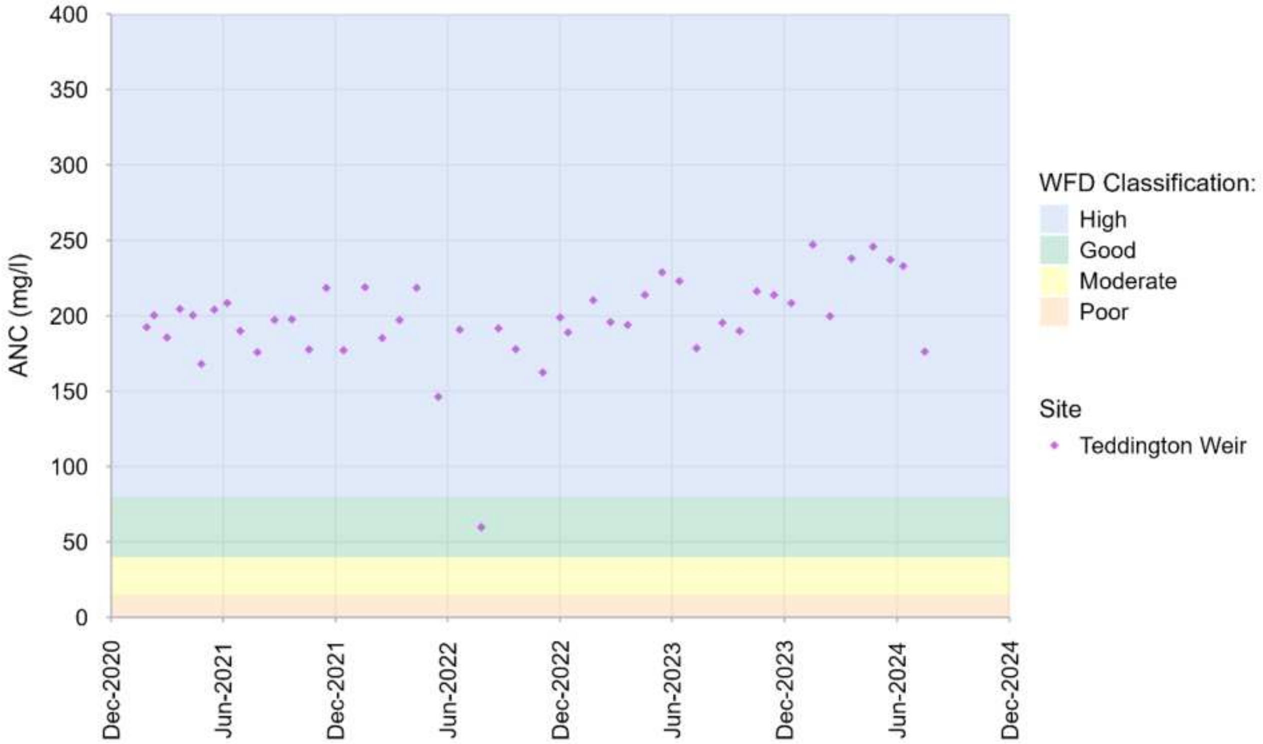
A.2.73 The baseline considered the ANC for the River Thames as a sensitive receptor to the discharge of recycled water. ANC is calculated using the Cantrell Method (Cantrell *et al.*, 1990) this method considers alkalinity and dissolved organic carbon to calculate ANC. The spot samples collected as part of the Thames Water SRO monitoring scheme are presented below Table A.11 and Plate A.22. It is considered to be consistent with High WFD status (using the WFD Directive standards for salmonid waters).

Table A.11 ANC summary Thames at Teddington

Determinand	Units	Mean	Mean	Max	WFD (mean)
ANC[19]	n/a	59.8	197	247	197

[19] Data collected Thames at Teddington 2020-2024

Plate A.22 ANC spot samples (Jan 2021 – Jul 2024)



Dissolved oxygen (DO)

A.2.74 The baseline considered the DO for the River Thames as a sensitive receptor to the discharge of recycled water. DO is continuously monitored, with hourly recordings, is used as evidence as presented in Table A.8 and Plate A.22. The DO readings are consistent with High status (using the WFD Directions standards for salmonid waters) except in summer when values in 2021 and 2022 were reduced. These reductions are likely due to algal dieback.

A.2.75 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as Good status for pH (2019) with an interim update (2022) also of Good status. This Good status is also reflected at the specific Environment Agency monitoring site closest to Burnell Avenue, *Thames at Teddington Weir (EA, n.d.c)* in 2019 and 2022, noting this spot sampling site is a component part of the water body status classification by the Environment Agency. Based on this classification, the sensitivity of the Burnell Avenue site to DO changes is High.

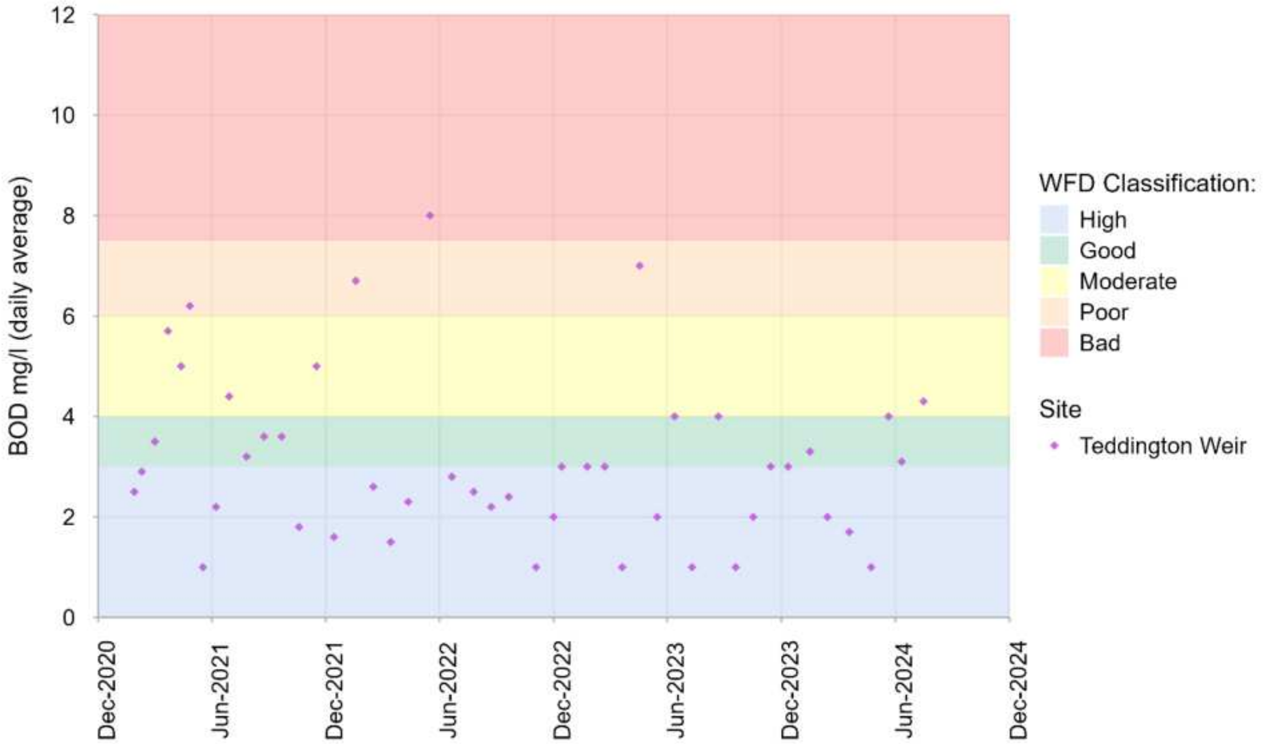
Biological oxygen demand (BOD)

A.2.76 The baseline considers BOD of the River Thames as a sensitive receptor to discharge of recycled water. Spot sample data from the Thames Water SRO monitoring with 46 samples from 2020 to 2024, is used as evidence as presented Table A.12 and Plate A.23. The 90th percentile of the data collected is consistent with Moderate status (using the WFD Directions standards for salmonid waters), noting BOD is not to be used for classification.

Table A.12 BOD summary Thames at Teddington

Determinand	Units	Min	Mean	Max	WFD (90 %ile)
BOD[20]	mg/l	1	3.1	8	5

Plate A.23 BOD spot samples (Jan 2021 – Jul 2024)



A.2.77 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as Good status for BOD (2015) (EA, n.d.c) with an interim update (2022) also of Good status. This Good status is also reflected at the specific Environment Agency monitoring site closest to Burnell Avenue, Thames at Teddington Weir (EA, n.d.c), in 2019 and 2022, noting this spot sampling site is a component part of the water body status classification by the Environment Agency. Based on this classification, the sensitivity of the Burnell Avenue site to BOD changes is High.

[20] Data collected Thames at Teddington 2020-2024

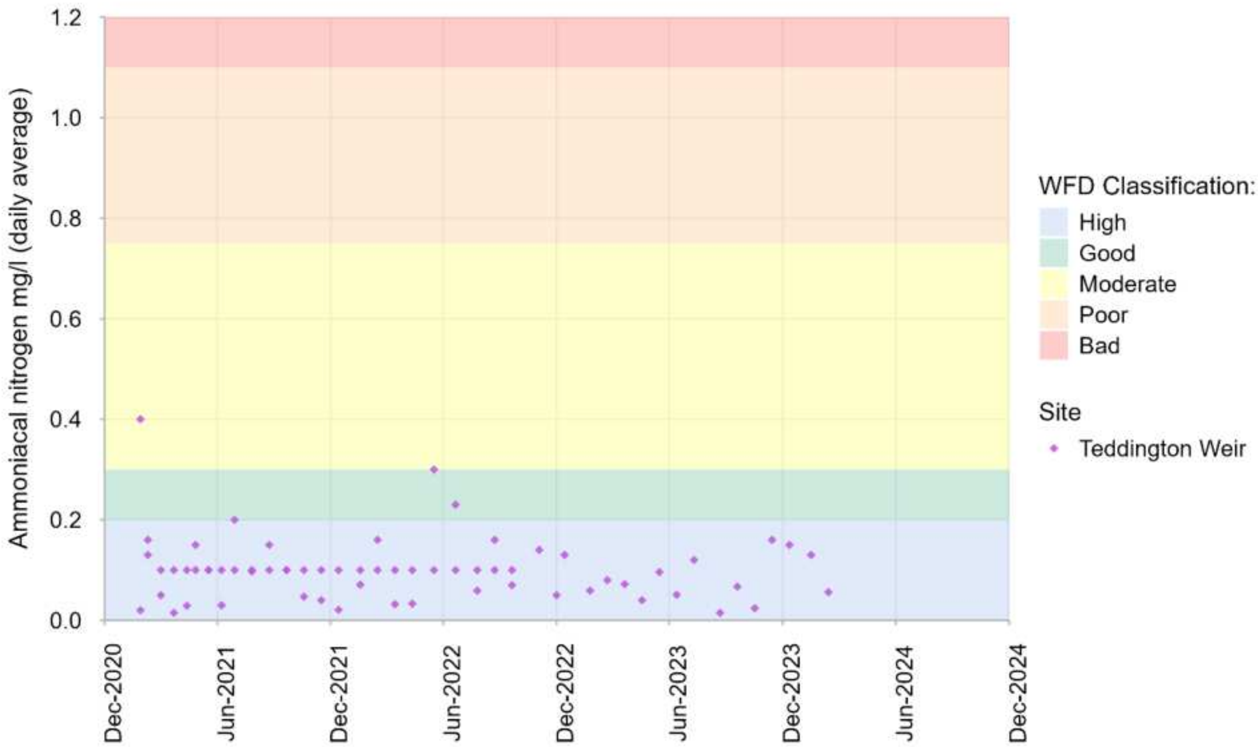
Total ammonia

A.2.78 The baseline considers the ammonia concentration of the River Thames as a sensitive receptor to discharge of recycled water. Spot sample data from the Thames Water SRO monitoring scheme between 2020 and 2024 at Thames at Teddington, is used as evidence presented in Table A.13 and Plate A.24. The 90th percentile ammoniacal nitrogen is consistent with High status (using the WFD Directions standards for salmonid waters).

Table A.13 Ammonia summary Thames at Teddington

Determinand	Units	Min	Mean	Max	WFD (90 %ile)
Ammoniacal nitrogen	mg/l (as N)	0.015	0.09	0.4	0.16

Plate A.24 Ammoniacal nitrogen spot samples (Jan 2021 – Jul 2024)



A.2.79 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as High status for ammonia (2019) with an interim update (2022) also of High status. This High status is also reflected at the specific Environment Agency monitoring site closest to Burnell Avenue, *Thames at Teddington Weir (EA, n.d.c)*, in 2019 and 2022, noting this spot sampling site is a component part of the water body status classification by the Environment Agency. Based on this classification, the sensitivity of the Burnell Avenue site to ammonia changes is High.

Nutrient quality

Soluble reactive phosphate (SRP)

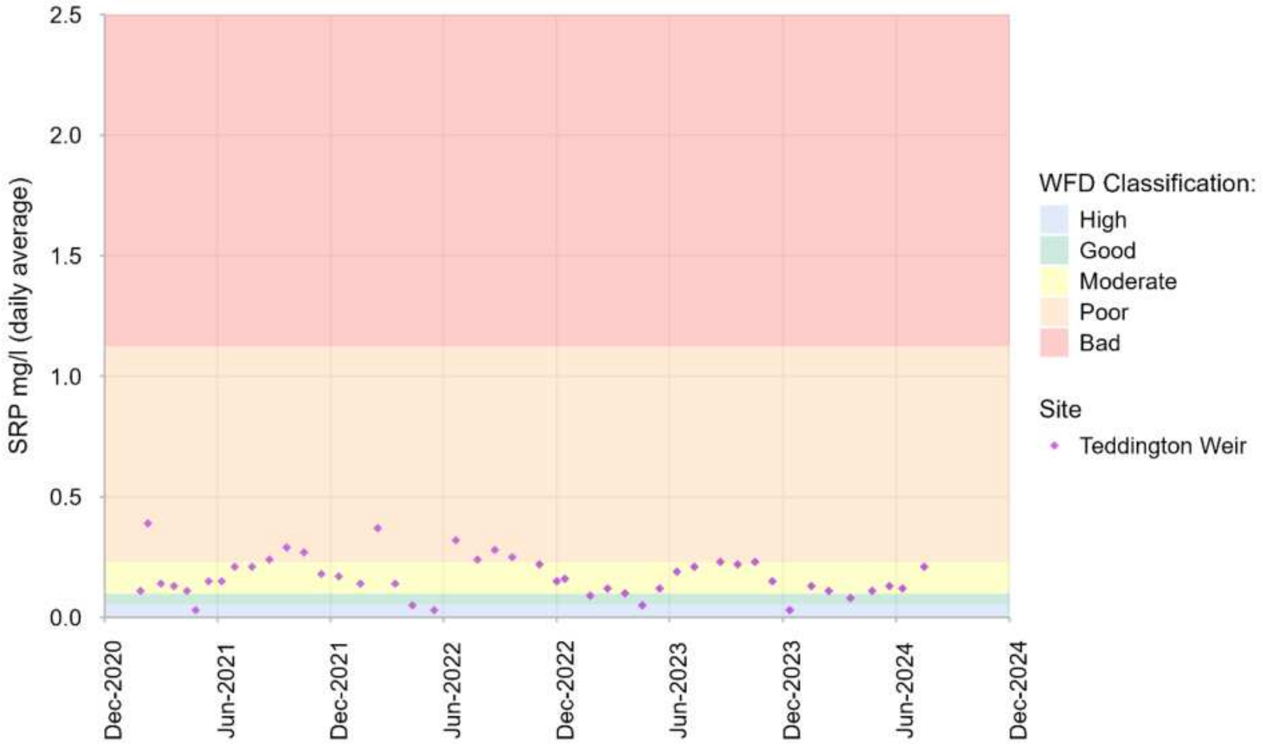
A.2.80 The baseline considers the SRP as a sensitive receptor for the River Thames to the discharge of recycled water. Spot sampling as part of Thames Water SRO monitoring scheme at Thames at Teddington with 46 samples taken between 2020 and 2024 as presented in Table A.14 and Plate A.25.

A.2.81 The average reactive phosphate is consistent with Moderate status (using the WFD Directions standards for salmonid waters)[21].

Table A.14 SRP summary Thames at Teddington

Determinand	Units	Mean	Mean	Max	WFD (mean)
SRP[22]	mg/l	0.03	0.17	0.39	0.17

Plate A.25 SRP spot samples (Jan 2021 – Jul 2024)



A.2.82 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as Moderate status for reactive phosphate (2019) with an interim update (2022) also of Moderate status. The Thames Water data since 2020 indicated Moderate status for reactive phosphate at this site therefore is reasonable and

[21] WFD reactive phosphorus standards are specific to each water body and have been determined by the 'EA 2015 River and Canals physico-chemical classifications – Site Specific Phosphate Standards' for Thames at Teddington
[22] Data collected Thames at Teddington 2020-2024

based on this classification, the sensitivity of the Burnell Avenue site pH changes is Moderate.

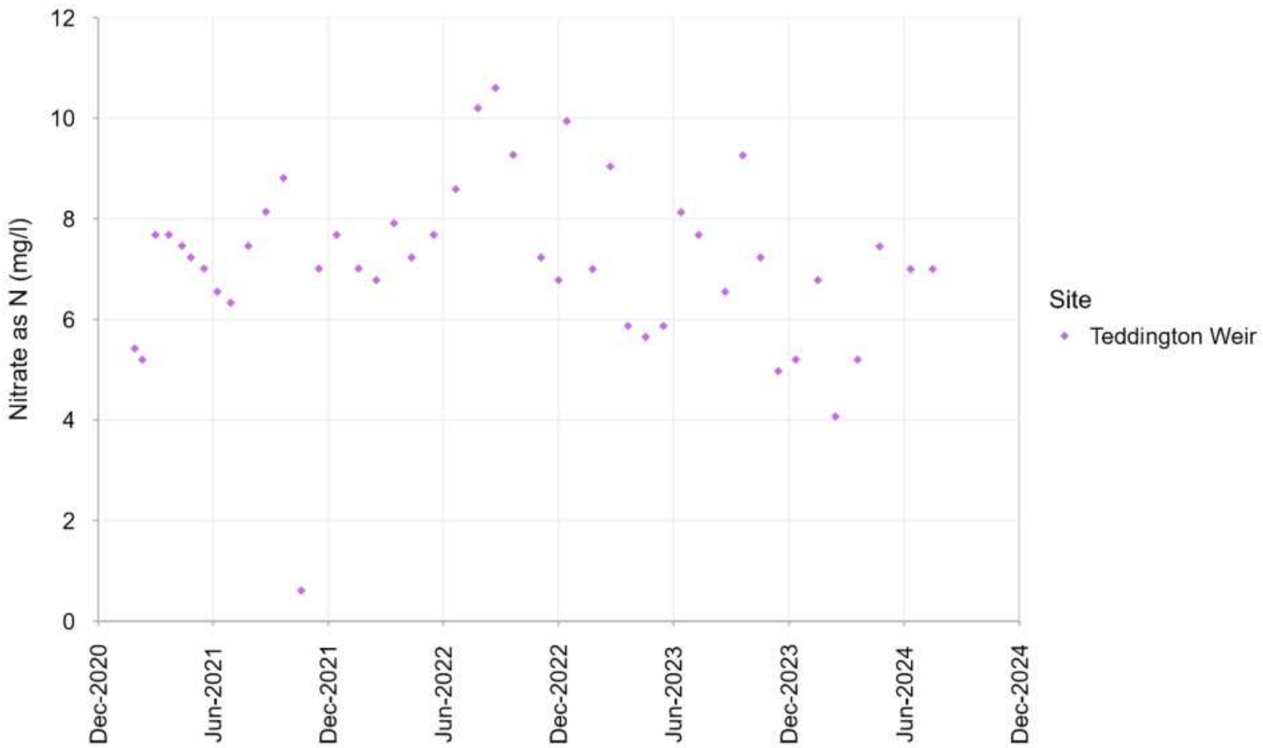
Nitrate

A.2.83 The baseline considers the nitrate as a sensitive receptor for the River Thames to the discharge of recycled water. Spot sampling as part of Thames Water SRO monitoring scheme at Thames at Teddington with 46 samples taken between 2020 and 2024 as presented in Table A.15 and Plate A.26. There are no WFD designations for nitrate.

Table A.15 Nitrate Summary Thames at Teddington

Determinand	Units	Mean	Mean	Max	WFD
Nitrate[23]	mg/l as N	0.61	7.1	10.4	n/a

Plate A.26 Nitrate spot samples (Jan 2021 – Jul 2024)



[23] Data collected Thames at Teddington 2020-2024

Hazardous chemicals

A.2.84 The baseline considers hazardous chemicals at the River Thames as sensitive receptors to the discharge of recycled water. Spot samples of all determinands were taken from Jan 2021 to July 2024 as a part of the Thames Water SRO monitoring scheme as presented in Table A.16. Overall, this is indicative if 'Moderate' status for Specific Pollutants and 'Fail' for chemical status. All Environmental Quality Standard (EQS) limits are based on freshwater and inland surface water standards.

A.2.85 It should be noted when reading Table A.16 that it has been highlighted where samples exceed EQS limits in red. Some exceedances are due to a lack of sensitivity in the limit of detection for example 3,4-Dichloroaniline has no samples above the limit of detection of 1µg/l but this is above the AA EQS of 0.2µg/l. These samples have been highlighted in yellow.

A.2.86 The Thames RBD RBMP3 identifies the water body that includes this reach of river[17] as Fail status for chemical and Moderate for specific pollutants (2019) with an interim update (2022) also of the same statuses. These Fail and Moderate is also reflected at the specific Environment Agency monitoring site closest to Burnell Avenue, *Thames at Teddington Weir*, in 2022.

A.2.87 The Thames Water data since 2021 indicated Fail and Moderate statuses for chemical quality and specific pollutants respectively at this site is reasonable and based on this classification, the sensitivity of the Burnell Avenue is Moderate.

Table A.16 WFD Chemical Sample Results and Indicative WFD Classification

Determinand[24]	AA-EQS (long term) Inland surface waters	MAC-EQS (short term) Inland surface waters	Units	Mean	Q95	No. of samples	No. > LOD	No. > EQS	No. > EQS	Does Average Exceed AA EQS	Does Max or 95% exceed MAC EQS
Specific pollutants											
2,4-dichlorophenol	4.2	140	ug/l	0.024	0.020	46	0	0	0	no	no
2,4-dichlorophenoxyacetic acid (2,4-D)	0.3	1.3	ug/l	0.030	0.063	46	8	0	0	no	no
3,4-Dichloroaniline	0.2	5.4	ug/l	1.000	1.000	46	0	46	0	yes	no
Arsenic dissolved	50	n/a	ug/l	0.951	1.200	46	46	0	0	no	
Benzyl butyl phthalate	7.5	51	ug/l	0.200	0.200	46	0	0	0	no	no
Carbendazim	0.15	0.7	ug/l	0.100	0.100	46	0	0	0	no	no
Chlorine free	2	5	ug/l	90.44	175	46	18	46	46	yes	yes
Chlorothalonil	0.035	1.2	ug/l	0.035	0.035	46	0	0	0	no	no
Chromium (III) dissolved	4.7	32	ug/l	1.030	1.175	46	5	0	0	no	no
Chromium (VI) dissolved	3.4	n/a	ug/l	3.207	7	47	22	21	0	no	n/a
*Copper dissolved	1	n/a	ug/l	2.243	3.175	46	46	46	0	yes	n/a
Cyanide total	1	5	ug/l	27.81	40	46	14	35	32	yes	yes

[24] All data collected Thames at Teddington 2024-2024

Determinand[24]	AA-EQS (long term) Inland surface waters	MAC-EQS (short term) Inland surface waters	Units	Mean	Q95	No. of samples	No. > LOD	No. > EQS	No. > EQS	Does Average Exceed AA EQS	Does Max or 95% exceed MAC EQS
Diazinon	0.01	0.02	ug/l	0.010	0.010	46	0	0	0	no	no
Dimethoate	0.48	4	ug/l	0.020	0.020	46	0	0	0	no	no
Glyphosate	196	398	ug/l	0.166	0.328	46	34	0	0	no	no
Iron dissolved	1000	n/a	ug/l	63.46	292.50	46	45	0	0	no	n/a
Linuron	0.5	0.9	ug/l	0.023	0.040	46	3	0	0	no	no
*Manganese dissolved	123	n/a	ug/l	13.48	24.75	46	46	0	0	no	
Mecoprop	18	187	ug/l	0.023	0.030	46	9	0	0	no	no
Methiocarb	0.01	0.77	ug/l	0.100	0.100	46	0	46	0	yes	no
Pendimethalin	0.3	0.58	ug/l	0.020	0.020	46	0	0	0	no	no
Permethrin	0.001	0.01	ug/l	0.001	0.001	46	3	1	0	yes	no
Phenol	7.7	46	ug/l	1.196	1.000	46	0	1	0	no	no
Tetrachloroethane	140	1848	ug/l	0.229	1.000	24	0	0	0	no	no
Toluene	74	380	ug/l	0.161	0.800	46	1	0	0	no	no
Triclosan	0.01	0.28	ug/l	0.010	0.010	46	0	0	0	no	no
*Zinc dissolved	10.9	n/a	ug/l	7.774	23.750	46	46	7	0	no	n/a
Priority hazardous substances											

Determinand[24]	AA-EQS (long term) Inland surface waters	MAC-EQS (short term) Inland surface waters	Units	Mean	Q95	No. of samples	No. > LOD	No. > EQS	No. > EQS	Does Average Exceed AA EQS	Does Max or 95% exceed MAC EQS
1,2-Dichloroethane	10	n/a	ug/l	1.000	1.000	57	0	0	0	no	n/a
Aclonifen	0.12	0.12	ug/l	0.100	0.100	46	0	0	0	no	no
Alachlor	0.3	0.7	ug/l	0.020	0.020	46	0	0	0	no	no
Aldrin	n/a	n/a	ug/l	0.020	0.020	46	0	0	0	n/a	n/a
Anthracene	0.1	0.1	ug/l	0.020	0.020	46	0	0	0	no	no
Atrazine	0.6	2	ug/l	0.020	0.020	46	0	0	0	no	no
Benzene	10	50	ug/l	0.159	0.775	46	0	0	0	no	no
polycyclic aromatic hydrocarbons sum	0.00017	n/a	ug/l	0.016	0.038	46	46	46	0	yes	n/a
Benzo(a)pyrene	n/a	0.27	ug/l	0.016	0.038	46	46	0	1	n/a	yes
Benzo(b)fluoranthene	n/a	0.017	ug/l	0.018	0.044	46	46	0	7	n/a	yes
Benzo(g,h,i)perylene	n/a	0.0082	ug/l	0.014	0.037	46	46	0	15	n/a	yes
Benzo(k)fluoranthene	n/a	0.017	ug/l	0.010	0.026	46	46	0	4	n/a	yes
Bifenox	0.012	0.04	ug/l	0.012	0.012	46	0	0	0	no	no
C10-13 Chloroalkanes (total)	0.4	1.4	ug/l	0.400	0.400	46	0	0	0	no	no
Cadmium total	0.25	1.5	ug/l	0.026	0.055	46	28	0	0	no	no

Determinand[24]	AA-EQS (long term) Inland surface waters	MAC-EQS (short term) Inland surface waters	Units	Mean	Q95	No. of samples	No. > LOD	No. > EQS	No. > EQS	Does Average Exceed AA EQS	Does Max or 95% exceed MAC EQS
Carbon tetrachloride	12	n/a	ug/l	1.000	1.000	46	0	0	0	no	no
Chlorfenvinphos	0.1	0.2	ug/l	0.020	0.020	46	0	0	0	no	no
Chlorpyrifos (chlorpyrifos-ethyl)	0.03	n/a	ug/l	0.020	0.020	46	0	0	0	no	n/a
Cybutryne (Irgarol)	0.0025	0.016	ug/l	0.003	0.003	46	0	0	0	no	no
Cypermethrin	0.00008	0.0006	ug/l	0.001	0.002	46	20	20	5	yes	yes
DDT total	0.025	n/a	ug/l	0.026	0.025	46	1	1	0	yes	n/a
di(2-ethylhexyl)phthalate	1.3	n/a	ug/l	0.150	0.150	46	0	0	0	no	n/a
Dichloromethane	20	n/a	ug/l	1.522	5.000	46	1	0	0	no	n/a
Dichlorvos	0.0006	0.0007	ug/l	0.001	0.001	46	0	46	46	yes	yes
Dicofol	0.0013	n/a	ug/l	0.001	0.001	46	0	0	0	no	n/a
Dieldrin	n/a	n/a	ug/l	0.020	0.020	46	0	0	0	n/a	n/a
Diuron	0.2	1.8	ug/l	0.050	0.050	46	0	0	0	no	no
Endosulfan	0.005	0.01	ug/l	0.020	0.020	46	0	46	46	yes	yes
Endrin	n/a	n/a	ug/l	0.020	0.020	46	0	0	0	n/a	n/a
Fluoranthene	0.0063	0.12	ug/l	0.032	0.036	46	46	20	1	yes	yes

Determinand[24]	AA-EQS (long term) Inland surface waters	MAC-EQS (short term) Inland surface waters	Units	Mean	Q95	No. of samples	No. > LOD	No. > EQS	No. > EQS	Does Average Exceed AA EQS	Does Max or 95% exceed MAC EQS
Heptachlor and heptachlor epoxide	0.0000002	0.0003	ug/l	0.001	0.001	46	0	46	46	yes	yes
Hexabromocyclododecane	0.0016	0.5	ug/l	0.000	0.000	46	32	0	0	no	no
Hexachlorobenzene	n/a	0.05	ug/l	0.021	0.020	46	1	0	0	n/a	no
Hexachlorobutadiene	n/a	0.6	ug/l	0.020	0.020	46	0	0	0	n/a	no
Hexachlorocyclohexane	n/a	0.04	ug/l	0.020	0.020	46	0	0	0	n/a	no
Isodrin	n/a	n/a	ug/l	0.021	0.020	46	1	0	0	n/a	n/a
Isoproturon	0.3	1	ug/l	0.002	0.002	46	1	0	0	no	no
*Lead dissolved	1.2	14	ug/l	0.188	0.470	46	26	1	0	no	no
Mercury dissolved	n/a	0.07	ug/l	0.005	0.022	46	34	0	0	n/a	no
Naphthalene	2	130	ug/l	0.021	0.028	46	3	0	0	no	no
*Nickel dissolved	4	34	ug/l	2.065	2.875	46	45	0	0	no	no
Nonylphenols (4-nonylphenol technical mix)	0.3	2	ug/l	0.049	0.103	46	16	0	0	no	no
Octylphenols ((4-(1,1',3,3'-tetramethylbutyl)pheno	0.1	n/a	ug/l	0.012	0.010	46	2	0	0	no	n/a
Pentachlorobenzene	0.007	n/a	ug/l	0.007	0.007	46	1	1	0	yes	n/a

Determinand[24]	AA-EQS (long term) Inland surface waters	MAC-EQS (short term) Inland surface waters	Units	Mean	Q95	No. of samples	No. > LOD	No. > EQS	No. > EQS	Does Average Exceed AA EQS	Does Max or 95% exceed MAC EQS
Pentachlorophenol	0.4	1	ug/l	0.020	0.020	46	0	0	0	no	no
Perfluorooctane sulfonic acid	0.00065	36	ug/l	0.005	0.008	66	61	61	0	yes	no
Quinoxyfen	0.15	2.7	ug/l	0.100	0.100	46	0	0	0	no	no
Simazine	1	4	ug/l	0.020	0.020	46	0	0	0	no	no
Terbutryn	0.065	0.34	ug/l	0.020	0.020	46	0	0	0	no	no
Tetrachloroethylene	10	n/a	ug/l	1.000	1.000	46	0	0	0	no	n/a
Tributyltin compounds (as tributyltin cation)	0.0002	0.0015	ug/l	0.000	0.000	46	41	3	0	no	no
Trichlorobenzenes	0.4	n/a	ug/l	0.439	0.850	46	0	3	0	yes	n/a
Trichloroethylene	10	n/a	ug/l	1.000	1.000	46	0	0	0	no	n/a
Trichloromethane (chloroform)	2.5	n/a	ug/l	1.000	1.000	46	0	0	0	no	n/a
Trifluralin	0.03	n/a	ug/l	0.020	0.020	46	0	0	0	no	n/a

Mogden STW

A.2.88 This section describes the relevant water resources and water quality baseline to support the impact assessment of potentially significant effects of the operation phase of the Project at Mogden STW site. No potentially significant effects were identified for construction phase at this site.

Baseline

A.2.89 Operation of the Project would reduce the volume of final effluent from Mogden STW discharged to the tidal River Thames at Isleworth Ait. At these times the quality of the final effluent would remain as without the Project. Positive effects are predicted on the upper tidal River Thames due to the reduction in discharge from Mogden STW at times of low river flow.

A.2.90 The thermal load added to the upper estuary by the final effluent would also reduce at times of low river flow, also a which is also a positive effect on the tidal River Thames. The reduction in final effluent would reduce the volume of water entering the upper estuary which has the potential to impact on tidal hydrodynamics, geomorphological processes and salinity in the tidal River Thames.

A.2.91 At times when the Project's intake is not operational, there would be no discharge at the Project's outfall. At these times the TTP would remain operational and recycled water would be discharged with the final effluent from Mogden STW discharged to the tidal River Thames at Isleworth Ait.

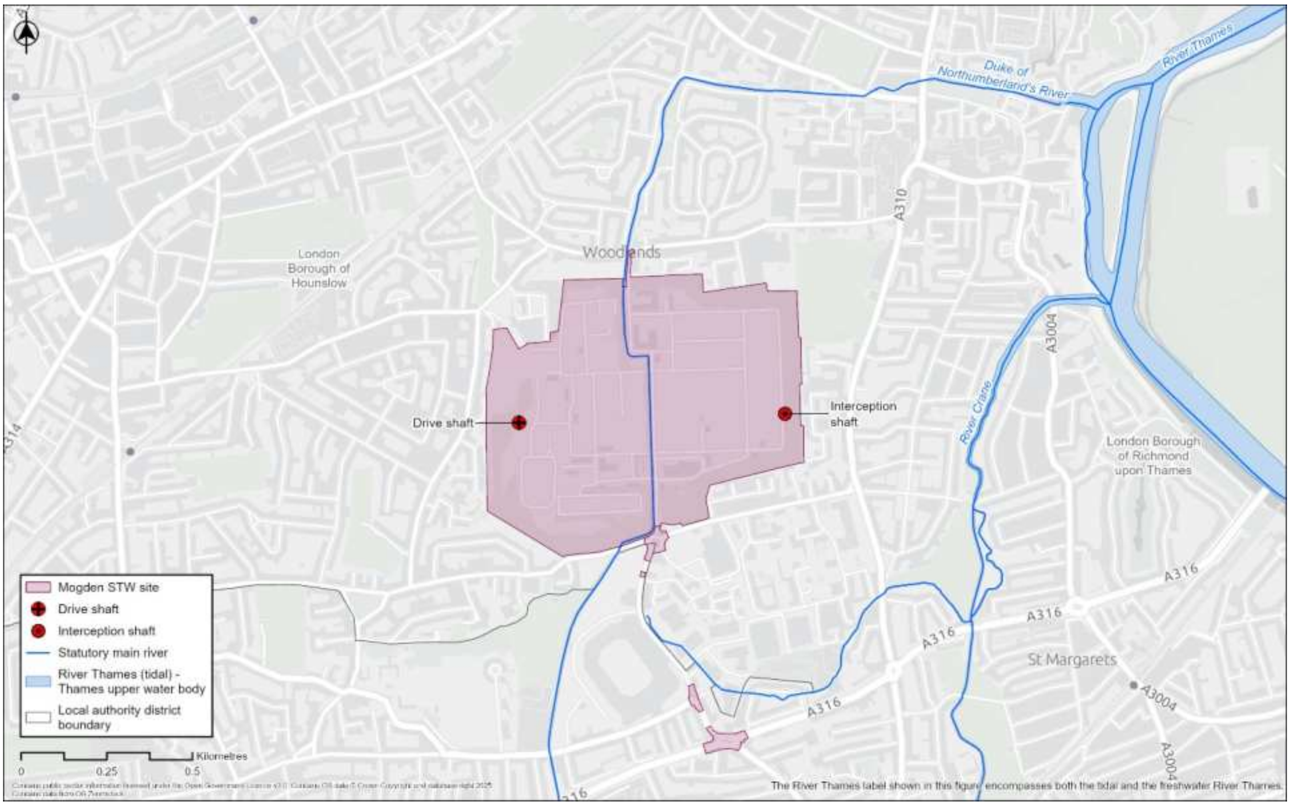
A.2.92 At these times the volume of the final effluent would remain as without the Project, but the quality would be improved. The improvement in the discharge from Mogden STW to the upper estuary at times of normal and high river flow is a positive effect of the Project.

A.2.93 The hydromorphological and geomorphological baseline of the upper estuary and its sensitivity to change in flow input is described under **Surface water resources**. The water quality baseline of the upper estuary and its sensitivity to change from reduced wastewater discharge and TTP discharge is described under **Surface water quality**.

A.2.94 The location of operation phase activities at the Mogden STW site are identified in Plate A.27 below. Richmond Sluice is located at approximately 5.7km from Teddington Weir along the modelled reach, while Mogden STW outfalls are located around 6.2km along the reach.

A.2.95 Baseline data within the tidal River Thames was modelled between Teddington Weir and Battersea, 25km downstream of the weir. Data was provided for tidal elevation, current speed, salinity, temperature, suspended solids, and DO extracted at every 1km along the reach.

Plate A.27 Operation phase activities at Mogden STW



Surface water resources

A.2.96 The Mogden STW site would include a reduction in discharge from the existing STW outfall to the tidal River Thames. The baseline considers the hydrodynamics and geomorphology of the tidal River Thames at the existing outfall location and in a zone of influence of tidal mixing. Potential hydrodynamic and geomorphological change from reducing the discharge of wastewater include:

a. Input flow – change from input flow rate to the upper estuary – see **Input flow**

b. Tidal elevation – change in tidal water level, and associated change in water depth and intertidal exposure in the tidal reach – see **Tidal elevation**

c. Current speed – change from local water conditions – see **Current speed.**

Input flow

A.2.97 Mogden STW has a permitted dry weather flow[25] of 559Ml/d. The average (National River Flow Archive, n.d.) flow conditions in the River Thames are 3,360Ml/d. As these are the two largest flow contributions to the upper tidal River Thames the final effluent contribution of flow is around 14% on average.

A.2.98 To support the assessment of change in flow conditions, scenario modelling has included a time-series representation of input flows from the freshwater

[25] Dry weather flow is a representation of low flow at a STW, indicative of the flow that is equalled or exceeded for 80% of the time.

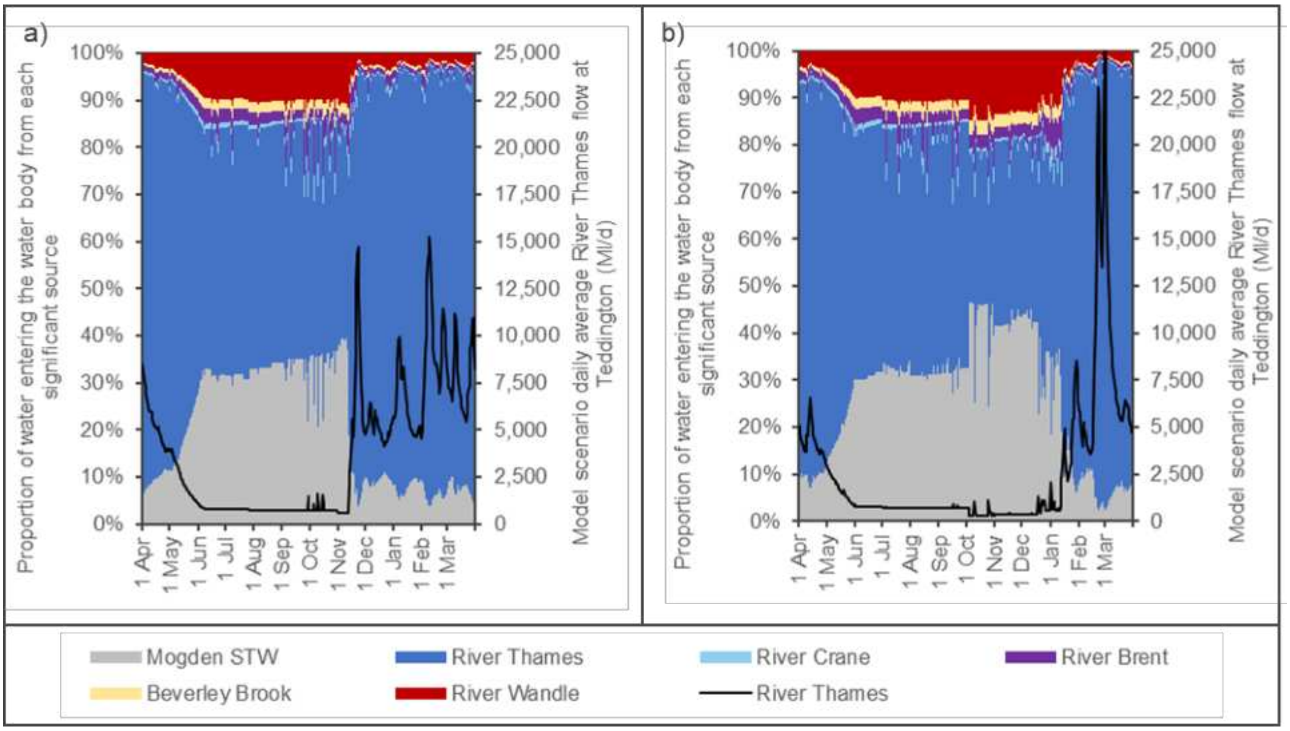
River Thames, significant tributaries to the upper tidal River Thames, and Mogden STW from the Project's stochastic modelling series. This represents flows in the 2030s time-slice based on parameterisation of river flows using rainfall runoff models and accounting for abstraction and discharge to the freshwater River Thames.

A.2.99 All other tributaries are parameterised using a scalar of the stochastic series for the non-wastewater flow of the Hogsmill River, a similar characteristic urban river in west London.

A.2.100 Evidence presented in Plate A.28 for the representative 1:5 year low flow scenario and representative 1:20 low flow scenario show that under low River Thames flow conditions the proportion of Mogden STW final effluent as water entering the upper Tideway can regularly be 30% rising towards 50% in rare circumstances once every 20 years.

A.2.101 The Mogden STW final effluent is evidenced as a very significant contributor to flow in the upper Tideway, potentially with important considerations for tidal elevation (see **Tidal elevation**) tidal currents (see **Current speed**) and water quality management (see **Surface water quality**).

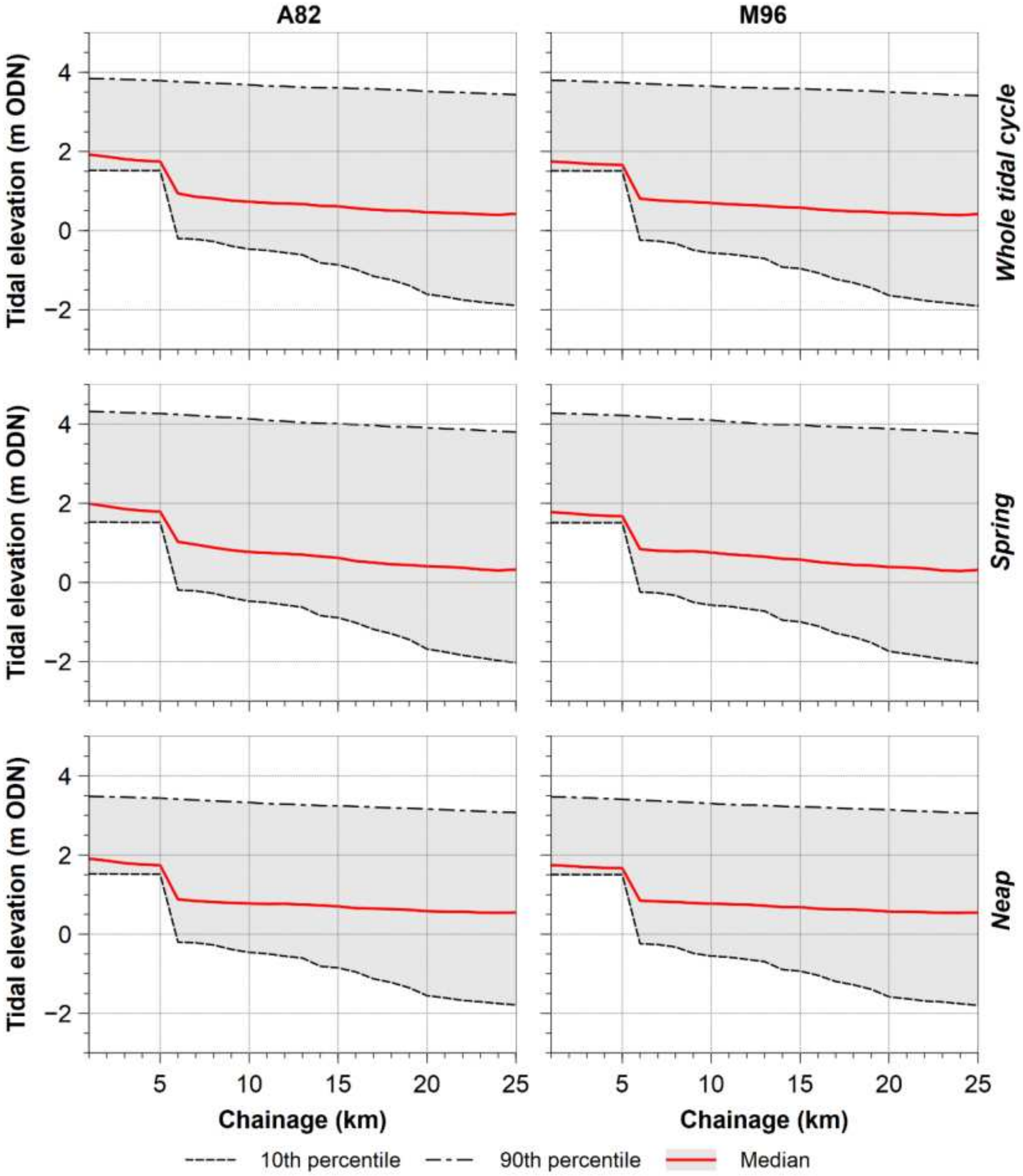
Plate A.28 Flow contribution to upper Tidal River Thames for representative a) 1:5 and b) 1:20 return frequency low flow scenarios



Tidal elevation

A.2.102 Plate A.29 shows the range of modelled baseline tidal elevation in the chainage of the 25km reach from 0km (Teddington Weir) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

Plate A.29 Tidal Elevation (m AOD) for A82 and M96 Scenarios



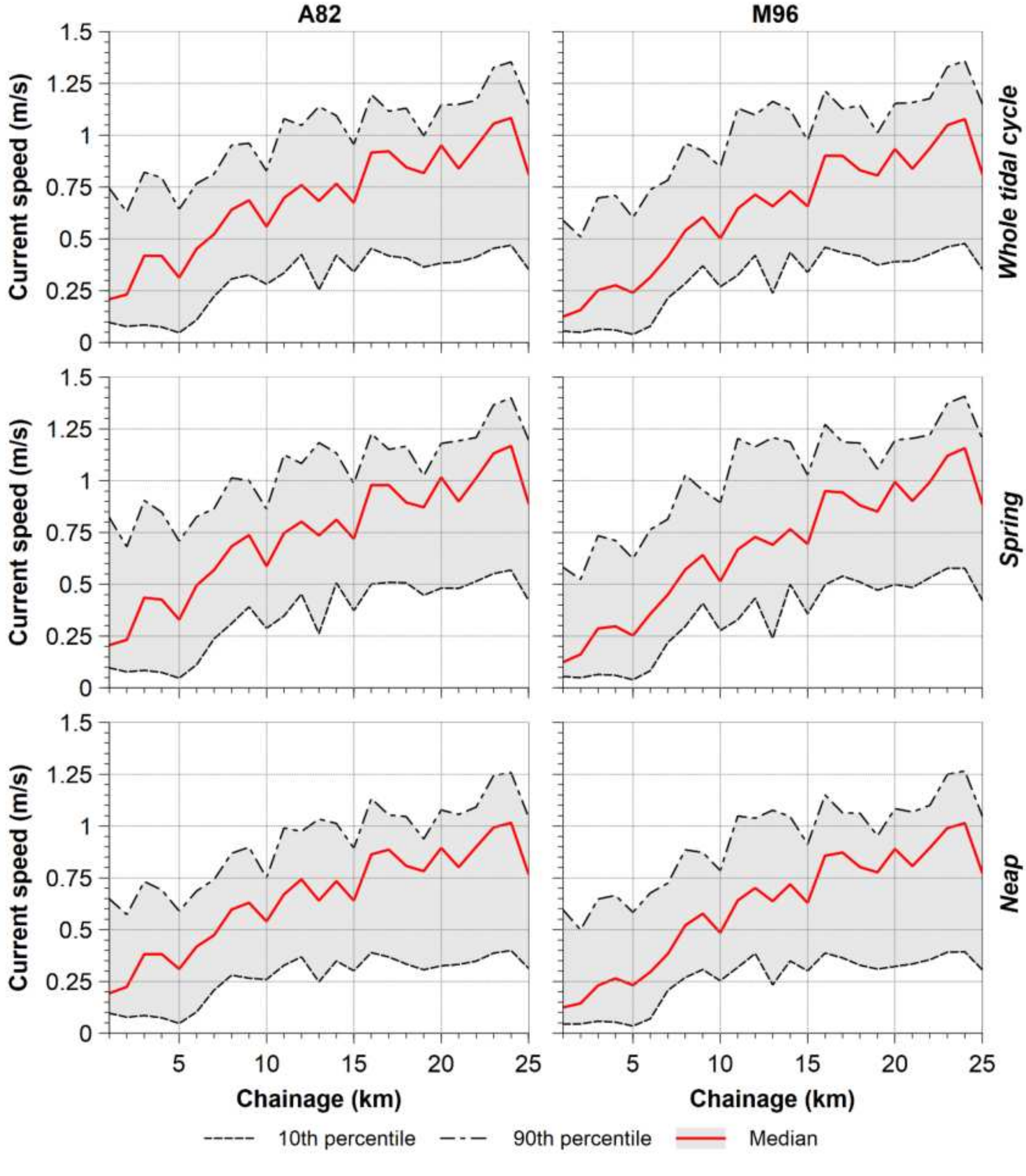
A.2.103 The tidal elevation data show median tidal elevations of ~2m AOD within Richmond Pound, declining to ~1m AOD outside of the pound and towards ~0.5m AOD around Battersea. 10th percentile elevations range from ~1.5m AOD inside of the pound to ~-0.2m AOD outside of the pound and ~-2m AOD towards Battersea. 90th percentile tidal elevations range from ~4m AOD at 0km declining to around ~3.0-3.5m AOD at 25km.

A.2.104 The data show there is no significant difference between A82 and M96 for each period of time, the whole tidal cycle, spring and neap, with some lower 10th and higher 90th percentiles for the spring tides when compared with neap tides

Current speed

A.2.105 Plate A.30 shows the range of modelled baseline current speed in the chainage of the 25km reach from 0km (Teddington Weir) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

Plate A.30 Baseline current speed for A82 and M96 scenarios



A.2.106 The median baseline current speed across all tidal stages for A82 and M96 range from ~0.15m/s at 0km increasing gradually along the reach to a peak of around 1.2m/s at 24km downstream and then declining to ~0.75m/s at 25km at the end of the reach. Both 10th and 90th percentile velocities follow a similar path, though current speeds are slightly lower for the neap tides than spring tides by ~0.1m/s. Between Teddington Weir and 15km downstream, median current speeds are elevated by ~0.1 m/s during A82 flows.

Surface water quality

A.2.107 The Mogden STW site would include a reduction in discharge from the existing STW outfall to the tidal River Thames. The baseline considers the water quality of the tidal River Thames at the existing outfall location and in a zone of influence of tidal mixing. Potential water quality change from reducing the discharge of wastewater and from discharging recycled water include:

a. Water temperature – change from local water conditions – see **Water temperature.**

b. Salinity – change from local freshwater to brackish conditions – see **Salinity.**

c. Suspended solids– change from local water conditions – see **Suspended solids.**

d. Dissolved oxygen– change from local water conditions – see **Dissolved oxygen.**

e. Nutrient quality – change to local conditions of dissolved inorganic nitrogen – see **Nutrients.**

f. Chemical dispersal – change to local conditions relating to the current discharge in the context of those chemicals listed in the WFD[26] – see **Chemical dispersal.**

Water temperature

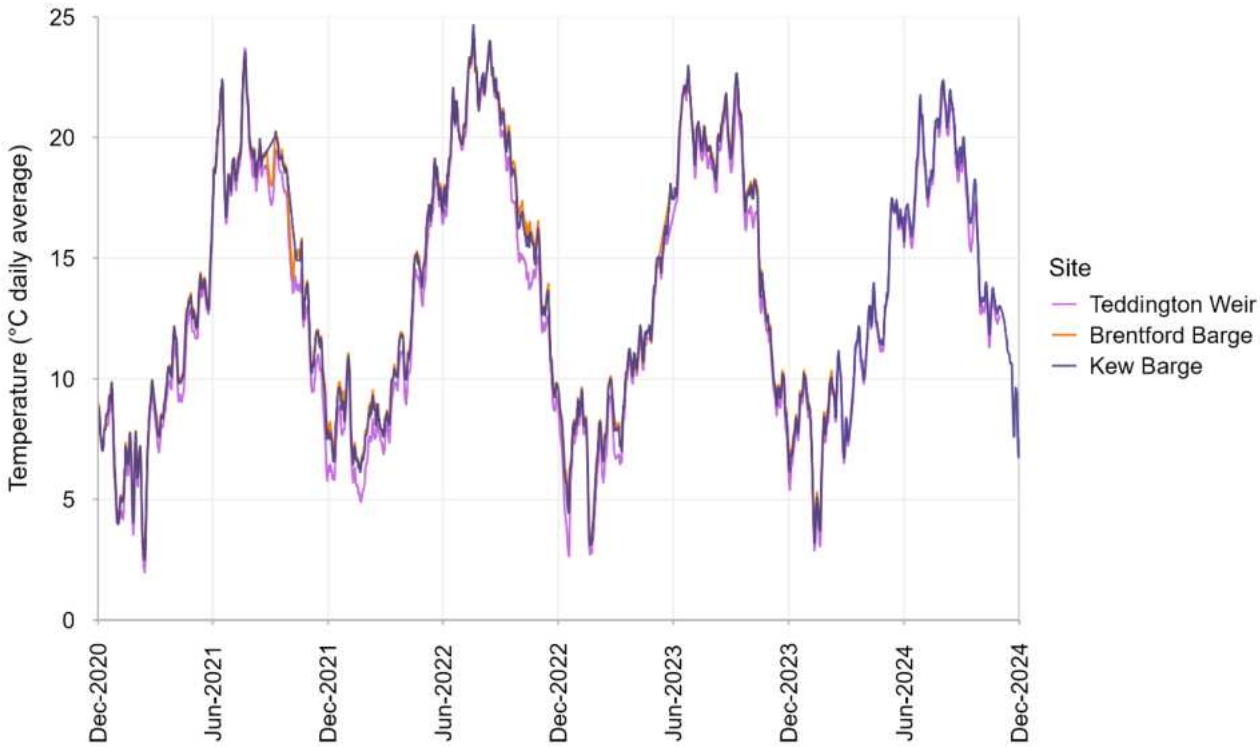
A.2.108 The baseline considers the water temperature in the tidal River Thames as a sensitive receptor to changes in the current Mogden STW discharge and discharging recycled water. There is continuous monitoring from a sonde at Kew Barge and Brentford Barge, as presented in Table A.17 and Plate A.31. The temperature follows distinct seasonal patterns and follows similar patterns to the freshwater Thames site, Thames at Teddington (also displayed on Plate A.32)

Table A.17 Summary of temperature sonde tidal River Thames

Determinand	Units	Min	Mean	Max
Temperature Kew Barge	ºC	2.19	13.60	25.8
Temperature Brentford Barge	ºC	2.24	13.5	25.5

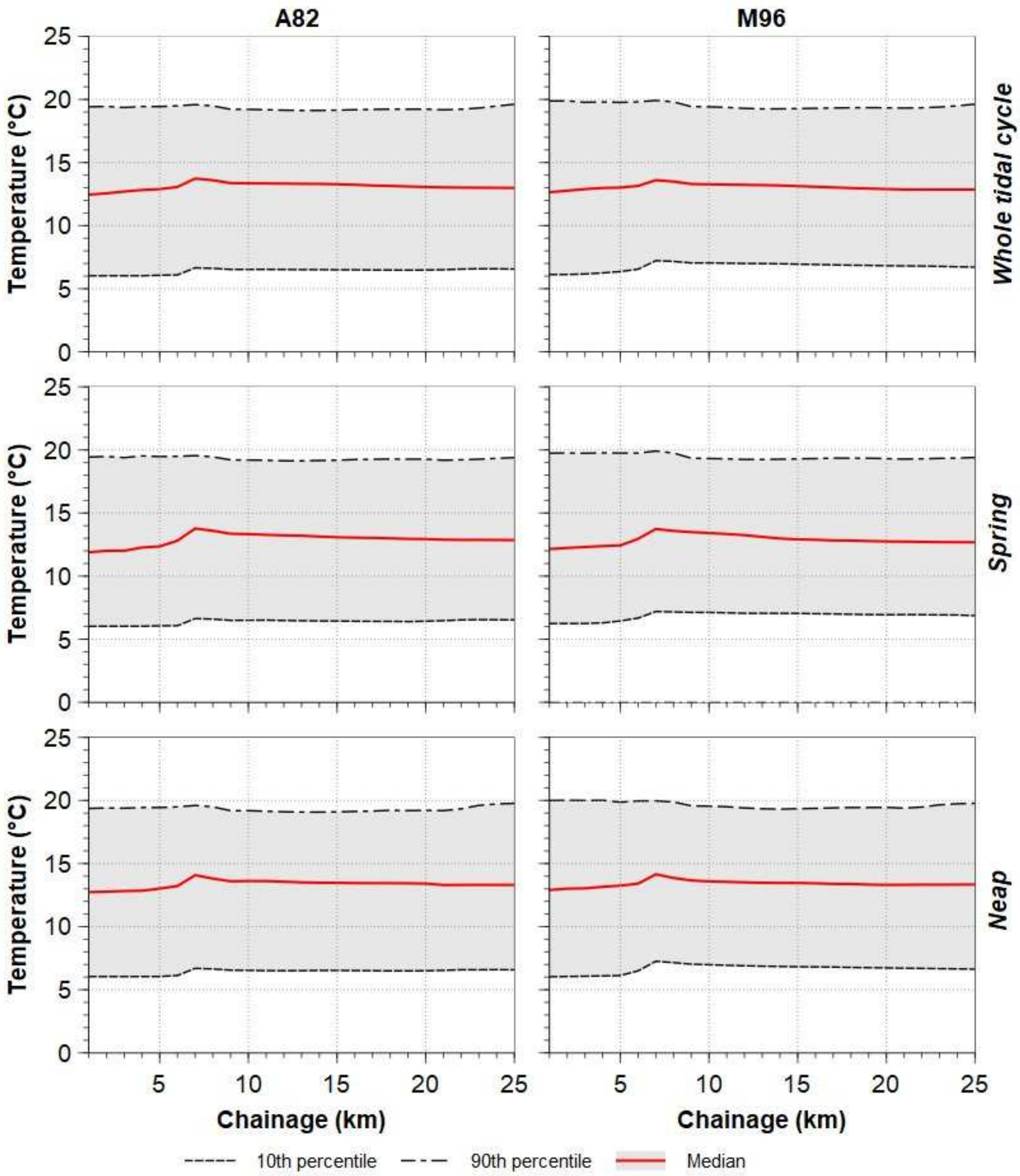
[26] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

Plate A.31 Temperature summary tidal River Thames



A.2.109 Plate A.31 shows the range of modelled baseline water temperature in the chainage of the 25km reach from 0km (Teddington Weir) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

Plate A.32 Baseline temperature for A82 and M96 scenarios



A.2.110 The baseline water temperature data show median water temperature of ~13°C within Richmond Pound, increasing to ~14°C outside of the pound around the Mogden STW discharge and declining to ~13°C for the remainder of the reach. 10th and 90th percentile temperatures remain relatively constant at ~6°C and ~19.5°C respectively for the whole reach, although there are slight increases in the 10th percentile and decreases in the 90th percentile around 7km. The data show there is no significant difference between A82 and M96 for each period of time, the whole tidal cycle, spring and neap.

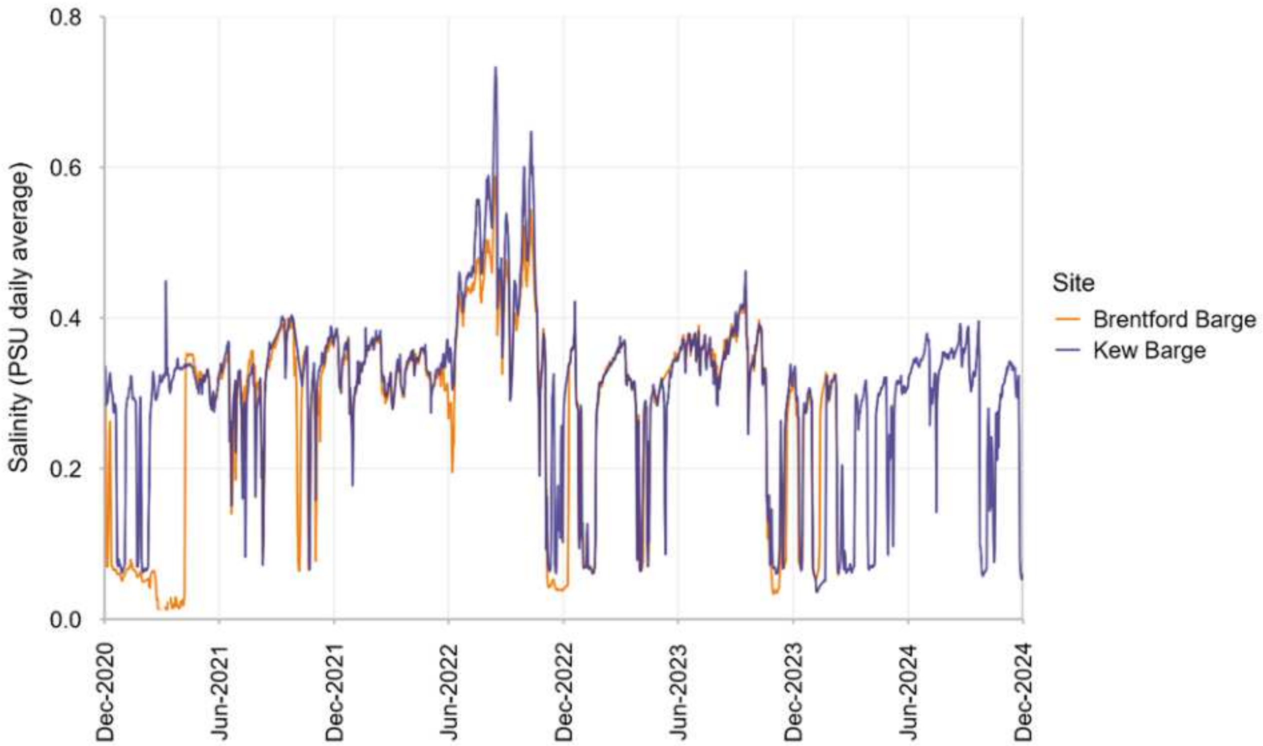
Salinity

A.2.111 The baseline considers the salinity in the tidal River Thames as a sensitive receptor to changes in the current Mogden STW discharge and discharging recycled water. There is continuous monitoring from a sonde at Kew Barge and Brentford Barge, as presented in Table A.18 and Plate A.33

Table A.18 Summary of Salinity Measurements in the tidal River Thames

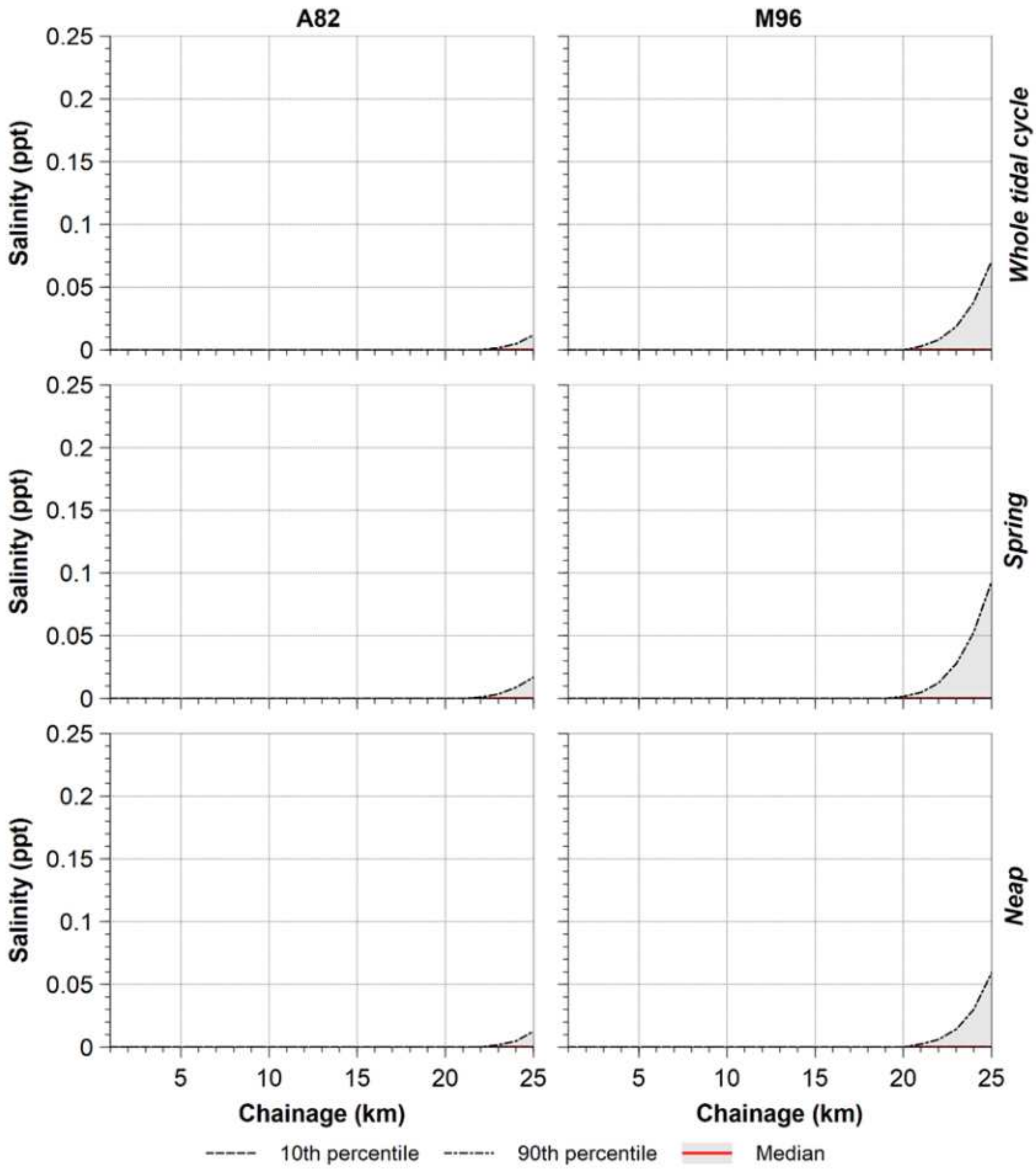
Determinand	Units	Min	Mean	Max
Salinity Kew Barge	PSU	0	0.30	12.8
Salinity Brentford Barge	PSU	0	0.28	1.1

Plate A.33 Salinity measurements in the tidal River Thames



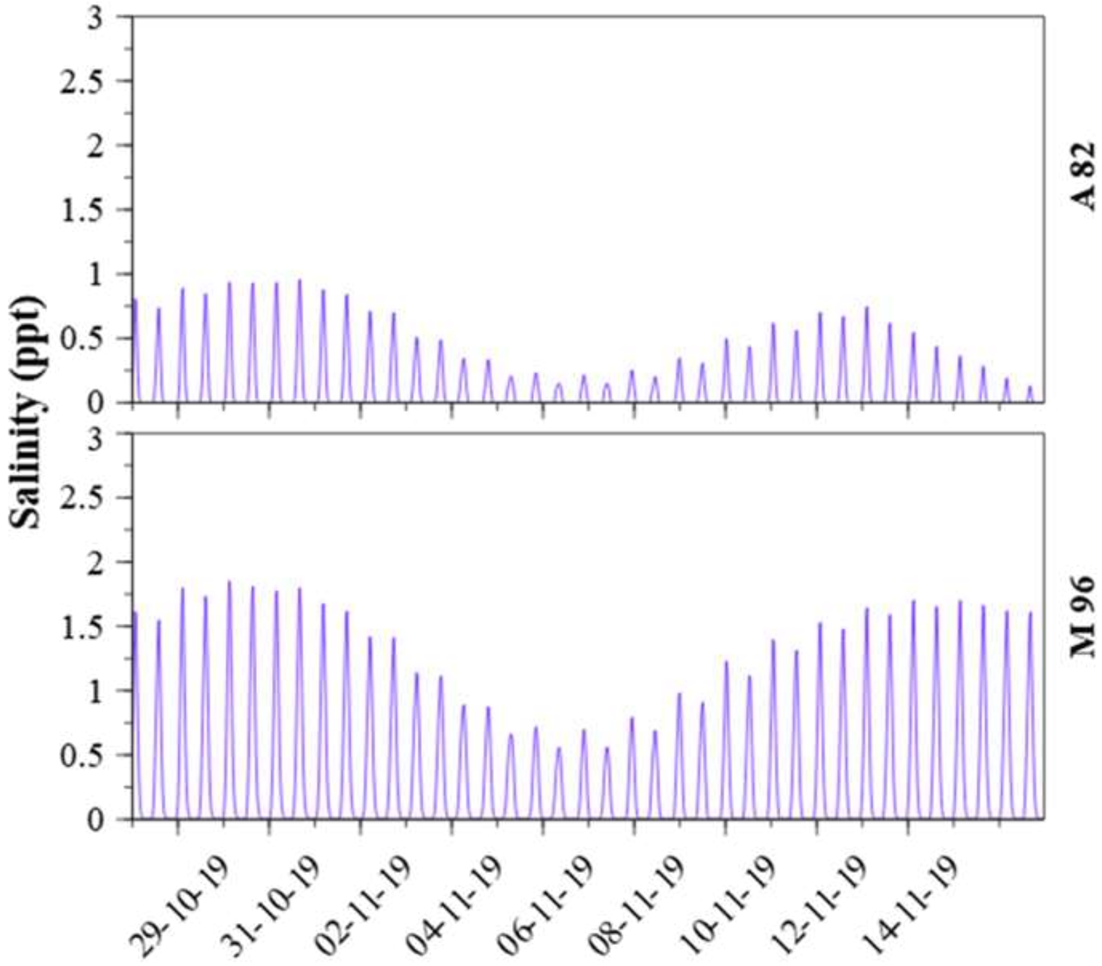
A.2.112 Plate A.34 shows the range of modelled baseline salinity in the chainage of the 25km reach from 0km (Teddington Weir) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

Plate A.34 Baseline salinity for A82 and M96 scenarios



A.2.113 The salinity data show median baseline and 10th percentile salinities are zero for all of the chainage of the 25km reach from 0km (Teddington Weir), with only the 90th percentile salinities showing increases after around 20km, increasing to ~0.01ppt for A82 and ~0.07ppt for M96. Spring tides show a slightly higher 10th percentile salinity of ~0.09ppt when compared to ~0.06ppt for neap tides. It is noted that the water body supports high tide habitat at Syon Park SSSI. It is based on this classification that the sensitivity of the Mogden STW site salinity is High.

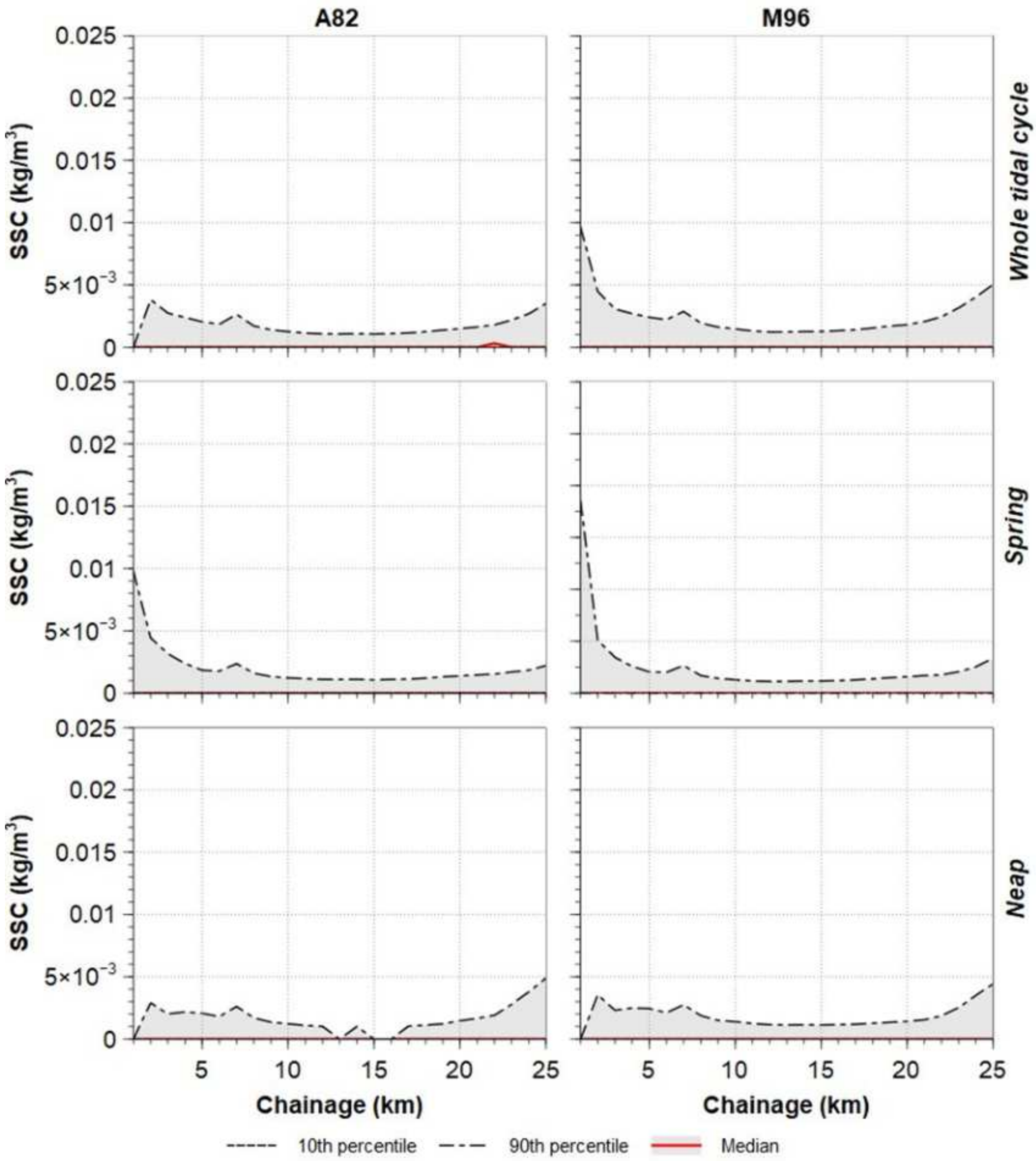
Plate A.35 Spring-neap-spring salinity cycle 29km downstream of Teddington Weir



Suspended solids

A.2.114 Plate A.36 shows the range of modelled baseline suspended solids in the chainage of the 25km reach from 0km (Teddington Weir) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

Plate A.36 Baseline suspended solids concentrations for A82 and M96 scenarios



A.2.115 The baseline suspended solids data show that median and 10th percentile suspended sediment concentrations are zero across the whole reach. Only the 90th percentile concentrations show any differences, and these changes are below 0.005kg/m^3, with the exception of between 0-2km where concentrations peak at ~0.01-0.015 kg/m^3 and decline towards 0.005kg/m^3 at 2km. The suspended solids data indicate very low concentrations over both A82 and M96 flows for all tidal states.

A.2.116 It is noted that the water body supports high tide habitat at Syon Park SSSI. Based on this classification, the sensitivity of the Mogden STW site suspended solids is High.

Dissolved oxygen (DO)

A.2.117 The DO of the tidal River Thames is a sensitive receptor to the changes in the current Mogden STW discharge and discharging recycled water. Continuous monitoring sondes at Brentford Barge and Kew Barge, with hourly recording, is used as evidence as presented in Table A.19 and Plate A.37. The 5th percentile value gives an indicative Good status.

Table A.19 Dissolved oxygen summary upper tidal River Thames (Brentford Barge and Kew Barge)

Determinand	Units	Mean	Max	Median	95th percentile	No of samples	5th percentile - WFD
Dissolved oxygen	mg/l	9.42	247	9.88	12.7	2020-2024	5.16

Plate A.37 tidal River Thames dissolved oxygen sonde readings

A.2.118 The Thames RBD RBMP3 identifies the water body that includes this reach of river[27] as Good status for DO with an interim update (2022). This Good status is also reflected at the specific Environment Agency monitoring site closest to Mogden STW, *Thames at Hammersmith Bridge*[28], in 2022. The Thames Water

[27] Thames Upper Water Body (https://environment.data.gov.uk/catchment-planning/WaterBody/GB530603911403)

[28] https://environment.data.gov.uk/catchment-planning/WaterBody/GB530603911403

data since 2020 indicate that Good status for DO at this site is reasonable. It is noted that the water body does not support in channel habitats protected/designated under UK habitat designation. It is based on this classification, the sensitivity of the Mogden STW site DO is Medium.

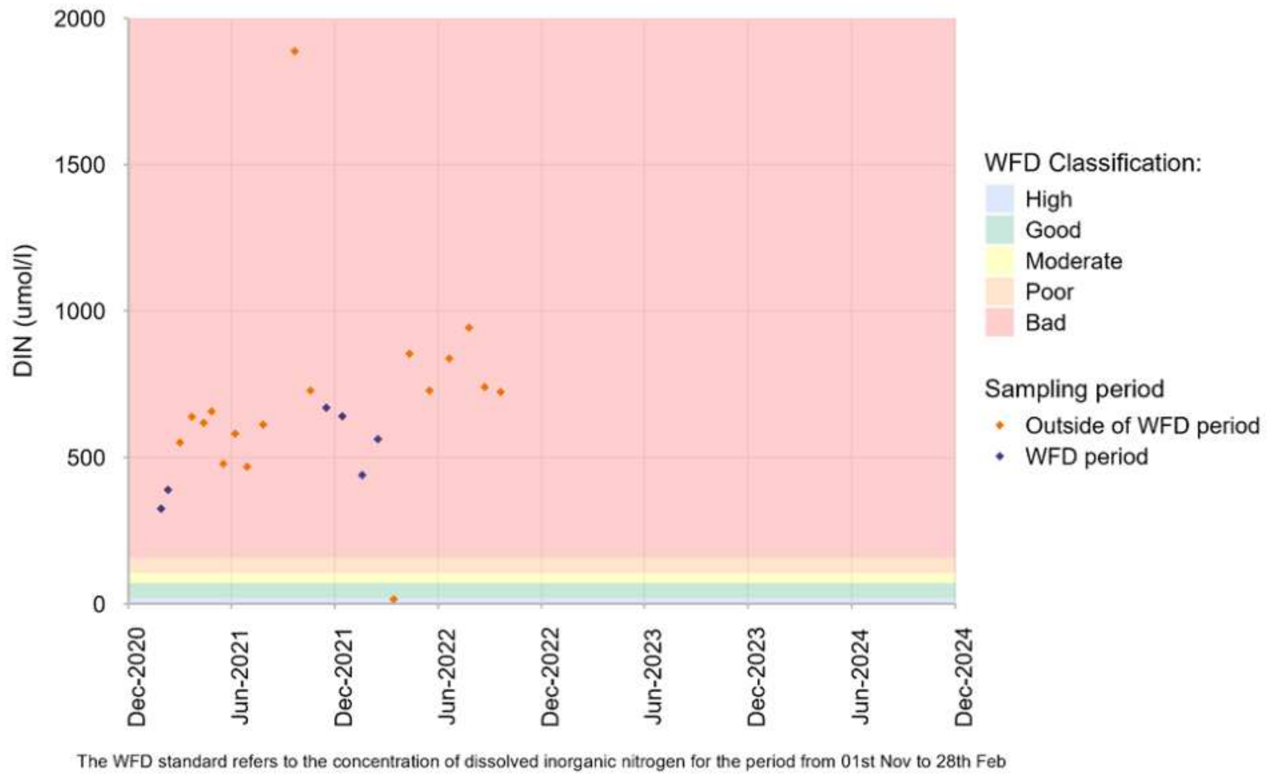
Nutrients

A.2.119 The nutrient dissolved inorganic nitrogen is considered a sensitive receptor to the discharge of recycled water to transitional and coastal waters. It was monitored[29] from 2020 to 2022 at Kew Bridge as presented in Table A.20 and Plate A.38 The samples taken within the WFD designation period indicate Bad status (using lower salinity, intermediately turbid standards for a transitional water body).

Table A.20 Calculated dissolved inorganic nitrogen data tidal River Thames

Determinand	Units	Mean	Max	Median	Q95	No of samples	No > LOD	Mean - WFD (Nov to Feb, µmoll-1)
Dissolved inorganic nitrogen	mg/l	9.18	26.4	8.94	13.1	23	23	504

Plate A.38 Thames at Kew Bridge dissolved inorganic nitrogen sample summary



29 dissolved inorganic nitrogen monitored as component part ammoniacal nitrogen, nitrate as N and nitrite as N.

A.2.120 The Thames RBD RBMP3 identifies the water body that includes this reach of transitional water body[30] as Good status for physico-chemical water quality elements. It should be noted that this does not include an assessment of dissolved inorganic nitrogen therefore there is no reference Environment Agency monitoring location or designation. The Thames Water data from the SRO monitoring scheme is consistent with Bad status. Therefore, the nutrient quality has negligible sensitivity as per the sensitivity criteria.

Chemical dispersal

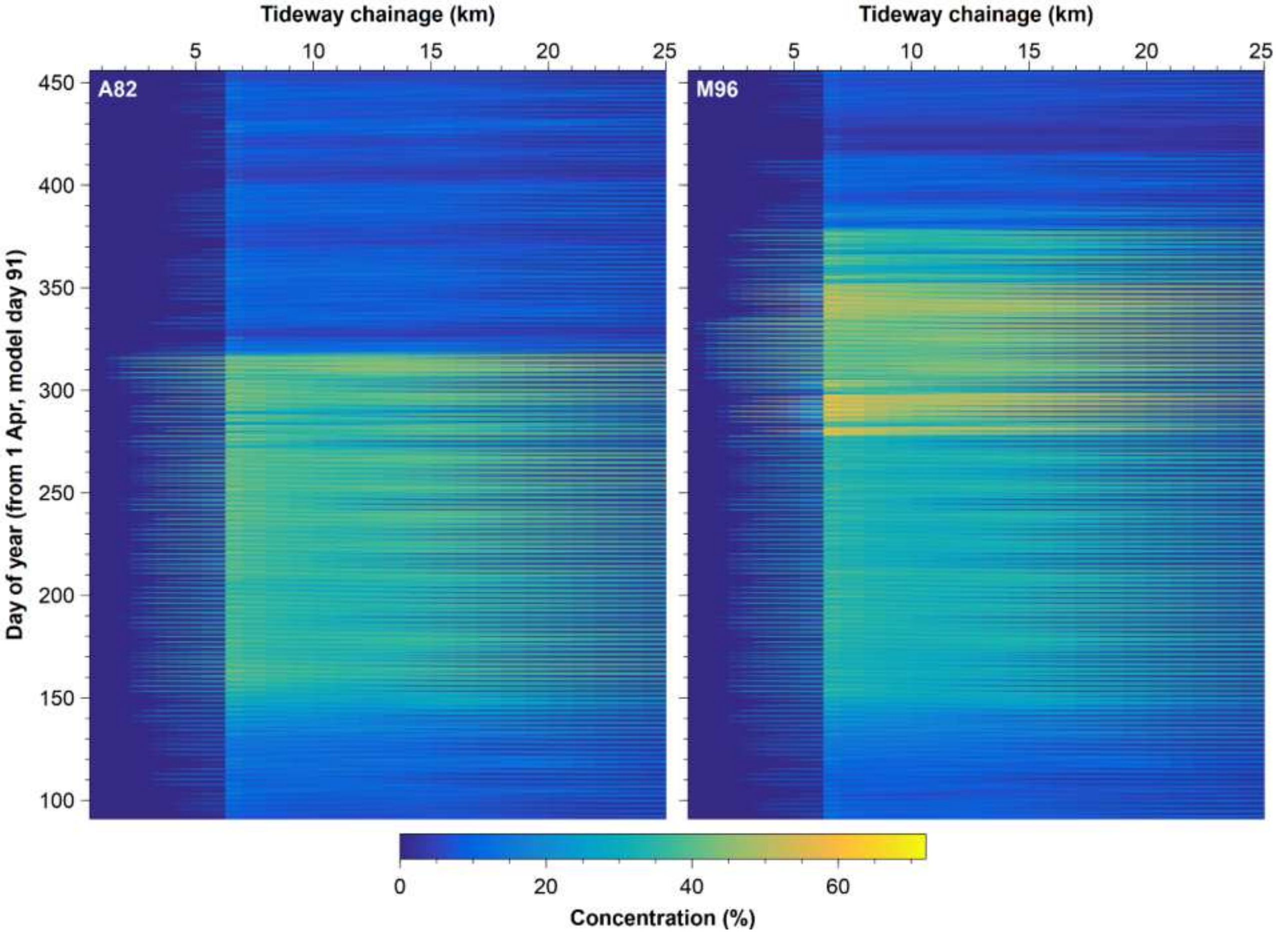
A.2.121 The Mogden STW outfall is included in the Thames RBD RBMP3 water body Thames Upper transitional water body[30]. This water body is designated as High status for specific pollutants (2019) with an interim also of High status (2022). The water body is also designated as Fail status for chemical status pollutants (2019) with an interim also of Fail status (2022). These statuses are reflected in the Environment Agency monitoring site which is close to the Mogden STW outfall *Thames at Hammersmith Bridge (Dove Pier)*[31]. As the specific pollutants are of High status but this water body does not support habitats protected/designated under UK habitat designation it is of Moderate sensitivity.

A.2.122 Plate A.39 shows the output of the conservative tracer modelling for the tidal River Thames between Teddington Weir (0km) and Battersea (25km). Conservative tracer data were extracted every 0.5km between Teddington Weir and out to 6.5km and then every kilometre until the end of the reach. Richmond Sluice is located at approximately 5.7km along the reach while Mogden STW outfalls (and the starting location of the conservative tracer introduction) are located around 6.2km along the reach (vertical line on each figure).

A.2.123 The data in the figures highlight the baseline concentration of Mogden effluent water as a percentage of the total water in the Tideway at a specific date and time (between 31 March 2019, day number 90 and 30 March 2020, day number 456 at half hourly intervals) at that specific chainage point along the Tideway. The temporal resolution of the data allow variation in baseline Mogden effluent to be visualised during diurnal tidal cycles

[30] Thames Upper Water Body: (https://environment.data.gov.uk/catchment-planning/WaterBody/GB530603911403)
[31] https://environment.data.gov.uk/catchment-planning/MonitoringSite/354663

Plate A.39 Conservative tracer modelling for A82 and M96 showing concentration of Mogden effluent water in the total volume of water in the tidal River Thames



A.2.124 For the A82 scenario, landwards of Mogden STW (6.2km to 0km) the majority of the water is not composed of Mogden effluent, generally ~0-10% with occasional spikes up to 50% during flood tides. The data show that under the A82 flows, the river has sufficient flow to resist the incoming tidal flows and be the dominant source of water (100%) for at least the initial 1km and sometimes up to 3km when flows are slightly higher (outside the 140-320 day number (20 May 2019 to 16 November 2019, respectively)).

A.2.125 Seaward of the Mogden STW (6.2km-25km) outside of the 130-320 day number period, ~20-30% of water is composed of Mogden effluent, with the higher concentrations occurring on the ebb tide while lower concentrations occur on the flood tide. This represents the movement of the water in the Tideway in response to tidal cycles and noting the impact of the inflowing river water at Teddington of maintaining a net positive movement in a seaward direction under most conditions.

A.2.126 During the 140-320 day number period concentrations in the Tideway seaward of Mogden STW, ~40-60% of the water is composed of Mogden effluent. Higher concentrations are again found on the flood tide.

A.2.127 For the M96 scenario, landwards of Mogden STW (6.2km to 0km) the majority of the water is not composed of Mogden effluent, generally ~0-10% with occasional spikes up to 60% during flood tides. The data show that under the M96 flows, the river has sufficient flow to resist the incoming tidal flows and be the dominant source of water (100%) for at least the initial 0.5km and sometimes up to 2-3km when flows are slightly higher (outside the 130-380 day number (20 May 2019 to 15 January 2020, respectively)).

A.2.128 In comparison to A82, higher effluent concentrations of up to 60-70% are seen around day number 280-300 when ~10-20% of the water at Teddington Weir is likely to be composed of Mogden effluent. As for A82 flows, seaward of the Mogden STW (6.2km-25km) outside of the 130-380 day number period, ~20-30% of water is composed of Mogden effluent, with the higher concentrations occurring on the ebb tide while lower concentrations occur on the flood tide.

A.2.129 The inflowing river water at Teddington still maintains a net positive movement in a seaward direction under most conditions. During the 130-380 day number period concentrations in the Tideway seaward of Mogden STW, ~40-60% of the water is composed of Mogden effluent, with a particular peak up to ~60-70% or higher between the 280-300 and 330-350 day number periods.

A.3 Evidence to support preliminary assessment of likely significant effects

A.3.1 This section details the evidence to support the preliminary assessment of likely significant effects at each site during the operational phase of the Project. Evidence to support preliminary assessment of construction activities is presented in Chapter 5: Water Resources and Flood Risk. The separate WFD Regulations compliance assessment is presented in Appendix 5.3.

Burnell Avenue

Evidence to support the preliminary impact assessment of operation phase activities

A.3.2 Abstraction at the Project's intake, occurring during low river flow conditions, has the potential to locally impact river currents and river velocities, which may in turn impact geomorphological processes in the river such as sedimentation rates. River levels would remain the same as these are controlled by the weir level at Teddington Weir.

A.3.3 The input of recycled water, from the TTP, at the outfall would restore river flows and river velocities to those without the Project in the length of remaining freshwater River Thames to Teddington Weir, and the river's contribution to the tidal River Thames over the weir.

A.3.4 As the recycled water mixes into the river water locally at the Project's outfall, there is potential for impact on the low river currents and low river velocities at times of low flow.

A.3.5 The recycled water itself has the potential for impact on water quality standards in the River Thames, noting this would be treated at the TTP and would be subject to a discharge permit from the Environment Agency to ensure environmental protection.

A.3.6 River and recycled water temperatures are similar during summer months, but seasonal differences in water temperature between the recycled water and river water identify there is the potential for an impact on water temperature in the River Thames at the outfall itself, dispersing with river flow.

A.3.7 Where there is potential for the recycled water to affect the water quality or water temperature of the freshwater River Thames, there is the potential for water passed forward over Teddington Weir to affect the water quality and temperature in the estuarine tidal River Thames.

A.3.8 The evidence for assessment of operation phase surface water resources quality impacts to the river is described under **Operation phase surface water resources evidence** section. At the Burnell Avenue site, relevant operation phase activities with pathways to river depth and velocity, and geomorphological impacts on the freshwater River Thames, are:

a. Potential impact on hydrodynamics and geomorphological processes due to abstraction at the intake and decreased river flow, both at the intake and between the intake and outfall.

b. Potential impact on hydrodynamics and geomorphological processes due to input of recycled water at the outfall

A.3.9 The evidence for assessment of operation phase surface water quality impacts to the river is described under **Construction phase surface water quality evidence** section. At the Burnell Avenue site, relevant operation phase activities with pathways to water quality contamination of the freshwater River Thames are:

a. Potential for impact on water quality standards, underlying water chemistry and water temperature in the River Thames due to input of recycled water at the outfall.

b. Potential for impact on water quality standards, underlying water chemistry and water temperature in the tidal River Thames from potential change in water quality passed forward from the freshwater River Thames (as amended by input of recycled water at the outfall).

Operation phase surface water resources evidence

A.3.10 Abstraction at the proposed intake would occur during low river flow conditions. These are evidenced further below under **River flow regime changes** section. The potential for changes in river depth and velocity and geomorphology associated with abstraction at the intake and discharge at the outfall are evidenced further below under **Change in river depth and velocity characteristics** section.

River flow regime changes

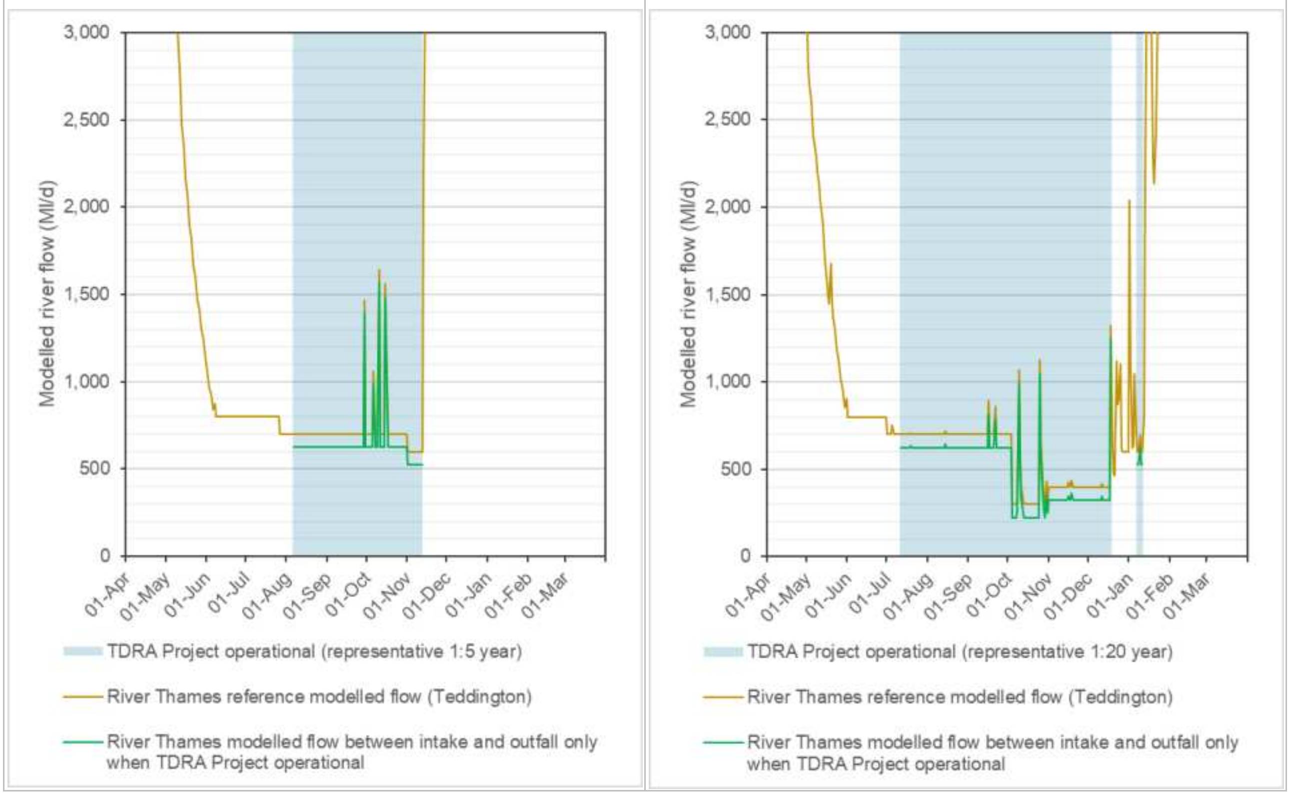
A.3.11 Selected representative years have been used to show an indicative flow pattern along the River Thames from Walton Bridge to Teddington Weir in 0 with the Project (75Ml/d). It is important to note that when operational for water resources purposes (Project in operation) flow changes associated with the Project would be exclusively within the ~250m reach between the intake and outfall, with no change at Teddington Weir. When the Project is not in operation for water resources purposes, there would be neither abstraction nor discharge to the freshwater River Thames at Teddington.

A.3.12 Reference condition flows in the River Thames at Teddington Weir are lowest during the representative Project in operation periods of summer and autumn. For the selected 1:5 year return period the lowest modelled flows at Teddington Weir are 600Ml/d for 12 dates in November.

A.3.13 For the selected 1:20 year return period the lowest modelled flows at Teddington Weir are 300Ml/d, for 17 dates in October. There are also periods of low flow as flows in the River Thames recede in late spring/early summer prior to the representative Project in operation periods. However, in general, outside the representative Project in operation periods river flows are much higher – to a peak of 15,000Ml/d in the A82 scenario and 25,000Ml/d in the M96 scenario, noting the flow axis is truncated in 0

Plate A.40 Flow in the freshwater River Thames used for modelled assessment of the Project scenarios

a) Locally at Teddington Weir; A82 1:5 moderate-low flow scenario | b) Locally at Teddington Weir; M96 1:20 very-low flow scenario



Change in river depth and velocity characteristics

A.3.14 Table A.21 shows the intake hydraulic model output of the Project for a modelled intake velocity of 0.1m/s.

A.3.15 This details measurements of various properties of the modelled intake draw-in field for a 0.1m/s intake velocity. The measurements represent changes above the hydrodynamic changes over the baseline with respect to three incipient river flow conditions, 700Ml/d, 400Ml/d and 300Ml/d

Table A.21 The Project intake hydraulic model output for a modelled intake velocity of 0.1m/s

River flow (before abstraction)	Intake draw in field (general characterisation)			Intake draw in field zone greater than 0.05 metres per second			Depleted reach between the intake and outfall	
	Modelled length of intake flow field draw in (m)	Modelled width of intake flow field draw in (m)	Modelled maximum velocity of draw in (m/s)	Modelled maximum length of zone along river (m)	Modelled maximum width of zone across river (m)	Modelled maximum depth of zone in river (m)	Modelled river surface reduction in the depleted reach (m)	Modelled dominant velocity between intake and outfall (m/s)
700Ml/d	34	15	-0.005 to -0.01	Not visible	4.0	1.3	0	0.025 to 0.05
400Ml/d	26	12	-0.005 to -0.01	Not visible	3.0	1.3	0	0.01 to 0.025
300Ml/d	25	12	0.005 to 0.01	Not visible	3.0	1.5	0	0 to 0.01

A.3.16 The review of the hydraulic modelling of the proposed intake shows very little difference in the general characterisation of the intake draw in field for the modelled intake velocity and different river flow scenarios. The general characterisation includes the full extent of change in river velocities as consequence of an intake. For all scenarios 82% of the 89m wide channel is completely unimpacted by the intake. The modelled width of the intake draw in field is between 12m and 15m; with a field width of 15m at the normal operating river flow of 700Ml/d.

A.3.17 At 700Ml/d, this intake field is short (34m) for a 0.1m/s intake velocity with a modelled in-channel structure of 29m length. Intake fields are smaller in length and width at lower river flows. Notwithstanding the velocity through the intake structure and the need for screening the velocity changes in the draw in field of the intake are small for all modelled scenarios, with greatest changes of 0.01m/s in comparison with the baseline river velocities.

A.3.18 In the reach between the intake and outfall (the depleted reach), abstraction from the Project would reduce river flow by 75Ml/d. None of the modelled scenarios show that the reduction in river flow associates with a reduction in water surface level and as such the river depth is maintained. This is as a direct result of the effect of Teddington Weir ponding the water level upstream of the weir. At 700Ml/d river flows, a 75Ml/d reduction in river flow is a 11% reduction, and the modelled dominant velocity between intake and outfall is in the band 0.025 to 0.05m/s, consistent with the no-abstraction baseline at these river flows.

A.3.19 At 400Ml/d river flows, a 75Ml/d reduction in river flow is a 19% reduction, and the modelled dominant velocity between intake and outfall is in the band 0.01 to 0.025m/s, consistent with the no-abstraction baseline at these river flows. At 300Ml/d river flows, a 75Ml/d reduction in river flow is a 25% reduction, and the modelled dominant velocity between intake and outfall is in the band 0 to 0.01m/s, which is a reduction from the dominant 0.01 to 0.025m/s in the no-abstraction baseline at these river flows. These are irrespective of the intake velocity.

A.3.20 Table A.22 details measurements of various properties of the modelled outfall plume for a 0.3m/s outfall velocity for a bankside outfall. Table A.23 details measurements of various properties of the modelled outfall plume for a 0.3m/s outfall velocity for a near bankside in-river outfall. The measurements represent changes above the hydrodynamic changes over the baseline with respect to three incipient river flow conditions, 700Ml/d, 400Ml/d and 300Ml/d.

Table A.22 The Project outfall hydraulic model output for a bankside outfall with a modelled outfall velocity of 0.3m/s

River flow (after discharge)	Outfall plume (general characterisation)					Outfall plume zone greater than 0.05m/s				
	Length of modelled plume (m)	Total modelled length of left bank change (m/s)	Max modelled change of left bank (m)	Width of modelled plume (m)	Modelled plume width as percentage of channel width (%)	Modelled max dominant change in outfall flow velocity from baseline (m/s)	Modelled max local change in outfall flow velocity from baseline (m/s)	Modelled max length of zone along river (m)	Modelled max width of zone across river (m)	Modelled max depth of zone in river (m)
700Ml/d	175	-0.01 to -0.05	186	34	45	0.005 to 0.01	0.1 to 0.2	32	6	1.2
400Ml/d	175	0.01 to -0.05	198	37	49	0.01 to 0.05	0.1 to 0.2	54	8	1.2
300Ml/d	175	0.01 to -0.05	188	34	45	0.01 to 0.05	0.1 to 0.2	64	8	1.3

Table A.23 The Project outfall hydraulic model output for a near bankside in-river outfall with a modelled outfall velocity of 0.3m/s

River flow (after discharge)	Outfall plume (general characterisation)					Outfall plume zone greater than 0.05m/s				
	Length of modelled plume (m)	Total modelled length of left bank change (m/s)	Max modelled change of left bank (m)	Width of modelled plume (m)	Modelled plume width as percentage of channel width(%)	Modelled max dominant change in outfall flow velocity from baseline (m/s)	Modelled max local change in outfall flow velocity from baseline (m/s)	Modelled max length of zone along river (m)	Modelled max width of zone across river (m)	Modelled max depth of zone in river (m)
700Ml/d	167	-0.01 to -0.05	200	27	36	0.005 to 0.01	0.1 to 0.2	10	2	1.5
400Ml/d	172	0.01 to -0.05	193	36	48	0.01 to 0.05	0.1 to 0.2	10	2	3.4
300Ml/d	157	0.01 to -0.05	160	34	45	0.01 to 0.05	0.1 to 0.2	10	3	1.8

A.3.21 The review of the hydraulic modelling of the initial design proposed for the bankside outfall (Table A.22) and near bankside in-river outfall (Table A.23) shows very little difference in the general characterisation of the outfall plume for the different river flow scenarios. The general characterisation includes the full extent of change in river velocities as consequence of an outfall.

A.3.22 For all scenarios the width of the plume is less than or equal to 49% of the channel width, with plume dimensions being inversely proportional to river flow scenario. Most notably, there is very little change in dominant flow velocities from the baseline, with changes of 0.005-0.01m/s (0.5-1.0cm/s) for the 700Ml/d flow scenario, reducing to 0.01-0.05m/s (1-5cm/s) for 400Ml/d and 300Ml/d flow scenarios seen locally in the plume downstream of the outfall.

A.3.23 A 0.05m/s or greater zone was defined from the modelled output as a higher velocity criterion for the purposes of fish impact assessment.

a. For the initial design of the bankside outfall the modelled outfall velocity of 0.3m/s, the 0.05m/s zone extends no further than 8m from the left bankside, extends no more than 32-64m depending on the flow scenario, and extends no further than 1.3m in depth. These zones all hug the right bank downstream of the outfall.

b. For the initial design of the near bankside in-river outfall the modelled outfall velocity of 0.3m/s, the 0.05m/s zone extends no further than 3m from the outfall, extends no more than 10m depending on the flow scenario, and extends no further than 3.4m in depth. These zones are local to the outfall and away from the bank.

A.3.24 With respect to the upper Tideway from downstream of Teddington Weir out to Richmond Pound (0-5km in a seaward direction) there is the potential for the outfall to exert some minor influence on hydrodynamic and physical properties in the estuary, despite the negligible changes identified in Table A.22.

A.3.25 Comparisons between baseline and with the Project modelled conditions for tidal elevation, current speed and suspended sediment concentration indicate that there is no influence on the upper Tideway from the operation of the Project and outfall.

Operation phase surface water quality evidence

A.3.26 The recycled water itself has the potential for impact on water quality standards in the River Thames, noting this would be treated at the TTP and would be subject to a discharge permit from the Environment Agency to ensure environmental protection.

A.3.27 River and recycled water temperatures are similar during summer months. However, seasonal differences in water temperature between the recycled water and river water could have a potential impact on water temperature in the River Thames at the outfall, which disperses with the river flow. This is evidenced further under Water temperature section. Potential for change in water quality standards relating to:

a. General physico chemical quality - see General physico-chemical water quality section.

b. Nutrient quality - see Nutrient quality (orthophosphate and nitrate) section.

c. Hazardous chemicals – see Hazardous chemicals section.

A.3.28 Where there is potential for the recycled water to affect the water quality or water temperature of the freshwater River Thames, there is the potential for water passed forward over Teddington Weir to affect the water quality and temperature in the tidal River Thames and this is evidenced where appropriate.

Water temperature

A.3.29 This section outlines the water temperature change in the freshwater Thames associated with the Project. A water temperature assessment has been undertaken for the 1:5 return frequency A82 flow scenario. This used flow data for the River Thames at Teddington for the A82 scenario together with scenario flow changes for the Project.

A.3.30 The time series temperature plot showing modelled river temperature at Teddington, Mogden STW final effluent and the temperature of the river once the recycled water is fully mixed into the receiving water can be seen in Plate A.41. The equivalent for the 1:20 return frequency M96 flow scenario can be seen in Plate A.42. Table A.24 details a summary of the temperature impacts of the Project on the River Thames for the A82 and M96 low flow scenarios

Plate A.41 Modelled temperatures in the Thames for A82 modelled low flow scenario

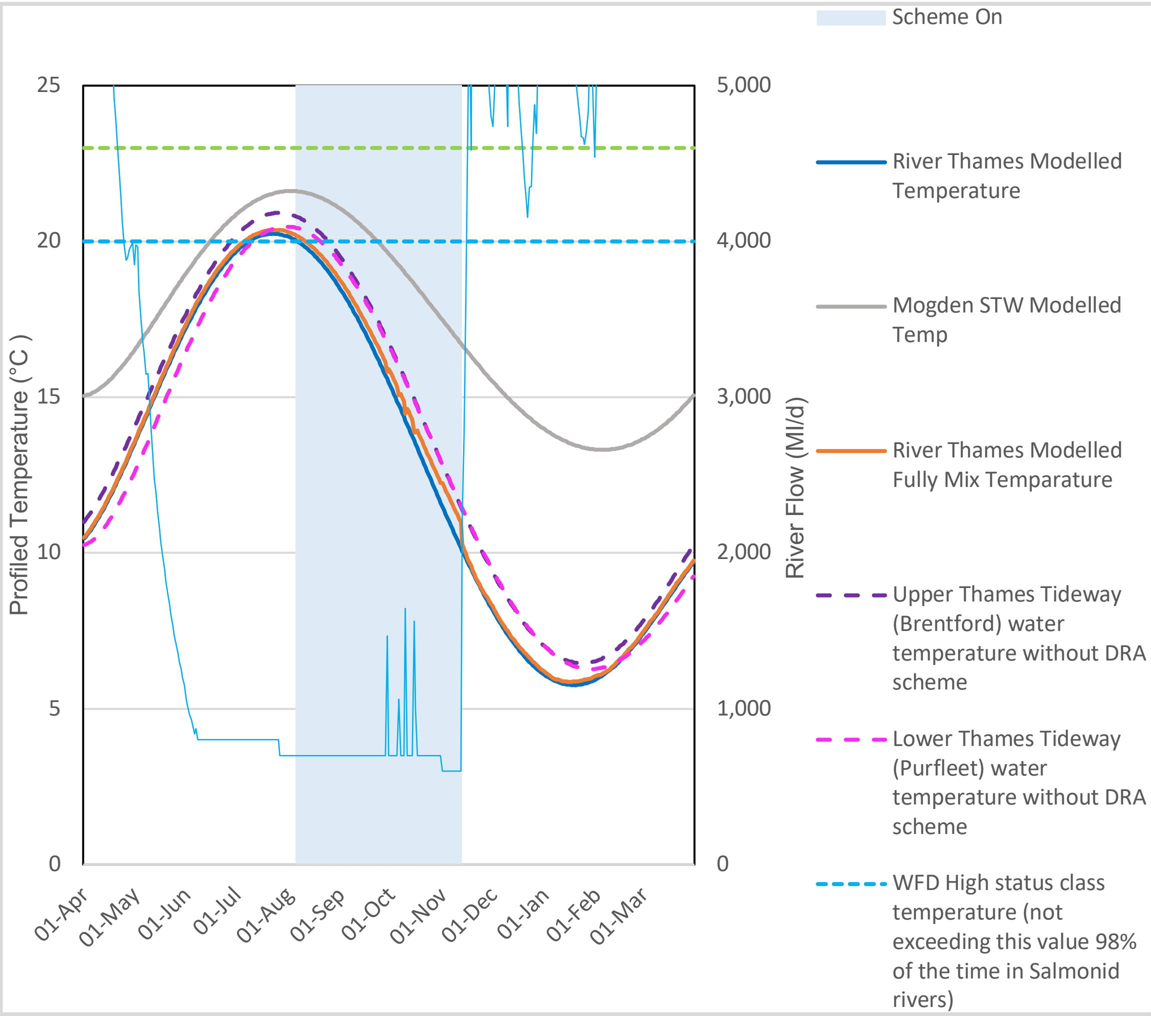


Plate A.42 Modelled temperatures in the Thames for M96 modelled low flow scenario

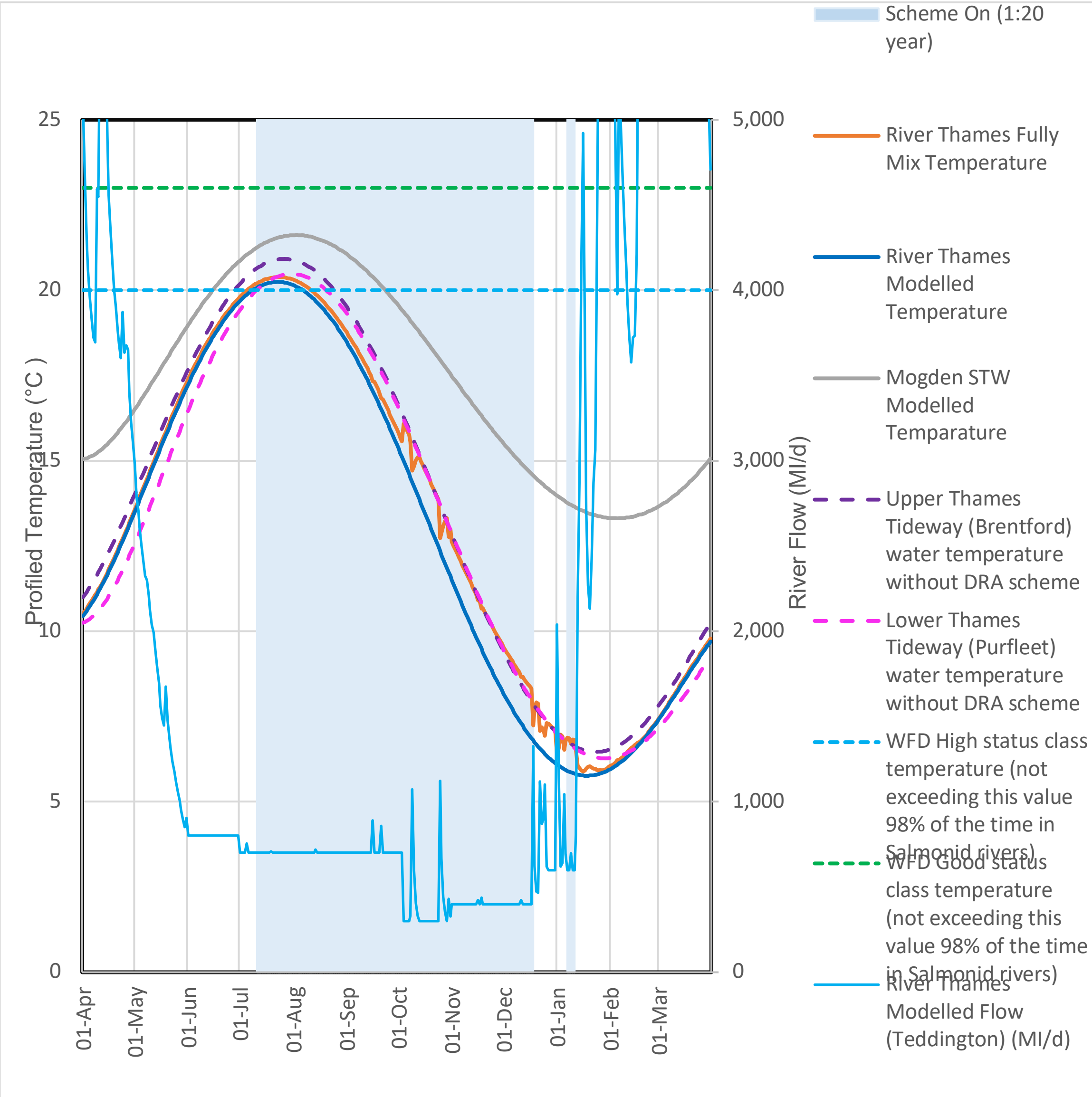


Table A.24 Summary of the Project modelled temperatures in the River Thames for the A82 and M96 moderate-low flow scenario (Scheme On)

	A82	M96
Average increase above baseline	0.4 ºC	0.7 ºC
Greatest daily temperature difference	0.8 ºC	1.45 ºC

General physico-chemical water quality

A.3.31 The assessment of the general physico-chemical water quality is based on a theoretical proposed permit for the Project recycled water, based on that of the Hogsmill STW discharge permit which is on the same reach of the river as this proposed discharge.

A.3.32 The proposed permit as well as the source water (Mogden STW final effluent) can be seen in Table A.25.

Table A.25 Theoretical permit limits for the Project recycled water

Parameter (showing mean value)	Source water (Mogden STW final effluent)	Recycled water for river discharge
pH	7.6	6.8
Total Ammonia	1.7 mgN/l	0.1 mgN/l
Total phosphorus	5.4 mg/l	0.5 mg/l
BOD	12.2 mg/l	6.9 mg/l
Suspended solids	36.0 mg/l	10.1 mg/l
Alkalinity ($CaCO_3$)	230 mg/l	174 mg/l

A.3.33 Based on the proposed permit a mass balance calculation was completed based on the 1 in 5 (A82) and 1 in 20 (M96) flow scenarios. Results can be seen in Table A.26.

Table A.26 Mass balance physico-chemical calculation results

	Determinand	A82				M96			
		Max	Average	Greatest change from baseline	% Change (Max)	Max	Average	Greatest change from baseline	% Change (Max)
Modelled year	Ammonia (mg/l)	0.0913	0.0903	0.0013	1.4	0.0925	0.08	0.0025	2.7
	BOD (mg/l)	3.58	3.23	0.48	13.4	4.05	3.4	0.95	23

	Determinand	A82				M96			
		Max	Average	Greatest change from baseline	% Change (Max)	Max	Average	Greatest change from baseline	% Change (Max)
	pH	8.08	8.07	-0.055	-0.68	8.08	8.04	-0.12	-1.5
	Suspended Solids (mg/l)	19	18.7	-1.1	5.78	19	18.3	-2.2	-12
Scheme on only	Ammonia (mg/l)	0.0911	0.0913	0.0013	1.4	0.0925	0.0915	0.0025	2.7
	BOD (mg/l)	3.58	3.58	0.48	13.4	4.05	3.66	0.95	23
	pH	8.06	8.03	-0.055	-0.68	8.05	8.01	-0.12	-1.5
	Suspended Solids (mg/l)	18.6	18	-1.1	5.78	18.4	17.7	-2.2	-12

A.3.34 The proposed permit limits may require review following a pre-permit assessment and pilot plant results if the percentage impact is not permittable at its current level.

Nutrient quality (orthophosphate and nitrate)

A.3.35 As above, the assessment of the nutrient water quality is based on the theoretical proposed permit for the Project recycled water, based on the Hogsmill STW discharge permit. The proposed permit as well as the source water (Mogden STW final effluent) can be seen in Table A.27. There is no available data on proposed nitrate concentration at this time.

Table A.27 Theoretical permit limits for the Project recycled water

Parameter (showing mean value)	Source water (Mogden STW final effluent)	Treated effluent for river discharge
Total phosphorus	5.4 mg/l	0.5 mg/l

A.3.36 Based on the proposed permit a mass balance calculation was completed based on the 1 in 5 (A82) and 1 in 20 (M96) flow scenarios. Results can be seen in Table A.28.

Table A.28 Mass balance calculation results

	Determinand	A82				M96			
		Max	Average	Greatest change from baseline	% Change (Max)	Max	Average	Greatest change from baseline	% Change (Max)
Modelled year	Total phosphorus (mg/l)	0.2	0.17	0.0438	21.9	0.24	0.19	0.0875	36
Project in operation only	Total phosphorus (mg/l)	0.2	0.19	0.0438	21.9	0.24	0.2	0.0875	36

Hazardous chemicals

A.3.37 The advanced treatment for the Project is under assessment through a pilot plant study. This study will determine the achievable water quality of hazardous chemicals within the discharge. This study will further be used to determine any permit requirements for the discharge. The impact assessment for hazardous chemicals will be completed with the completion of the pilot plant assessment and results presented in the Environmental Statement.

Mogden STW

A.3.38 This section provides evidence for the relevant surface water resources and surface water quality preliminary impact assessment for the Mogden STW site, specifically for operation phase activities under Evidence to support the preliminary impact assessment of operation phase activities section. No construction phase activities related to water resources and water quality aspects have been identified at this site.

Evidence to support the preliminary impact assessment of operation phase activities

A.3.39 The EIA Scoping assessment identified a potential effect during operation phase to the tidal River Thames associated with changes to the quantity of water discharged from Mogden STW existing outfall. The Project would not change the amount of water entering the tidal River Thames from the freshwater River Thames at the normal tidal limit at Teddington Weir. Evidence for the preliminary impact assessment of operation phase activities is provided under Operation phase surface water resources evidence section for surface water resources and under Operation phase surface water quality evidence section for surface water quality.

Operation phase surface water resources evidence

A.3.40 Change in discharge flow rate from the current STW outfall from Mogden STW to Isleworth Ait in the upper tidal River Thames are evidenced further below under Input flow changes section. The potential for changes in tidal elevation associated with reduction in Mogden STW discharge with operation of the Project are evidenced further below under Tidal elevation section. The potential for changes in tidal current speed associated with reduction in Mogden STW discharge with operation of the Project are evidenced further below under Current speed section.

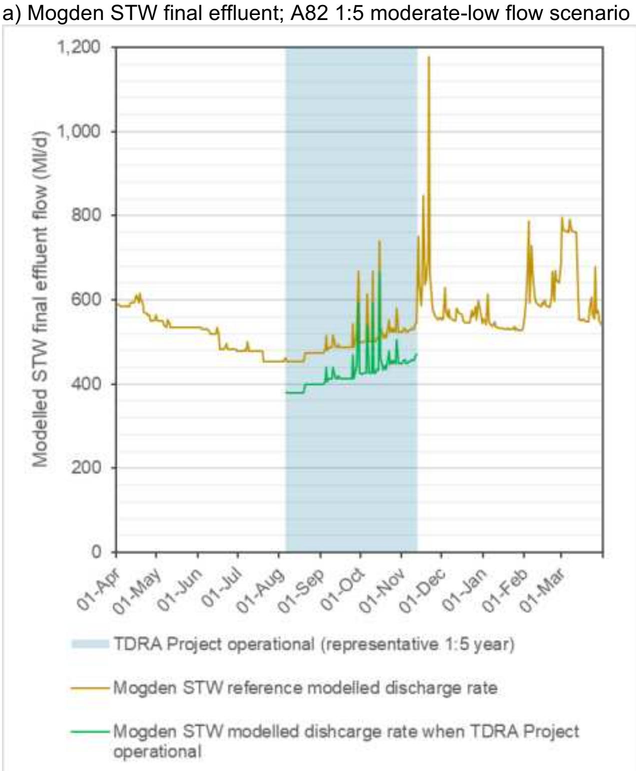
Input flow changes

A.3.41 Final effluent flows from Mogden STW discharged to the tidal River Thames at Isleworth Ait would reduce by the corresponding amount which would reduce by operation volume of the Project (up to 75Ml/d).

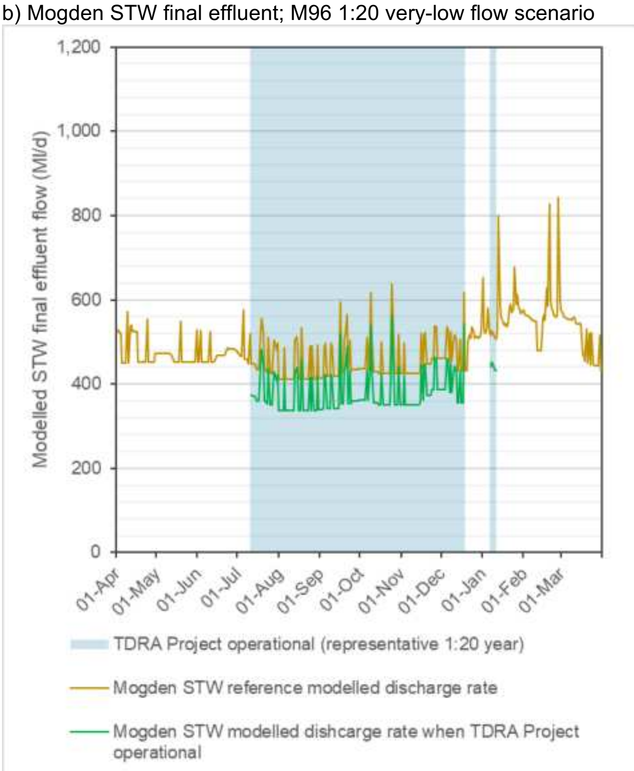
A.3.42 Estuarine hydrodynamics assessment has been undertaken for both the A82 and M96 representative model years with the Project. This represents a maximum case of effluent contribution from Mogden STW to the upper tidal River Thames. A flow series has been derived for Mogden STW final effluent based off measured effluent flow rates at the STW and the daily flow characteristics locally in west London in the model years. Modelled effluent flow rates are shown in Plate A.43.

Plate A.43 Mogden STW final effluent flow rates used for modelled assessment of Mogden water recycling scenarios

a) Mogden STW final effluent; A82 1:5 moderate-low flow scenario



b) Mogden STW final effluent; M96 1:20 very-low flow scenario



A.3.43 In the A82 scenario during the Project in operation period, modelled Mogden STW reference condition flows are 504Ml/d (daily mean). The Project would reduce these flows by 75Ml/d, a 14% reduction. In the M96 scenario during the Project in operation period, modelled Mogden STW reference condition flows are 458Ml/d (daily mean). The Project would reduce these flows by 75Ml/d, a 16% reduction.

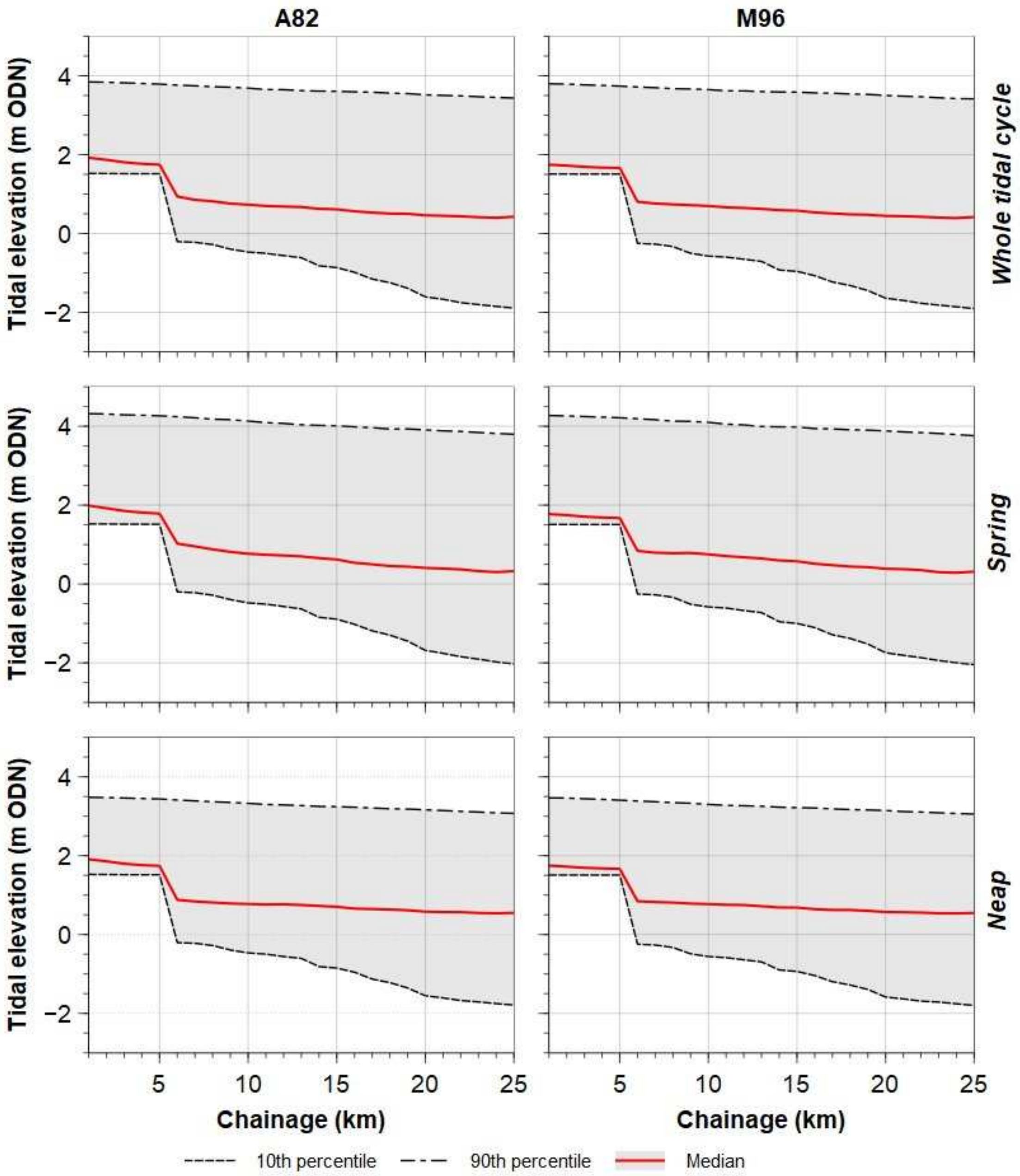
A.3.44 In addition to the Mogden STW final effluent flow rates, the 2D/3D tidal River Thames hydrodynamic model was parameterised with a representative daily variable flow series for each of the following tributaries of the tidal River Thames: freshwater River Thames, River Crane, River Brent, Beverley Brook, River Wandle, River Ravensbourne, River Lee, River Roding, River Beam, River Ingrebourne, Running Water Brook/Rainham Marshes, River Cray and River Darent, Mar Dyke; and, Beckton STW and Crossness STW.

A.3.45 Physical environment parameters were modelled for the tidal River Thames between Teddington Weir and Battersea (25km) during operation of the Project. Modelled data was collected and assessed for tidal elevation, salinity, temperature, suspended solids, current velocity and DO, extracted at every 1km along the reach, undertaken for the Project (75Ml/d). Richmond Sluice is located at ~5.7km along the reach while Mogden STW outfall is located approximately 6.2km along the reach. The modelling was undertaken by HR Wallingford and outputs from their Upper Tideway model are presented below and compared against baseline conditions when no Project is in operation (baseline conditions).

Tidal elevation

A.3.46 Plate A.44 shows the range of modelled tidal elevation in the chainage of the 25km reach from 0km (Teddington Weir) during the Project operation (75Ml/d) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

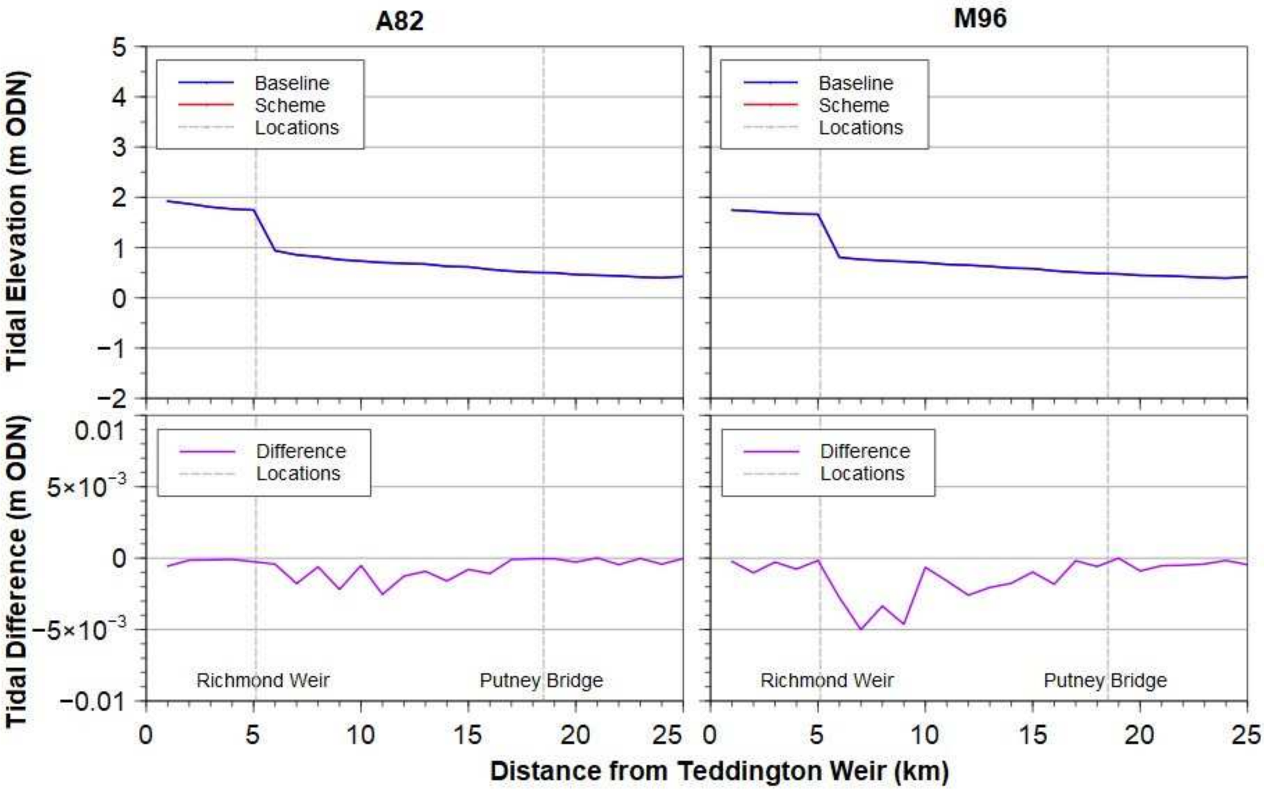
Plate A.44 Tidal elevation (m AOD) during 75Ml/d operation for A82 and M96 scenarios



A.3.47 The tidal elevation data show median tidal elevations of ~2m AOD within Richmond Pound, declining to ~1m AOD outside of the pound and towards ~0.5m AOD around Battersea. 10th percentile elevations range from ~1.5m AOD inside of the pound to ~-0.2m AOD outside of the pound and ~-2m AOD towards Battersea. 90th percentile tidal elevations range from ~4m AOD at 0km declining to around ~3.0-3.5m AOD at 25km. The data show there is no significant difference between A82 and M96 for each period of time, the whole tidal cycle, spring and neap, with some lower 10th and higher 90th percentiles for the spring tides when compared with neap tides.

A.3.48 The median (50th percentile) tidal elevation across the entire tidal cycle during operation of the Project was compared against baseline conditions in the tidal River Thames. Plate A.45 shows that operation of the Project has minimal impact on tidal elevation in the Upper Tideway. The greatest differences occur downstream of Mogden STW (6.2km), with maximum reductions of tidal elevation of 0.003m AOD occurring during A82 flows, and 0.005m AOD during M96 flows. Negligible differences in tidal elevation occurs for both A82 and M96 upstream of Richmond Weir and downstream of Putney Bridge. Between 6-15km downstream of Teddington Weir, reductions in tidal elevation for M96 is approximately ~0.002 m AOD greater than A82.

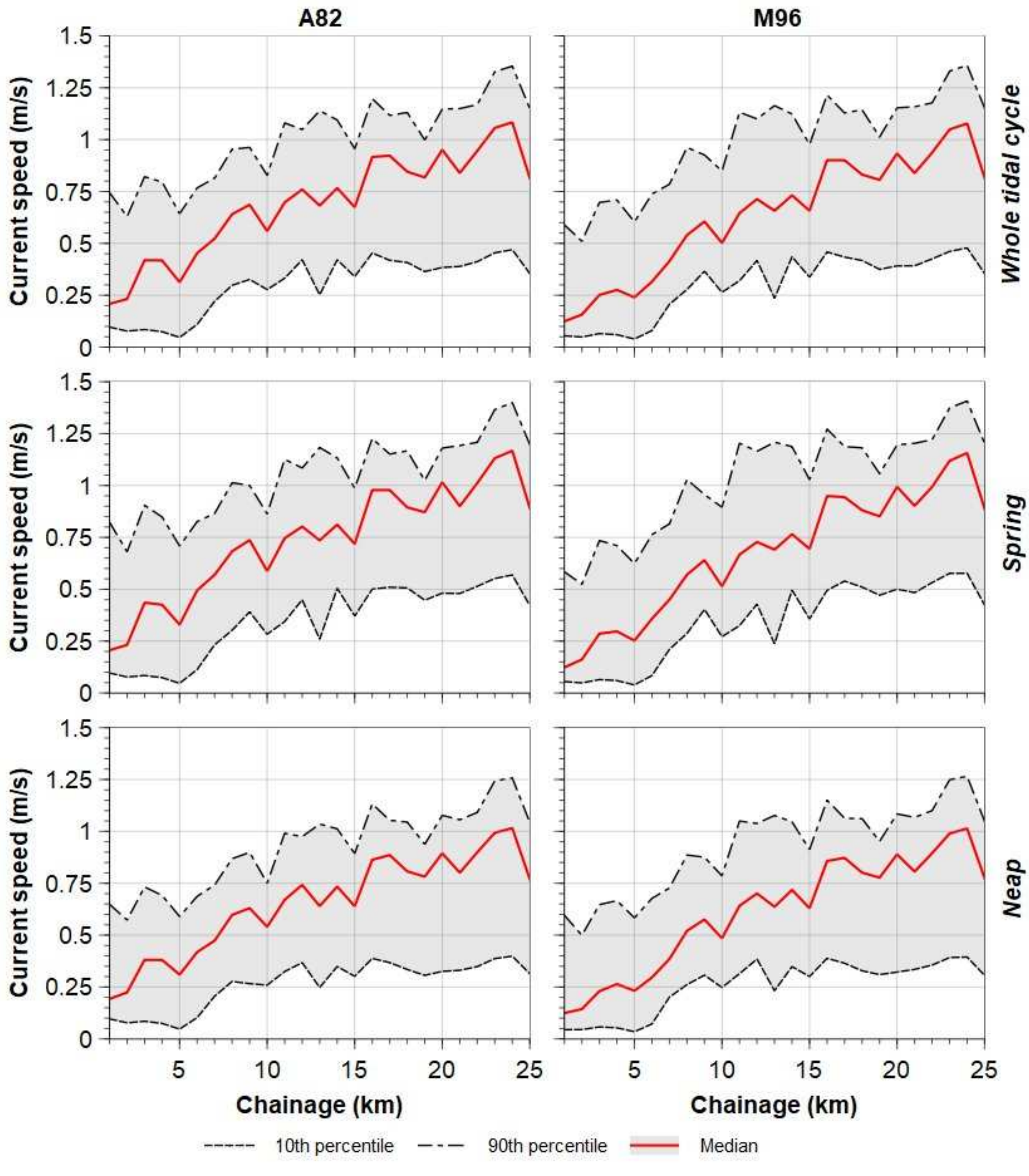
Plate A.45 Median Tidal Elevation (m AOD) change in the Upper Tideway under a 75 Ml/d operation



Current speed

A.3.49 Plate A.46 shows the range of modelled current speed in the chainage of the 25km reach from 0km (Teddington Weir) during the Project operation (75Ml/d) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

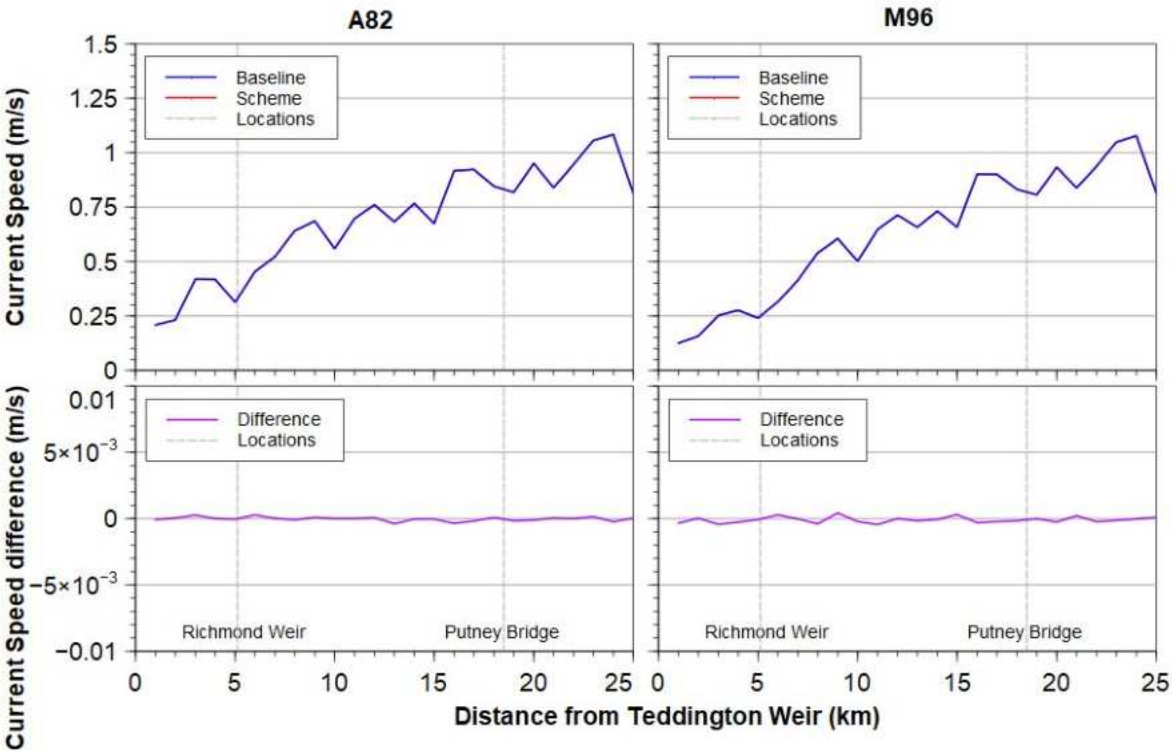
Plate A.46 Current speed during 75Ml/d operation for A82 and M96 scenarios



A.3.50 The median (50th percentile) current speed across all tidal stages for A82 and M96 range from ~0.15m/s at 0km increasing gradually along the reach to a peak of around 1.2m/s at 24km downstream and then declining to ~0.75m/s at 25km at the end of the reach. Both 10th and 90th percentile velocities follow a similar path, though current speeds are slightly lower for the neap tides than spring tides by ~0.1m/s. Between Teddington Weir and 15km downstream, median current speeds are elevated by ~0.1 m/s during A82 flows.

A.3.51 The median current speed across the entire tidal cycle during operation of the Project was compared against baseline conditions in the tidal River Thames. Plate A.47 shows that operation of the Project has negligible impact on current speed in the Upper Tideway. Current speed differences fluctuate between -0.001 and 0.001m/s for both A82 and M96 flows across the entirety of the reach, with no noticeable trends. There are no significant differences between observations for the A82 and M96 models.

Plate A.47 Median current speed change in the Upper Tideway under a 75Ml/d operation



Operation phase surface water quality evidence

A.3.52 Change in discharge flow rate from the current STW outfall from Mogden STW to Isleworth Ait in the upper tidal River Thames has potential to change the water quality of the upper tidal River Thames. Potential changes associated with reduction in Mogden STW discharge:

a. Water Temperature - Evidenced further under **Water temperature** section.

b. Salinity - Evidenced further under **Salinity** section.

c. Suspended Solids - Evidenced further under **Suspended solids** section.

d. Dissolved Oxygen - Evidenced further under **Dissolved oxygen** (DO) section.

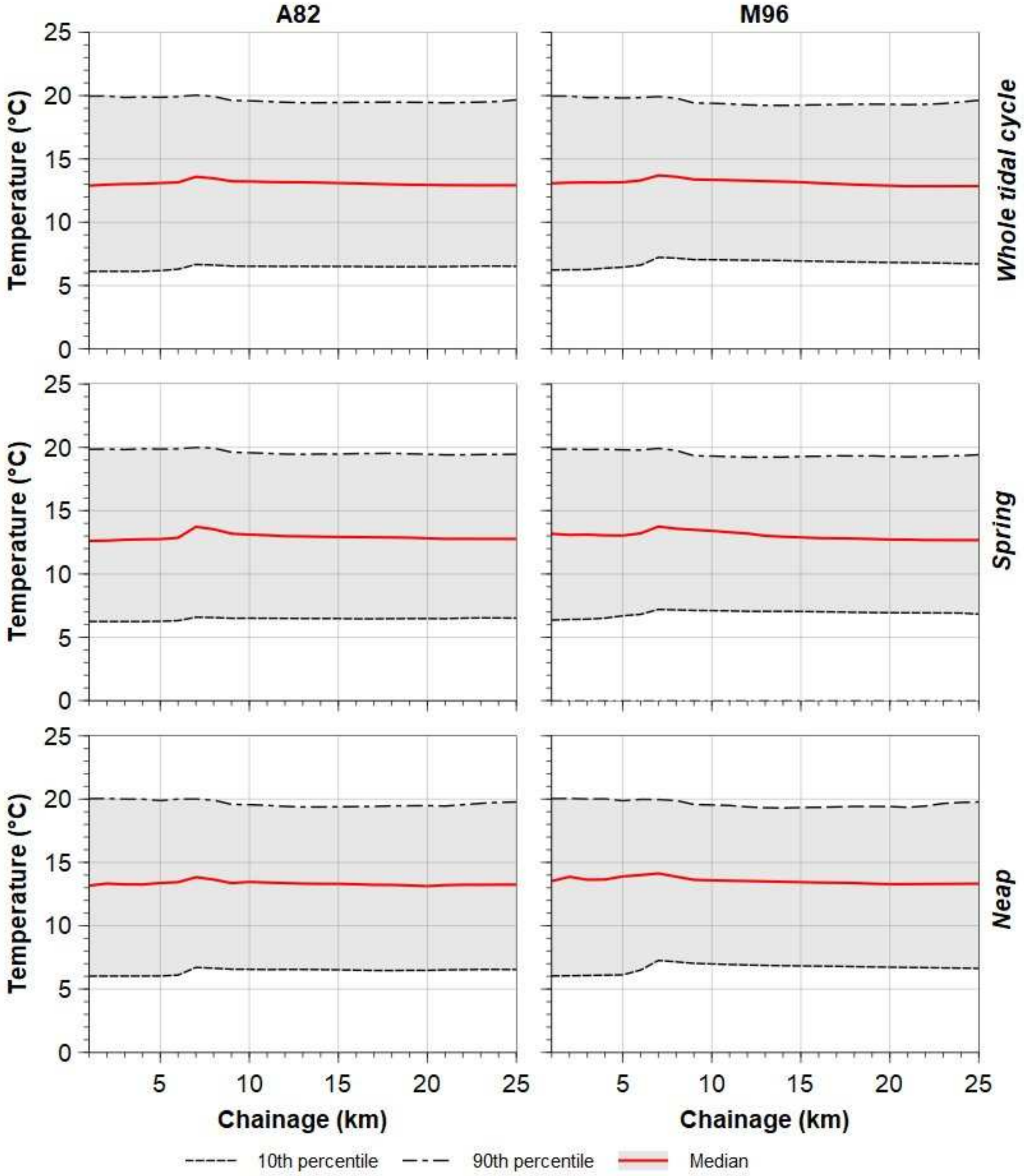
e. Nutrient Quality (Dissolved Inorganic Nitrogen) - Evidenced further under the **Nutrient quality** section.

f. Chemical Dispersal - Evidenced further under **Chemical dispersal** section

Water temperature

A.3.53 Plate A.48 shows the range of modelled water temperature in the chainage of the 25km reach from 0km (Teddington Weir) during operation of the Project for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

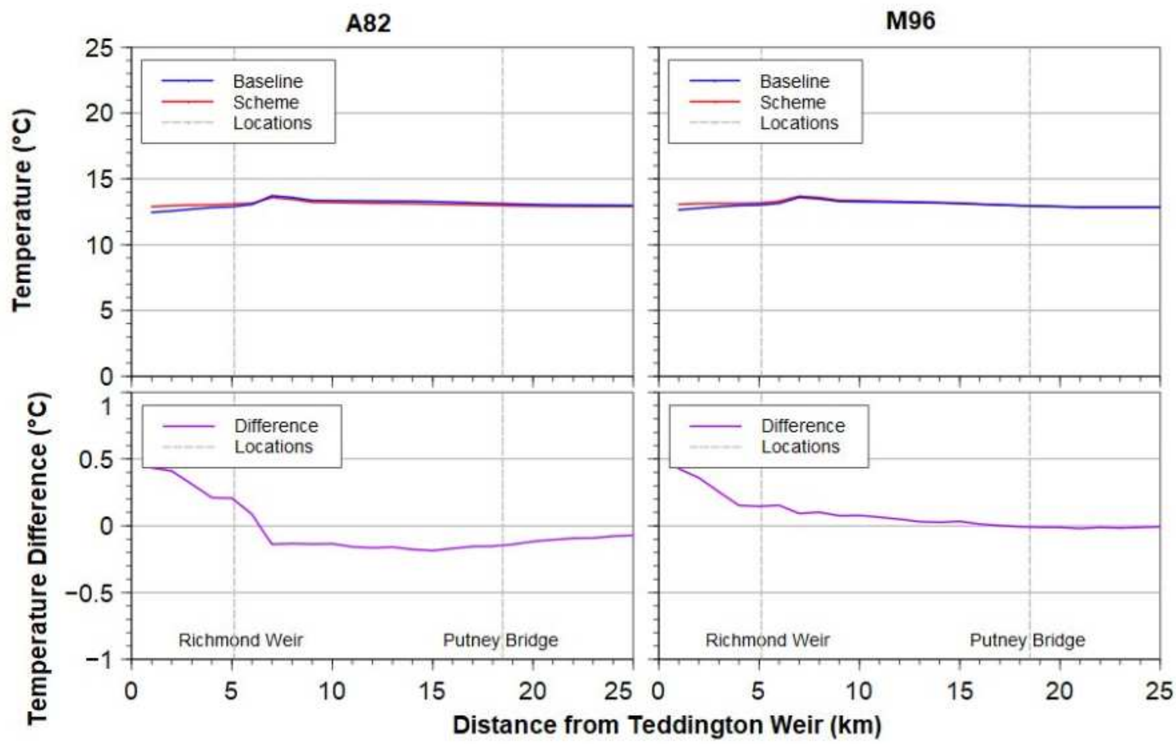
Plate A.48 Water temperature during 75Ml/d operation for A82 and M96 scenarios



A.3.54 The water temperature data show median water temperature of ~13°C within Richmond Pound, increasing to ~14°C outside of the pound around the Mogden STW discharge and declining to ~13°C for the remainder of the reach. 10th and 90th percentile temperatures remain relatively constant at ~6°C and ~19.5°C, respectively for the whole reach, although there are slight increases in the 10th percentile and decreases in the 90th percentile around 7km. The data show there is no significant difference between A82 and M96 for each period of time, the whole tidal cycle, spring and neap.

A.3.55 The median (50th percentile) water temperature across the entire tidal cycle during operation of the Project was compared against baseline conditions in the tidal River Thames. Plate A.49 shows that operation of the Project has the greatest impact on water temperature directly downstream of Teddington Weir. 1km downstream of the weir, during A82 flows, water temperature in the Upper Tideway are ~0.5 °C greater than during baseline conditions. This temperature increase is reduced heading downstream until approximately 6.5km, where temperatures begin to decrease compared to baseline conditions to a minimum of ~0.2 °C lower, reached 7km downstream. Here the temperature difference levels out until Putney Bridge where the water temperature difference slowly returns back to baseline conditions as it flows towards the end of the reach (25km). Similar trends in temperature differences are observed during M96 flows upstream of Richmond Weir, with higher temperatures observed during baseline conditions that decrease to baseline conditions until 4km downstream. Following these temperatures steady out at ~0.2°C greater than the baseline, before slowly returning to baseline conditions between 6-15km

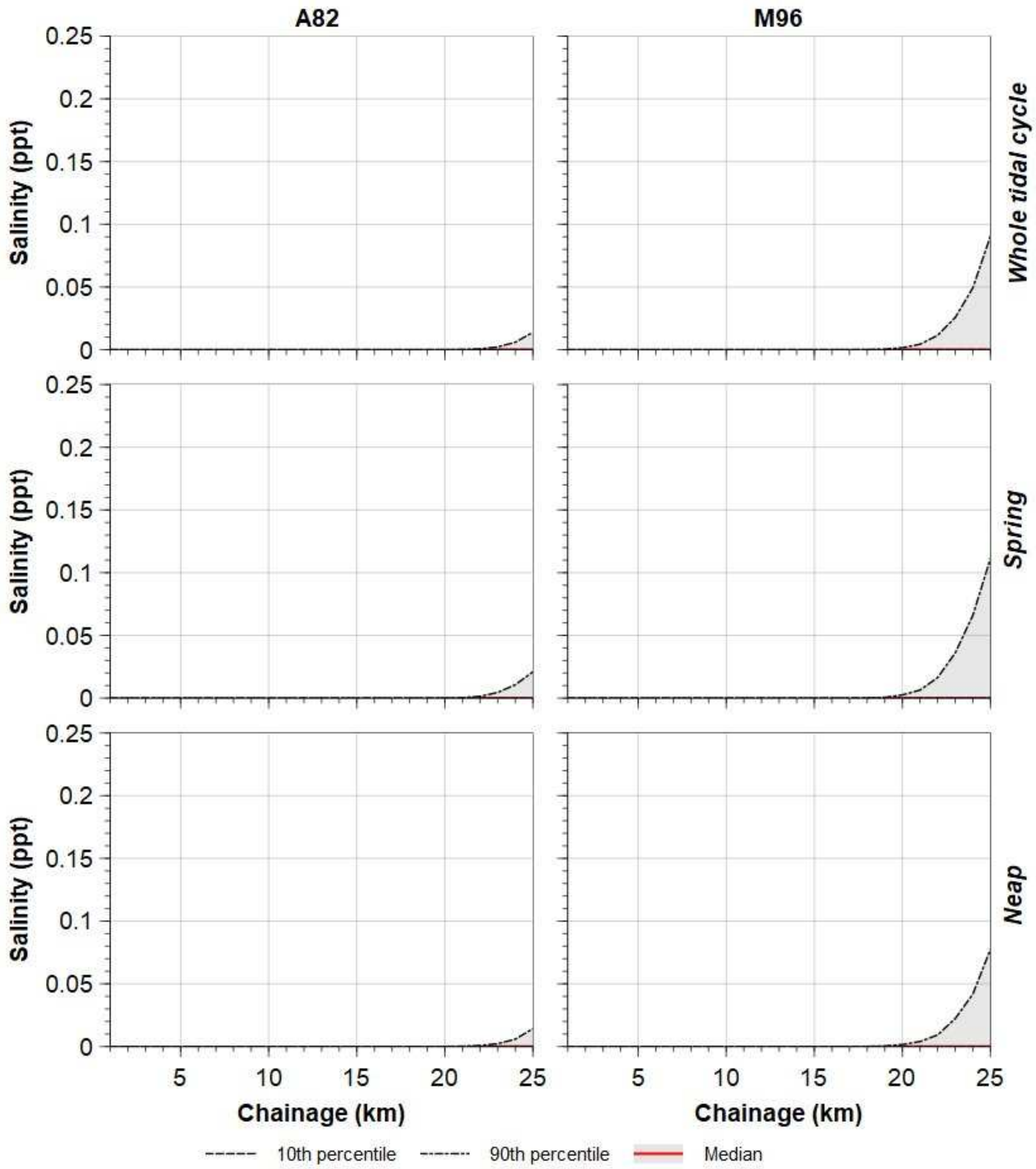
Plate A.49 Median water temperature change in the Upper Tideway under a 75Ml/d operation



Salinity

A.3.56 Plate A.50 shows the range of modelled salinity in the chainage of the 25km reach from 0km (Teddington Weir) during the Project operation (75Ml/d) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

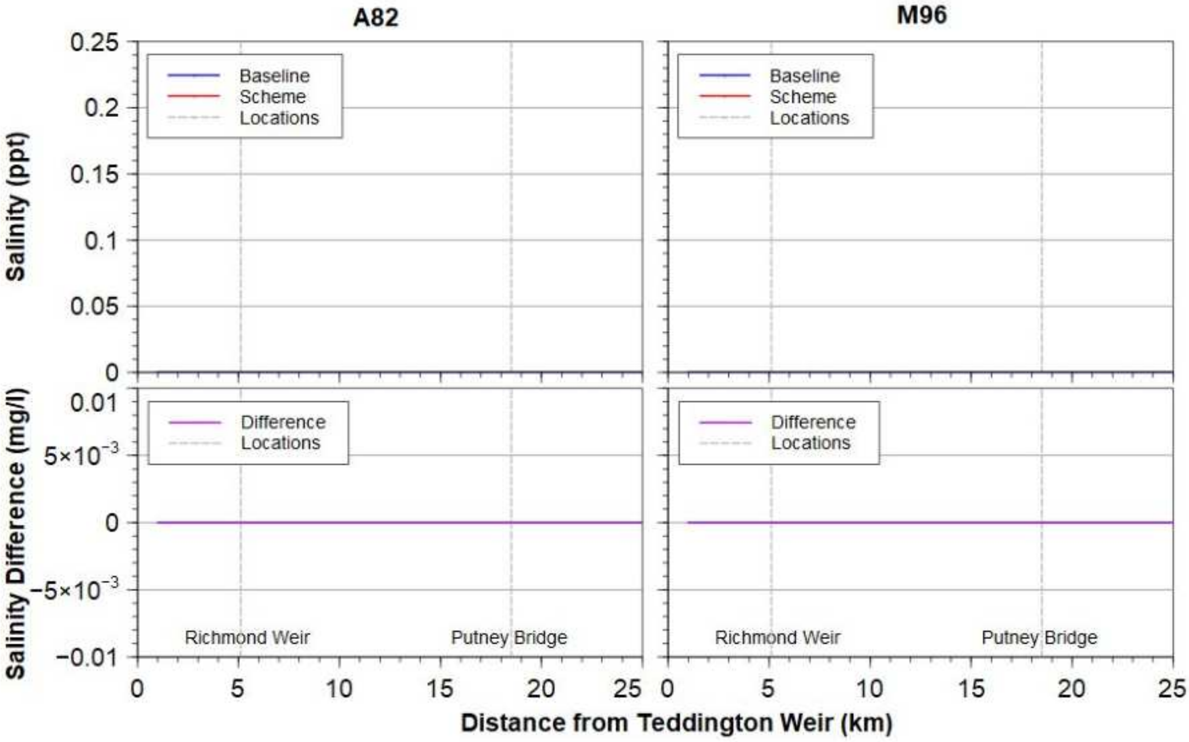
Plate A.50 Salinity during 75Ml/d operation for A82 and M96 scenarios



A.3.57 The salinity data show median baseline and 10th percentile salinities are zero for all of the chainage of the 25km reach from 0km (Teddington Weir), with only the 90th percentile salinities showing increases after around 20km, increasing to ~0.01ppt for A82 and ~0.08ppt for M96. Spring tides show a slightly higher 10th percentile salinity of ~0.11ppt when compared to ~0.07ppt for neap tides.

A.3.58 The median (50th percentile) salinity across the entire tidal cycle during operation of the Project was compared against baseline conditions in the tidal River Thames. Plate A.51 shows that operation of the Project has negligible impact on salinity in the upper tidal River Thames. As median salinity was 0 for all 25km of the reach under baseline and operation conditions, no differences were observed between the two.

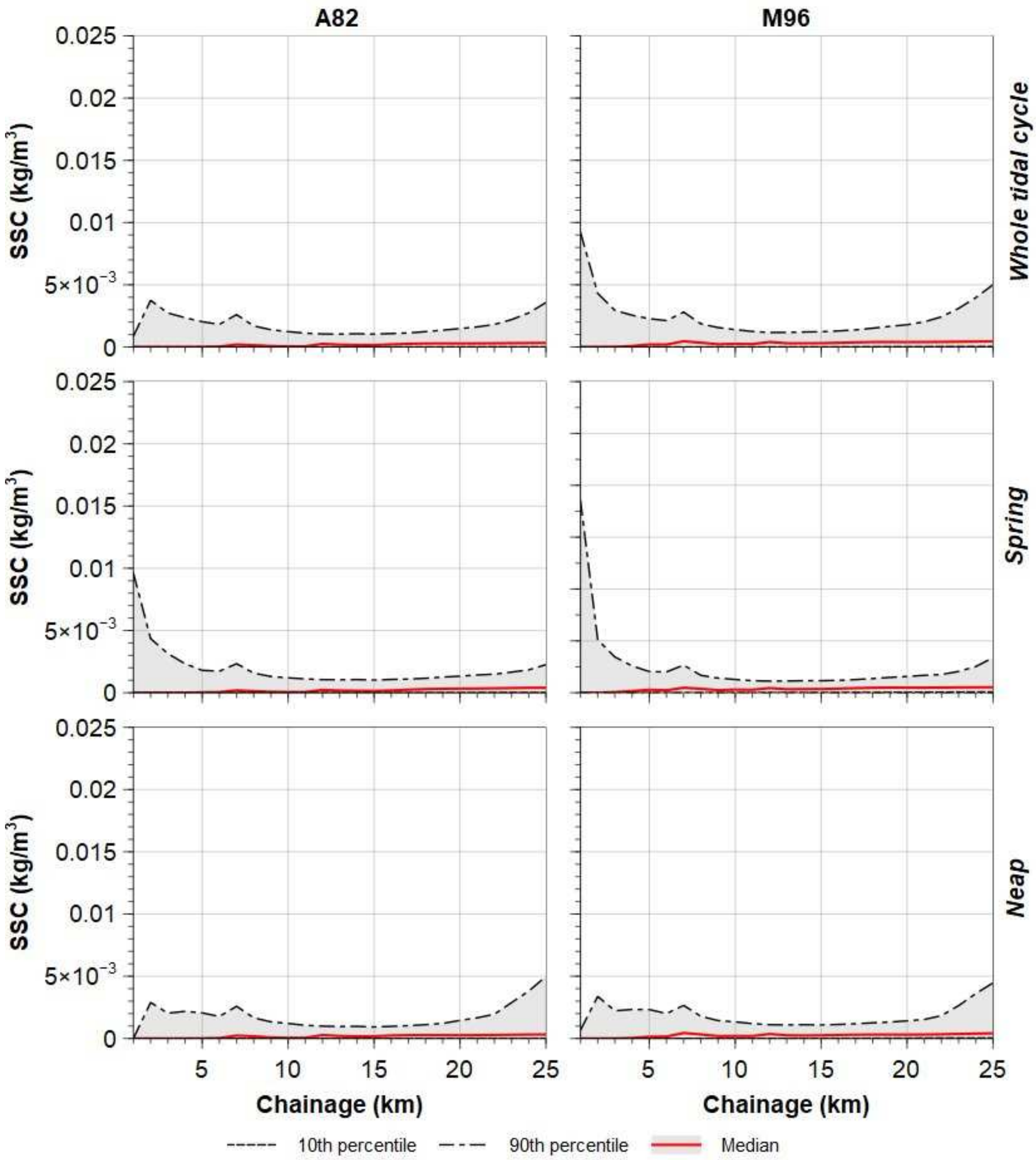
Plate A.51 Median salinity change in the Upper Tideway under a 75Ml/d operation



Suspended solids

A.3.59 Plate A.52 shows the range of modelled suspended solids in the chainage of the 25km reach from 0km (Teddington Weir) during operation of the Project (75Ml/d) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

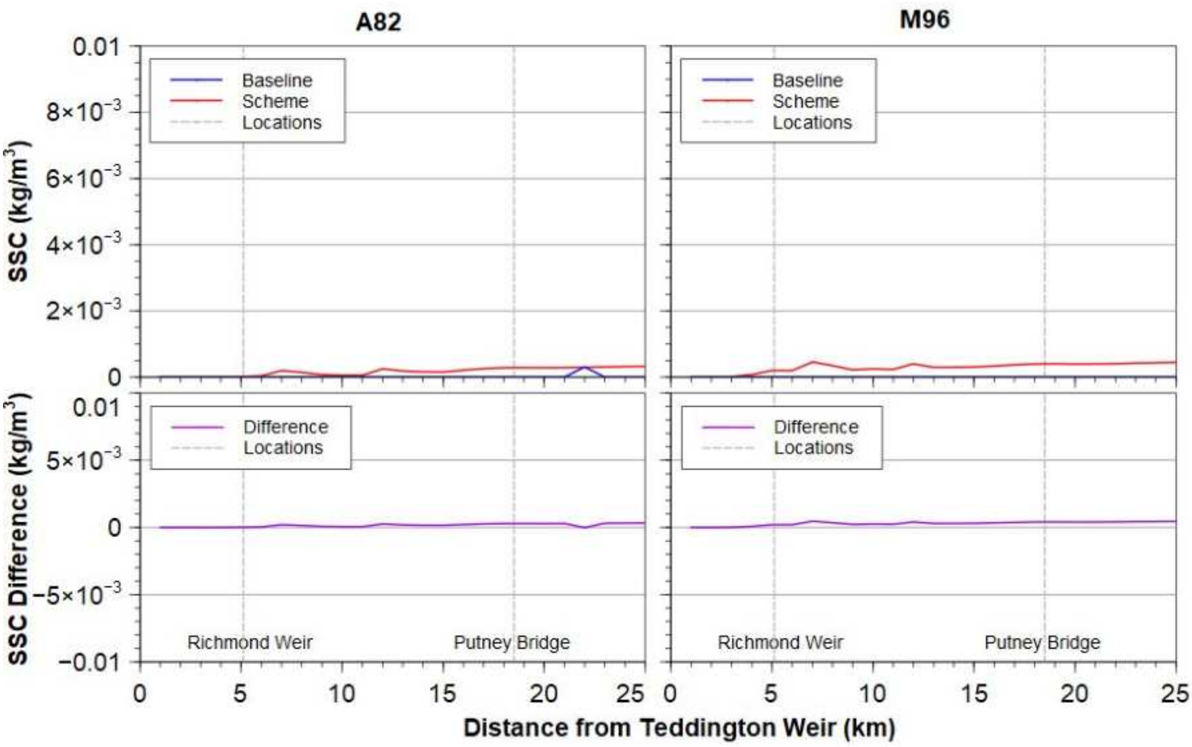
Plate A.52 Suspended solids during 75Ml/d operation for A82 and M96 scenarios



A.3.60 Plate A.52 suspended solids data show that 10th percentile suspended sediment concentrations are zero across the whole reach, with minor concentrations of suspended sediment up to 0.001kg/m^3 observed under median concentrations downstream of Mogden STW (6.2km). The majority of 90th percentile changes in suspended sediment concentrations are below 0.005kg/m3, with the exception of between 0-2km where concentrations peak at ~0.01-0.015kg/m^3 and decline towards 0.005kg/m^3 at 2km. The suspended solids data indicate very low concentrations over both A82 and M96 flows for all tidal states.

A.3.61 The median (50th percentile) suspended solids concentration across the entire tidal cycle during operation of the Project was compared against baseline conditions in the tidal River Thames. Plate A.53 shows that operation of the Project has minimal impact on suspended solids in the Upper Tideway. As the median suspended solid concentrations remained ~0 for the entirety of the chainage of the 25km reach from 0km (Teddington Weir) under baseline conditions, differences between the baseline and the Project can be equated to suspended solid concentrations under operation of the Project, with concentrations up to 0.001 kg/m^3.

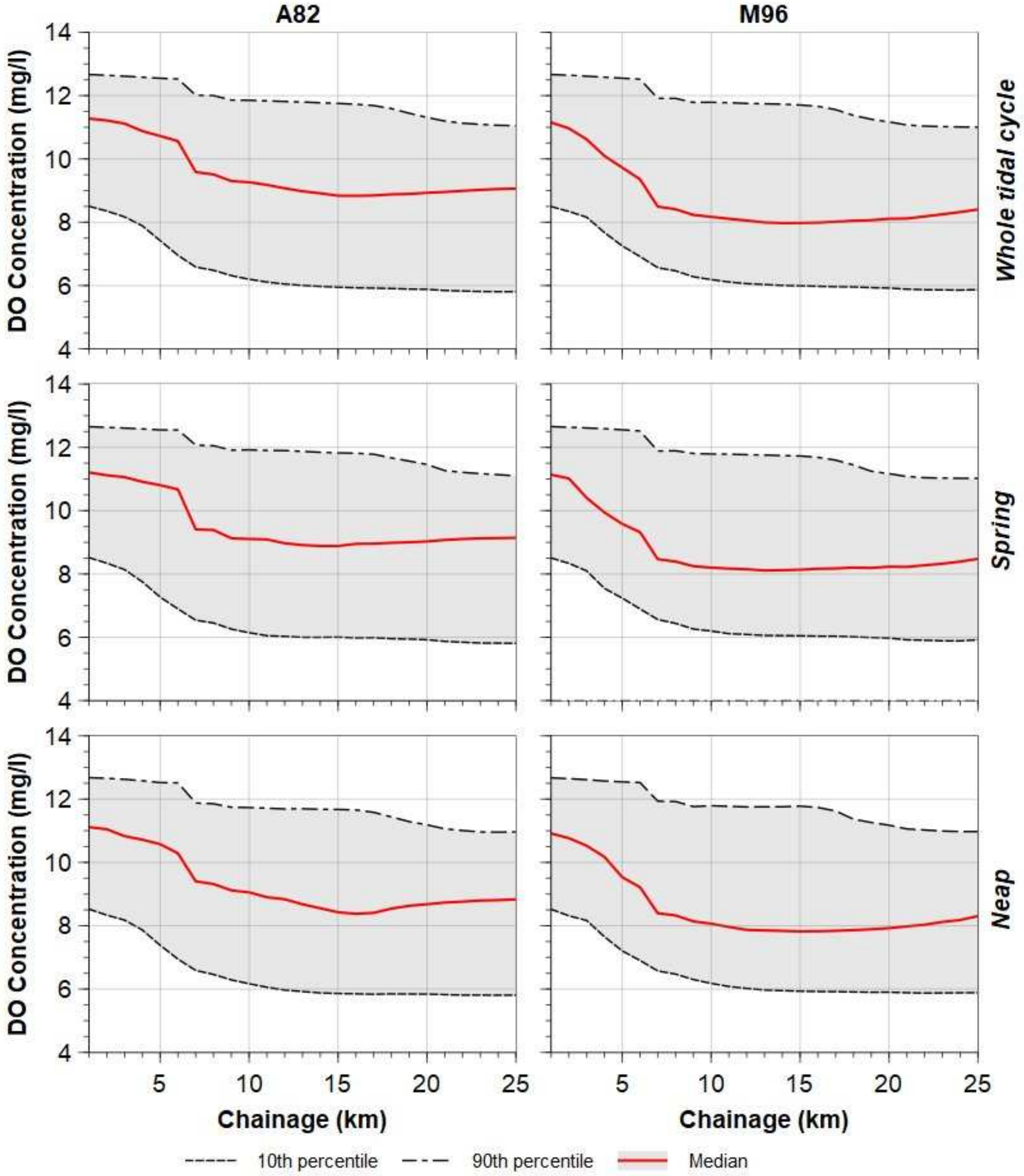
Plate A.53 Median suspended solids change in the Upper Tideway under a 75Ml/d operation



Dissolved oxygen (DO)

A.3.62 Figure A.54 shows the range of modelled DO concentration in the chainage of the 25km reach from 0km (Teddington Weir) during operation of the Project (75Ml/d) for the A82 and M96 flows under the whole tidal cycle, springs and neaps.

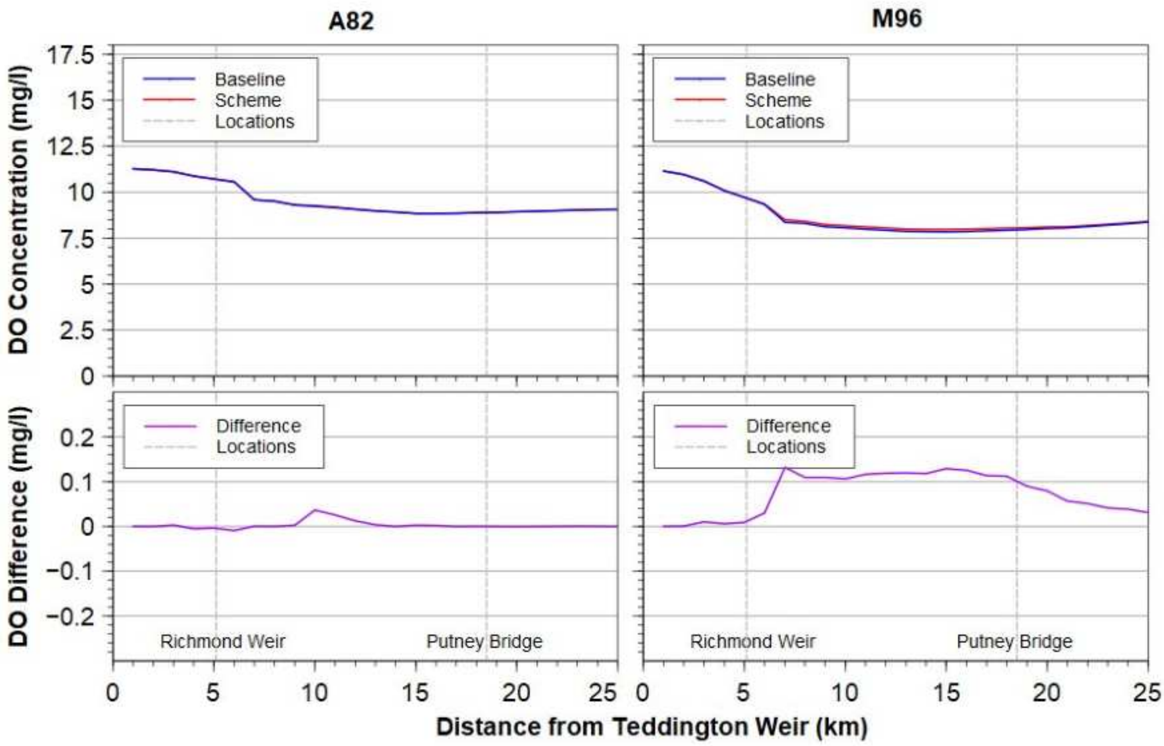
Plate A.54 Concentration during 75Ml/d operation for A82 and M96 scenarios



A.3.63 The median DO concentration for A82 flows shows an initial value of ~11mg/l, declining toward 6km, followed by a drop to ~9mg/l at 7km and remaining around this value for the rest of the reach. For the A82 flows, neap tides show slightly reduced median DO concentrations around 15km by up to 0.5mg/l. Baseline DO concentrations for the M96 flows follow the same trend as for A82 flows but median DO concentrations decline to ~8.5mg/l at 6km, followed by a decline to ~8mg/l around 10-20km, followed by a slight increase towards the end of the reach. Neap tides again show slightly reduced median DO concentrations when compared to spring tides. 10th and 90th percentile DO concentrations show similar ranges for both A82 and M96 flows for all tidal states.

A.3.64 The median (50th percentile) DO concentration across the entire tidal cycle during operation of the Project was compared against baseline conditions in the tidal River Thames. Plate A.55 shows that operation of the Project has minor impact on DO concentrations in the Upper Tideway. During A82 flows differences in DO under baseline and Project conditions are negligible for the entirety of the reach, with the exception of 9-13km downstream of Teddington Weir where DO concentrations are increased by a maximum of 0.02mg/l during operation of the Project. During M96 flows negligible differences in DO concentrations are observed upstream of Richmond Weir. DO data downstream of Richmond Weir (5km) indicates DO increases by ~0.1 mg/l between 7-18km, before gradually returning to baseline conditions towards the end of the reach. As such, the impacts of the Project are greater on DO conditions within the Upper Tideway during M96 flows than A82 but the change is small under both scenarios.

Plate A.55 Median dissolved oxygen change in the Upper Tideway under a 75Ml/d operation



Nutrient quality (dissolved inorganic nitrogen)

A.3.65 The impact assessment for the reduction in nutrient inputs to the tidal River Thames will be completed with the completion of the pilot plant assessment and results presented in the Environmental Statement.

Chemical dispersal

A.3.66 The impact assessment for the reduction in hazardous chemicals to the tidal River Thames will be completed with the completion of the pilot plant assessment and results presented in the Environmental Statement.

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Thames Water